

TESTING FAITH: A MIXED METHODS STUDY INVESTIGATING THE RELATIONSHIP
BETWEEN PRAYER AND TEST ANXIETY AMONGST COLLEGE STUDENTS

A Dissertation

Presented in Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy

with a

Major in Educational Leadership

in the

Department of Graduate Education

Northwest Nazarene University

by

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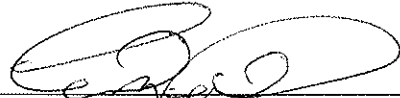
April 2016

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AUTHORIZATION TO SUBMIT DISSERTATION

This dissertation of Drey Campbell, submitted for the degree of Doctor of Philosophy in Education with a major in Educational Leadership and titled "Testing Faith: A Mixed Methods Study Investigating the Relationship Between Prayer and Test Anxiety Amongst College Students," has been reviewed in final form. Permission, as indicated by the signatures and dates given below, is now granted to submit final copies.


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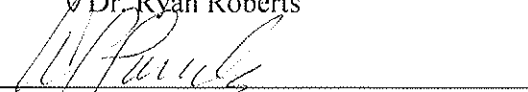
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ACKNOWLEDGEMENTS

I would like to acknowledge my Lord and Savior Jesus Christ. It is only with God that I have anything and am able to do anything. There are many people that have helped me along the way, including my wife, my friends, my dog, and my family. Above all though, the Lord created them, so he is the first and only one to give credit to. God, thank you for being my light and my salvation.

DEDICATION

I dedicate this dissertation to anyone who suffers the awful effects of test anxiety. May the efforts in this paper give you an option for peace.

ABSTRACT

Test anxiety is a problem that affects college students. Explanatory mixed methods research was completed with the objective of understanding the interrelationship of prayer and test anxiety as well as the potential therapeutic effects of Christian prayer on test anxiety. It was hypothesized that Christian prayer would have significant effects on the reduction of physiological test anxiety biomarkers of salivary cortisol (SC), salivary alpha amylase (SAA), and heart rate (HR). The framework of the cognitive attentional theory (CAT) of test anxiety was used as a lens to gain insight into the phenomena of test anxiety and the use of prayer as a hypothesized alleviating agent. Undergraduates among four different majors of study from a university in the Northwest United States were volunteer participants in the study. 48 participants were put into three 20-minute experimental groups to determine if a relationship existed between concentrated Christian prayer and test anxiety. The experimental groups were: Focused Christian Prayer, Guided Meditation, and Study Guide. In order to further understand the relationship of prayer and test anxiety, students were also grouped and analyzed by their scores on the Westside Test Anxiety Scale (WTAS) and their value of prayer in their lives. The mean age of the sample was 20.02 yrs old. SC and SAA were measured with Assay kits ordered from Salimetrics Company, and HR was measured using Gurin Santamedical SM-110 finger pulse oximeters. Two focus groups were conducted to help explain the quantitative data gathered. Results from the quantitative research did not clearly show that prayer is more effective than meditation or study guide to alleviate biomarkers of test anxiety. Quantitative results did suggest that students who valued prayer higher in their lives experienced less

biomarkers of test anxiety. Nine qualitative themes from the two focus groups emerged to help shed light on the findings of the quantitative data. The unique interrelationship of prayer and test anxiety is discussed. More studies on the phenomena of prayer and test anxiety are supported.

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Chapter I

Introduction

Statement of the Problem

College students experience a plethora of stressors while pursuing their educational success (Hurst, Baranik, & Daniel, 2013; Robotham, 2008). One of those stressors is test anxiety. Test anxiety starts in elementary schools, where higher standards are placed on both children and the schools they attend (Casbarro, 2004; Huberty, 2010; Zeidner, 1998). Elevated standards for schools can often equal more evaluative testing, and more testing can then equate to more test anxiety for students--with some students being shown to be unable to sleep the evening before a test and/or even vomit on the test day (Casbarro, 2004; Huberty, 2010). As students progress, they can be plagued by the idea that graduation requires high performance on standardized testing, which causes repeated situational anxiety that has the potential to lead to long term low self confidence, low motivation for school work, and overall poor school performance (Huberty, 2010; Onyeizugbo, 2010; Salend, 2011).

Evaluative testing continues through each level of school all the way into college, with testing occurring frequently among a variety of classes. Acre-Medina and Flores-Allier (2012) studied the stress that young adults feel when they applied to be admitted to public universities and found that many students were not properly taught how to cope with test anxiety, which affected their application to and success in college. Some anxiety is said to be normal for students, and can even be helpful for testing--but too much can be disadvantageous (Cizek & Burg, 2006). According to a recent comprehensive book published on testing anxiety, due to the large emphasis on testing in universities, test anxiety is one of the challenges facing students in each field of study (Zeidner, 1995). Test anxiety has been revealed to impact a substantial

number of college students (Chappell et al., 2005). Research shows that test anxiety impacts 25 to 40 percent of students (Cassady, 2010; Huberty, 2010). Studies have shown that testing anxiety is not an imagined psychosomatic disorder, rather, it is an often-debilitating set of physiological and cognitive factors that affect performance by drawing attention away from the evaluative task (Hagtvet, 1983; Loupus, 2008; Morris & Liebert, 1970; Sarason, 1975; Wine, 1971; Zeidner, 1998). Different researchers have shown that self-reported test anxiety is related to negative test performance in both educational and work environments (Ackerman & Heggestad, 1997; Hembree, 1988; Seipp, 1991).

Test anxiety is visible in modern publications due to its prevalence in society. In a publication by Salend (2011), test anxiety was brought to real life with student's personal accounts:

- "I'm ok until I get in the room. Everyone is talking about the test and what they studied and what they think will be on the test. It makes me so nervous, and I start to freak out."
- "I'm working on the test and then when I encounter something I'm not sure of, I start to panic. My chest gets tight, my stomach starts churning, and I get sweaty, and feel overwhelmed. I don't care about the test or how I do on it. I just want to get it over with and get out of there."
- "I start to think about what will happen if I don't do well on the test and then things snowball and I lose my focus. Even if I know the answer, I start to blank out and struggle to find the right words to explain it or start to think about other things. As soon as I leave the room, I remember everything and can answer the questions" (Salend, 2011, p. 2).

Test anxiety has the potential to negatively affect student grades, graduation chances, opportunities for advancement, and college opportunities (Salend, 2011). Test anxiety is a

confounding factor for college students and detrimental to scholastic success. Several studies have been conducted on diverse ways to overcome test anxiety, from test anxiety support groups to physical exercise programs (Cohen, 1980; Damer & Melendres, 2011; Prato & Yucha, 2013; Topp, 1989). Learning how to focus and limit test anxiety can be a way for college students to increase performance in their pursuit of higher education (Hembree, 1988; Putwain, Woods, & Symes, 2010).

Individuals cope with stressors in their lives differently (Billings & Moos, 1981; Zeidner, 1995) and students have different options for limiting stress and anxiety in their educational efforts (Kondo, 1996; Cohen, 1980). Kondo (1996) explains that in most exam situations students may feel discomfort and want to avoid testing, but are expected to attend and use coping methods for anxiety. One way that people can select to relieve anxiety and stress in their lives is to connect with a higher power through prayer (Harris et al., 2005; Stanley, 2009). Hoge (1996) reported that 95% of American adults share a belief in God, and Gallup Polls indicated that 92% of American's believed in God (Gallup, 2011). Prayer is one method people use to concentrate on God and feel that they are connected with said God in their lives (James, 1902; Prayer, 2014). 83% of American's trust that God responds to prayers (DeJong, 2010) and according to the 2013 Gallup polls, 56% of Americans believe that religion can answer most or all of today's problems. 75% of Americans felt if more American's were religious it would be positive for American society (Gallup, 2013).

Prayer has been studied in a variety of disciplines, such as education, psychology, medicine, and sociology (Baesler, 2012). More recently, with the invention of brain scanning and heart rate measurement technology, prayer has frequently been examined (Borg et al., 2003; Stanley, 2009; Owen, Hayward, Koenig, Steffens, & Payne, 2011). Researchers have spent time

attempting to discover specific regions of the brain that are used in prayer (Beauregard, 2006; Schjødt, Stødkilde-Jørgensen, Geertz & Roepstorff, 2008) and the hypothetical ability of prayer to heal those whom are suffering from different conditions such as heart disease, head injuries, and/or anxiety/depression (Owen et al., 2011; Vannemreddy, Bryan, & Nanda, 2009).

Since test anxiety affects college students at an instrumental phase of their lives, the potential calming and centering effects of prayer on test anxiety are essential. Research on meditation, relaxation, and eastern prayer on anxiety reduction exist (Dehghani et al., 2012; Prato & Yucha, 2013), but a study on prayer's effect on test anxiety levels in university students has not been conducted. One of the reasons there are limited studies on prayer in relation to test anxiety is because prayer is a difficult term to clearly define (Bade & Cook, 2008). Prayer is unique and personal for each person that engages in it, and varies across different religious contexts (Finney & Maloney, 1985; Giardini, 1987; Levin & Taylor, 1997; Pargament, 1990).

For the purpose of this study, the term and phenomenon of focused Christian prayer will be utilized. Focused Christian prayer is a method that believers in the life and resurrection of Jesus Christ use to stay in concentrated communication with God, who shows Himself and speaks to humans through Jesus and the books in the Holy Bible (Constable, 2003). Christians believe to experience a personal relationship with God and are able to seek help and reassurance directly from Him, feeling as if God is an advocate or trusted friend, which can make personal stressors easier to manage (Pargament, 1997; Poloma & Gallup, 1991). Although not all college students may understand that prayer is an option, it can be assumed that students attending Christian universities would be likely to use prayer as a source of strength (Baesler, 2009; Helping students keep the faith in college, 2013).

Coping with examination situations is an area of study in test anxiety research (Stober, 2004) and there is a strong appeal to study the effects of prayer on testing anxiety in college students, since it has been shown that attention to prayer is linked to increased mental health (Larson & Larson, 1991; Poloma & Gallup, 1991). Neuroimaging studies have shown persistent negative thoughts can be changed with directive mental efforts (Schwartz, Stapp, & Beauregard, 2005) and the belief in a God who comforts in times of need provide hopefulness and optimism (Poloma & Gallup, 1991). The time for examination of focused Christian prayer as a means to lower test anxiety is at hand since researchers are advising faculty and staff to help promote ways for college students to handle stress (Hurst, Baranik, & Daniel, 2013). According to Robotham (2008), the “key role for higher education institutions in relation to stress is the provision of appropriate resources to enable individuals to deal with stress” (p. 7).

Stories of college students using prescription, legal, and illegal drugs to self-medicate for problems with anxiety/stress during the college years are prevalent, with illicit drug use among Americans over the age of 18 being 23.9 million persons in 2012 (U.S. Department of Health and Human Services, 2012). Donahue and Benson (1995) revealed a correlation in young adults between suicidality and the quantity of time spent in religious undertakings each week. The need for controlled studies on prayer is dire, since in educational and scientific spheres the issue of prayer is often put on the same level as hopefulness, pathological processes, and fantasy (Ellis, 1986; Ellis, 1988; Tart, 1992; Tart, 2002).

If prayer is studied and shown to be an effective method to limit test anxiety, additional studies about the benefits of Christian prayer become necessary. If more studies about Christian prayer are conducted, the suggestion for more students to use non-harmful ways to relieve stress and anxiety in the college experience can be directed. Since college is often a time for students

to define motives, identities, preferences, and goals (Markus & Kitayama, 2003), the research of prayer as a way to help with test-related anxiety may lead students to developing life changing habits limiting overall stress and increasing well-being (Harris, Schoneman & Carrera, 2002).

Research Questions

Research questions are used to fully explore a topic and the relationships between variables (Crewell, 2012). The drive of this research is to study a relatively unexplored topic worthy of investigation (Boelens, Reeves, Replogle & Koenig, 2012; Ellison, Burdette & Hill, 2009; Haas, 2007; Harris, et al., 2002; Roberts, Ahmed, & Hall, 2000; Tisdell, 2000). Many studies have been conducted on different types of prayer and differing ways of decreasing test anxiety independently, but at this point, there has not been a study aimed at determining the effect of focused Christian prayer on test anxiety. Since there is research showing test anxiety can negatively affect student outcomes, (Chappell et al., 2005) the proposed questions in this study will attempt to determine if there is an impact of Christian prayer on students levels of test anxiety. The two central research questions for this study are:

1. Is there a difference in the physiological responses to test anxiety of students who use focused Christian prayer compared to students who meditate or use a study guide?
2. How do college students believe focused Christian prayer impacts test anxiety?

The first research question is examined with quantitative methods—analyzing the salivary biomarkers of heart rate, salivary alpha amylase and salivary cortisol and three different independent variables (experimental groups, Westside Test Anxiety Scale scores, prayer value).

The second question is looked at quantitatively with two focus groups. The breakdown is shown below.

Table 1

Research Questions

Research Question:	Variables:
R1.1: What is impact of Christian Prayer, Meditation, and use of a study guide on test anxiety as evidenced by changes in heart rate, Salivary Cortisol, and Salivary Alpha Amylase?	dV's: HR, Salivary Cortisol Levels, Salivary Alpha Amylase Levels iV's: Exp. Group
R2: How do college students believe focused Christian prayer impacts test anxiety?	N/A

Theoretical Framework

The purpose of a theoretical framework is to provide the researcher with a guide for understanding phenomena and conceptual mechanisms in a study (Ravitch & Riggan, 2012). It is a way to understand the history of the topics being addressed, as well as a key for moving forward into uncharted territory. The framework that has been selected for this dissertation is the Cognitive Attentional Theory (CAT) of test anxiety, as created and built upon by prominent researchers in the field of test anxiety (Culler & Holahan, 1980; Weinstein, Cubberly, & Richardson, 1982; Sarason, 1980; Wine, 1971). The point of the theoretical framework in this study is to guide the understanding of test anxiety as a cognitive attentional phenomena that impacts students taking part in evaluations (Mandler & Sarason, 1952; Wine, 1971). The Cognitive Attentional Theory is used to conceptualize how the use of prayer, as a way to focus cognitive attention and provide hope, could be used to decrease test anxiety in university students. The CAT is based on the premise that students who are impacted by high test anxiety are primarily influenced by their lack of attentional focus and unique distracting thoughts while being evaluated (Meichenbaum & Butler, 1980; Sarason, 1972, 1980, 1984, 1988; Wine, 1971,

1980). According to Wine (1971), during testing, students with elevated levels of test anxiety focus inward on themselves, which interrupts their capacity to focus on the testing. According to the assumptions of the CAT framework, teaching students to focus on a concentrated Christian prayer before a testing situation may have the ability to lessen the experience of test anxiety for students. The theoretical framework and implications therein will be more fully explored in the following chapter.

Research Definitions

In order to fully understand the current study, it is essential to grasp the terms related to the research. A more complete understanding of research is gained when terms are defined for the chosen study according to Creswell (2012). Creswell (2013) adds that clarity is also gained by assigning definitions to research terms. The following terms are defined based on research.

- **Anxiety:** Anxiety is a subjective condition that affects both the physiological and emotional processes. Responses to anxiety include, but are not limited to, worry, nausea, tension, increased heart rate, perspiration, confusion, distractibility, and panic (Sarason, 1980; Spielberger & Diaz-Guerrero, 1986; Whitmore, 1987) Anxiety can be conceptualized as either trait anxiety, which is generalized anxiety, or state anxiety, which is situation specific (Huberty, 2010; Spielberger, Gorsuch, & Lushene, 1970).
- **Test anxiety:** Test anxiety can be understood as a subjective state during evaluations (Pekrun et al., 2004) that produces a disruption of concentration though physiological and mental stimulation where fear of failure or negative consequences is present (Liebert & Morris, 1967; Morris & Liebert, 1969; Spielberger & Vagg, 1995; Wine, 1971; Zeidner, 1998).

- **Multidimensional construct:** A multidimensional construct is the understanding that an item is made up of multiple parts or dimensions. For the purpose of the research, test anxiety is understood as a multidimensional construct (Zeidner, 1999) that has both biological and cognitive components (Morris & Liebert, 1970). Test anxiety is understood as a cognitive variable that has physiological aspects (Sarason, Sarason, & Peirce, 1990).
- **Cognitive Attentional Theory (CAT):** This is the framework for this dissertation study. The CAT concentrates on the thought-process dimension of test anxiety. Developed by multiple researchers (Mandler & Sarason, 1952; Wine, 1971), it is the idea that test anxiety is initiated when thoughts related to the actual material of an evaluation are overrun with negative thoughts concerning performance, perceptions, and fears. These negative thought processes are distracting to students and derail concentration, which leads to poor results and reinforcement of said test anxiety.
- **Prayer:** The word “pray” originates from the word precari in Latin, which means to entreat or to ask (Das & Anand, 2012). Prayer has since been defined in many different ways, since it is a term that can be used among a plethora of different contexts and cultures (Finney & Maloney, 1985; Giardini, 1987; Levin & Taylor, 1997; Pargament, 1990). In a study by Hood, Spilka, Hunsberger, and Gorsuch (1996) it was determined that there is overlap in the way prayer is described. James (1904) gave a generalized and well-accepted definition of prayer, defining it as every kind of internal communication with a power recognized as divine. The point of that communication is to create meaningful relationship with the deity being prayed to (Park, 2005; Silberman, 2005). Stanely (2009) defined prayer as different than meditation in that it is singularly focused

on God and losing oneself into God through love and grace. Das and Anand (2012)

further express that prayer can be either individual or in groups, and is an essential tool of spiritual practice.

- **Christian Prayer:** A method of prayer that followers of Jesus Christ use to stay in communication with God, who shows Himself and speaks to humans through Jesus and the books in the Holy Bible (Constable, 2003). Christians, through this prayer, experience a personal relationship with God and are able to seek help and reassurance directly, feeling as if God is an advocate or trusted friend (Pargament, 1997; Poloma & Gallup, 1991; Stanley, 2009). Prayer has been shown to be desired by Christians in mental health treatment settings (Weld & Eriksen, 2007).
 - **Focused Christian Prayer:** For the purpose of this study, the term focused Christian prayer is used frequently. As stated, prayer is diverse and can be defined in many different ways (Finney & Maloney, 1985; Giardini, 1987; Harris et al., 2005; Levin & Taylor, 1997; Pargament, 1990). Some prayer types are less focused and more meditative, with the person praying not going in any particular direction, but concentrating on the feeling of God's presence (Breslin & Lewis, 2008; Pargament, 1997). Since the framework for this dissertation is based on cognitive attentional functioning, focused Christian prayer is a type of prayer that has been coined by the researcher as a way to address the diversity of differences of prayer. For the purpose of this study, focused Christian prayer is defined as a prayer that is intentionally focused on God/Jesus Christ. One example would be reading the Lord's Prayer found in the book of Matthew in the Holy Bible (Matthew 6:9-13, New International Version). The act of reading the prayer out

loud in the moment requires concentrated devotion, which addresses the concentration difficulties that the Cognitive Attentional Theory proposes (Wine, 1971).

- **Meditation:** Meditation can be either sacred or secular and is a form of focused self-regulation of the body and thoughts in the mind, which can help a person gain awareness and foster well-being and less stressful states (Haynes & Zabel, 2004).

Significance of the Study

College students experience test anxiety, which can have a negative impact on academic performance (Chappell et al., 2005; Salend, 2012, Onyeizugbo; 2010). There is evidence that prayer can help with many of life's stressors and can lead to healing (Breslin & Lewis; 2008; Boelens, Reeves, Replogle & Koenig, 2009; Stanley, 2009; Vannemreddy, Bryan & Nanda, 2009; Whittington & Scher, 2010). Researchers who have completed studies on test anxiety and prayer individually have suggested that more research needs to be done on each topic. According to Tisdell (2000), until recently, except in adult religious education, spirituality has not been given much attention. Harris, Schoneman, and Carrera (2002) expand on this, expressing that literature, to date, on prayer and anxiety is unclear. Roberts, Ahmed, and Hall (2000) examined multiple studies on the use of prayer to alleviate ill health and found results to be inconclusive. Roberts et al. (2000) reported that studies showed few completed trials on the value of prayer. It was concluded that the evidence presented thus far is stimulating enough to rationalize further study of prayer (Boelens, Reeves, Replogle & Koenig, 2012; Roberts, Ahmed & Hall, 2000). Ellison, Burdette, and Hill (2009) echoed this by demonstrating links between religion, stress, and mental health remains understudied, especially in relation to anxiety. Ellison et al. (2009) indicated meditation induces physiological changes and prayer/meditation engage the same

mechanisms; thus showing a need to keep testing prayer. Haas (2007) reported that prayer, although directed at a spiritual/supernatural being, is accessible to scientific investigation. Haas (2007) stated that the mind is the center of thought and not all of our thoughts are verbal. The researcher affirmed that to attempt and gather evidence of prayer actually being heard by God is done so by testing if prayers are trailed by what was requested in them. Haas (2007) argues only accurate scientific analyses can deliver reliable confirmation by eliminating coincidental occurrences and predispositions from the outcomes.

Studying coping techniques that help students alleviate the effects of test anxiety can promote adjustments in student behaviors (Zeidner, 1998). Many different methods have been attempted to reduce test anxiety, thus showing a concentrated effort to reduce the disruptive occurrence (Ahern & Norris, 2011; Damer & Melendres, 2011; Jonson, 2013; Plante, Marcotte, Manuel, & Willemsen, 1996; Prato & Yucha, 2013; Topp, 1989). Since students suffering from test anxiety are negatively affected by not being able to focus on the task at hand (Wine, 1971), examining potential methods to decrease test anxiety is necessary. With the ability to change negative thought processes through concentrated efforts being shown (Schwartz, Stapp, & Beauregard, 2005), a study of the effects of focused Christian prayer as one form of test anxiety reduction is supported (Tloczynski & Fritzsich, 2002). At this time, the researcher has found no reported cases measuring the effect of prayer, or focused Christian prayer, on test anxiety. This is one niche of the field that is yet to be explored. There is a need for a more robust understanding of the benefits of Christian prayer and its potential to help with college stressors such as testing anxiety.

Currently there is a need for unique methods to reduce test anxiety since testing demands are consistently being placed on college students (Robotham, 2008) and increased test

performance has been shown to increase student self-efficacy (Onyeizugbo, 2010). At this crossroad of exploration is the study of the effects of Christian prayer on test anxiety. If the study were found to yield significant results, then more studies on the benefits of Christian prayer in relation to anxiety or other stressors could be conducted. It has also been shown if students were to find a technique to be effective as well, they would be more likely to use it and encourage peers do so (Hughes, Gourley, Madson, & Le Blanc, 2011). Different specific types of prayer may be analyzed for their exact effects on testing anxiety and prayer could be studied as a way to alleviate other forms of stress/anxiety. This research adds to both fields of study and opens the doors for potential studies to expand our understanding of both prayer and test anxiety in college students and other populations.

Overview of Research Methods

Data for test anxiety was collected in two unique ways since multidimensional assessments of anxiety are supported in literature (Loupos et al, 2008). Quantitative data was first collected on physiological measures of anxiety. Fingertip heart rate monitors from Gurin, known as the Santamedical SM-110 finger pulse oximeter measured student heart rates. Salivary cortisol and alpha amylase were measured with saliva testing kits from a company named Salimetrics. The physiological measures were taken from three different groups: focused Christian prayer, meditation, and study guide. Qualitative data was collected from two focus groups about test anxiety in relation to prayer.

The methodology chosen for this study was an explanatory sequential mixed methods design (Creswell, 2012). This study is one with a quantitative approach, followed by a qualitative approach. Ivancova, Creswell, and Stick (2006) are proponents of mixed methods studies, since they offer a unique way to gather information on a topic. Mixed methods designs

are said to be conceptually more complex, since they may provide a basis for triangulation and unique ways of conceptualizing the problem (Spratt et al., 2004). The reasoning for this type of design is for the qualitative data to help explore the quantitative data further. The data collection went as follows:

- Quantitative Data Collection
- Quantitative Data Analysis
- Qualitative Data Collection
- Qualitative Data Analysis
- Incorporation/Triangulation of the Quantitative and Qualitative Outcomes

The participants for the study were 48 college students from a Christian University in the Northwest United States. Participants were selected randomly from four different undergraduate fields of study and testing was conducted in a lab setting on the college campus.

Students from the four different disciplines were offered the opportunity to take a test in which they could have a chance to win one hundred dollars. To purposefully increase test anxiety, students were informed that all scores would be posted in a public arena, and that the top scores would be paid two separate one hundred dollar prizes.

To determine baseline biomarker readings, students were measured for their heart rates, salivary cortisol, and salivary alpha amylase independent of a pre-informed testing evaluation one week before the evaluation measurements. In order to determine student test anxiety levels, during the first meeting, the Westside Test Anxiety Scale (WTAS, see Appendix L pt. 4) (Driscoll, 2004) was administered. Based on the scores, students were then separated into four different groups:

- (1) 1.0—1.9 Comfortably low test anxiety

(2) 2.0—2.9 Normal or average test anxiety/High normal test anxiety

(3) 3.0—3.9 Moderately high/High test anxiety

(4) 4.0—5.0 Extremely high anxiety (Driscoll, 2004.)

Students were then categorized based on their scores on the WTAS, and randomly placed into one of three groups in order to diversify each group sample (shown below). For the three groups, each set of students were evaluated for physiological symptoms of anxiety by heart rate, salivary cortisol, and salivary alpha amylase. Heart rate was taken before any indication of testing, upon notification of testing, and then after the experimental conditions. Saliva was collected in symmetry with each heart rate measurement. For the experimental condition, each group was given twenty minutes for either a focused Christian prayer time, a guided meditation time, or time to review an IQ test study guide. The three groups were as follows:

- Group 1: HR Measured/Saliva taken, twenty minute introduction period, Notification of testing, HR Measured/Saliva taken, twenty minutes broken into a time for different types of focused Christian prayer, HR Measured/Saliva taken.
- Group 2: HR Measured/Saliva taken, twenty minute introduction period, Notification of testing, HR Measured/Saliva taken, twenty minute guided meditative time given, HR Measured/Saliva taken.
- Group 3: HR Measured/Saliva taken, twenty minute introduction period, Notification of testing, HR Measured/Saliva taken, twenty minutes time given for examination of prepared IQ test study guide, HR Measured/Saliva taken.

An extra question was added after the WTAS to determine the importance of prayer in student's lives. Students were asked if prayer was very, somewhat, or not important at all in their lives. Based on the data gathered from this question, two focus groups were created. One

focus group of 7 students was created from the students who reported prayer to be Very Important in their lives. Another group of 4 students was created from students who reported prayer to be somewhat important in their lives. Zero of the three students who reported as unimportant agreed to participate in a qualitative focus group.

SPSS was used to analyze the quantitative data in the study. An analysis of variance with post-hoc analyses were used to determine statistical differences of HR, SC, and SAA between the three different experimental groups, the WTAS groups, and prayer value groups (Creswell, 2012). A supposed relationship between focused Christian prayer and reduced test anxiety was sought. Two qualitative focus groups were conducted in a research lab on campus. The two focus groups of students were recorded on two different devices and transcribed. Coding was used to determine themes and the data was examined. Examining the results of the qualitative data and applying the subjective themes from the qualitative interview process helped to provide an explanatory context to the quantitative data.

Chapter II

Review of Literature

Introduction

Millions of students around the world will be accepted into college this year (Guay, 2005) and according to a report by Achieve, Inc. (2004), it was found that colleges and employers are requiring more of high school students than they have in previous times. Beginning from a young age, testing has been the choice of educational systems as a way to evaluate performance (Segool, Goforth, Carlson, Von der Embse, & Barterian, 2013). This evaluation process forms the path that leads students to their academic institution of choice. Some students go through testing with no problems, but many students are impacted by the anxiety a testing scenario presents (Ackerman & Heggstad, 1997; Bonaccio & Reeve, 2010; Casbarro, 2004; Hembree, 1988; Onyeizugbo, 2010; Putwain, Woods, & Symes, 2010). Combined with the ever-present reality that college is a place of stress for students, test anxiety can have an impact on a student's success, which can lead to undesirable affects on student behaviors, emotions, and self-confidence (Hurst, Baranik, & Daniel, 2013; Salend, 2012). There is an array of information regarding test anxiety, but no one solution has been found to be entirely effective at this point in time. There is an opportunity at hand to study unique options for dealing with test anxiety.

Prayer is an approach people use to help cope with their anxieties in life and is a potential solution for limiting test anxiety (Dehghani et al., 2012; Laird, Snyder, Rapoff & Green, 2004). Prayer is a traditional ritual that is vital to all five world religions and billions of human beings (Geertz, 1973). According to Zeng (1996), seventy percent of prayers at an East Asian church were directed towards help on examinations. The effects of prayer have been debated for many

years, and the fact that there are still studies being conducted indicates that the phenomena of prayer as a beneficial practice is currently relevant in academic arenas (Beauregard & Paquette, 2006; Benson et al., 2006; Boelens, Reeves, Replogle, & Koenig, 2009; Boelens, Reeves, Replogle, & Koenig, 2012).

The literature review progresses in a way to assist in the conceptual understanding of test anxiety and prayer, within the scope of the Cognitive Attentional Theory (CAT). The figure below is a road map of the literature review to follow.

Figure 1

Literature Review Road Map

Test Anxiety	Prayer
Growing up with Testing	Understanding Prayer
Test Anxiety Among College Students	The Use and Benefits of Prayer
Understanding Test Anxiety	Prayer and the Brain
Test Anxiety as a Multidimensional Construct	Prayer and Anxiety
Physiological Test Anxiety	
Cognitive Attentional Theory of Test Anxiety	
Support of the Cognitive Attentional Theory	
Modern Theories of Test Anxiety	
Methods to Lower Test Anxiety	

Growing Up With Testing

Starting at a young age, children have more anxiety about testing in classrooms when compared to classroom settings where there is no testing (Segool et al., 2011). Beginning from

early years in school, testing is something that happens inside the classroom. Sarason (1959) expressed that we exist in a test-conscious/test-giving society where people's lives are partly determined by their performance on tests. Due to this determination, test anxiety has been shown to start in grade school and progress up through high school (Segool et al., 2013). The issue of increased anxiety throughout education needs to be addressed since Bateson et al. (2011) summarized multiple studies on cultural anxiety confirming long-term effects of increased anxiety in populations who have more perceived threats. Zeng (1996) showed that the culture of exams can be ruthless and impartial sorting devices that justify social hierarchies, forcing parents pay considerable amounts of money to have priests pray for exam success for their children.

America has moved to the more standards and accountability in the educational environment, implementing nationwide Common Core State Standards in 1996 (Achieve Inc, 2015) and the No Child Left Behind (NCLB) Act of 2001 (NCLB; U.S. Congress, 2002). NCLB led to a significant surge of testing in each school level and increased the recompenses and occurrence of that testing (Segool et al., 2013). Common Core State Standards (CCSS) are a unique set of unverified academic benchmarks in Math and English, that, when adopted provide funding, but bring nationalized assessments and statewide data collection systems to individual states, teachers, and students ("What is Common Core?", n.d.). The CCSS are endorsed and maintained by the Council of Chief State School Officers and the National Governor's Association as a way to create constant achievement goals for students in order to make them more prepared to work in a globalized market (www.corestandards.org). The CCSS are academic standards that outline benchmarks for what students should know and be able to do by the end of different grade level ("Common Core: Myths Vs Facts", n.d.). One mother/educator from the Northwest voiced her opinion of the common core standards on her son.

It (CCSS) beats him down. It discourages him. It exhausts him. It makes him dread going to school and then lash out in anger at the nightly homework that is associated with these common core modules. It is turning him off of school and if this trend continues, he will be far from college and career ready because he will want nothing to do with college (“How Common Core is Slowly Changing My Child”, n.d.).

Multiple professionals have studied the insights that adults related to educational systems have regarding the use of national testing initiatives, and imply that high-stakes testing have elevated anxiety and stress in students while decreasing their motivation—and amplified job stress for teachers while lowering their job fulfillment (Abrams et al., 2003; Barksdale-Ladd & Thomas, 2000; Jones & Egley, 2004, 2006; Jones et al., 1999). This testing leads into the college experience.

Test Anxiety Among College Students

College students have diverse issues to work through during their educational experience, and many report having and wanting help with testing anxiety (Gallagher & And, 1992; Sarason & Mandler, 1952; Zeidner & Nevo, 1992). College is an important time of life for many people and much scholastic testing occurs during that time (Guay, 2005). Early studies on test anxiety indicated that highly anxious college students did poorly on intelligence tests, opposite of students with low anxiety that performed better (Sarason & Mandler, 1952). It was demonstrated that the amount of anxiety that students experienced varied among individuals, but was often felt during testing.

Test anxiety can be viewed as different than generalized anxiety and other anxiety disorders (Huberty, 2009). Test anxiety is understood to be an individual emotional state, felt before or throughout a specific assessment, relating to the act of finishing the assessment itself,

the risk of failing, and any associated undesirable moments (Bonaccio & Reeve, 2010). Research has shown students are anxious before a test even begins due to the perceived instrumentality of test results (Reeve, Bonaccio, & Charles, 2008). Hembree (1988) analyzed 562 studies and found that test anxiety instigated poor functioning, decreased student confidence, caused negative valuations, produced defensiveness, and related to other types of anxiety.

At this point in time, test anxiety in college is a notable issue (Arul-Lawrence, 2014; Gallagher & And, 1992). Arul-Lawrence (2014) completed a study of 300 higher education students and found that 75.3% of those surveyed had either high or moderate testing anxiety. Another study of 785 urban college students found that college students reported a need for much assistance while attending college in the areas of:

- Lessening depression
- Learning more focused test taking strategies
- Developing better time management skills
- Controlling anxiety and nervousness (Gallagher & And, 1992)

Test anxiety was the eighth highest ranked need for assistance and learning to control test anxiety was the fourth highest skill development concern (Gallagher & And, 1992).

Test anxiety is a concern since it has been shown to be detrimental to school success due to its affect on evaluation performance and self-esteem (Chappell et al., 2005; Onyeizugbo, 2010; Salend, 2012; Weinstein, Cubberly, & Richardson, 1982). Students from multiple universities were surveyed regarding Grade Point Averages (GPAs) and test anxiety levels, showing that graduate students and undergraduate students with high anxiety rates had lower GPAs (Chappell et al., 2005; Talib & Sansgiry, 2012). Talib and Sansgiry (2012) conducted research to identify factors related to university student academic performance. 199 students

were surveyed on different academic factors and results were analyzed. A low and high GPA group were established, setting the bar at a 3.0 GPA. Talib and Sansgiry (2012) found that students with low and high GPAs differed significantly on the factors of academic and testing competence, test anxiety, and time management skills. The researchers noted that test anxiety was a significant element related to academic performance. Talib and Sansgiry (2012) affirm that the higher a student's test anxiety, the more potential for a reduction in GPA.

One reason for the decreased success in evaluation settings is that test anxiety has been shown to impact attention and cognitive functioning (Caparos & Linnell; 2012; Meichenbaum, 1972; Wine, 1971). Students with high test anxiety are shown to have less active retrieval when answering essay/short answer questions. Naveh-Benjamin, McKeachie, Lin, and Holinger (1981) stated that, "Current theories of test-anxiety suggest that the major effect of anxiety in an evaluative situation is as an interfering agent" (p. 816). The study by Naveh-Benjamin et al. (1981) confirmed that performance on different types of questions was significantly poorer for highly test-anxious students. The study also revealed that test anxiety was negatively related to grade point averages and overall grades in college courses (Naveh-Benjamin et al., 1981).

Test anxiety not only affects school performance, but can have an effect on college student's mood as well. Stowell, Tumminaro, and Attarwala (2008) completed a study, which examined 50 highly anxious university students for an increase in their negative moods and salivary cortisol levels. Mood and salivary cortisol levels of students were measured before, during, and after a regular course exam and compared to the same students when they did homework only (Stowell et al., 2008). The Test Anxiety Inventory (TAI) was used along with different scales that measured mood and coping (Spielberger et al., 1978). The study grouped the testing anxiety management subscales into problem-focused, emotion-focused and evasion

management strategies. The study found that steady academic tests from a range of courses produced slight, but significant, alterations in negative dispositions of college students (Stowell et al., 2008). The study showed that managing anxiety by eluding testing worked as a cushion to keep students high in apprehension from experiencing more negative moods (Stowell et al., 2008). Comparable to findings by Pekrun et al. (2004), it was found that undesirable mood was peak prior to and through an exam, and that negative disposition was linked with somatic conditions on the day of the test (Stowell et al., 2008). A study by Onyeizugbo (2010) found that students who had higher success in academics had higher self-efficacy. Along with this, the professor from the University of Nigeria also found that student test anxiety was correlated with poor academic performance.

Understanding Test Anxiety

Many theories on test anxiety have been proposed since the 1950's. In order to first empathetically grasp the phenomenon of test anxiety, the symptoms and outcomes of test anxiety must be established.

In a publication by Salend (2011), a simplified chart was created to help conceptualize the possible physical, behavioral, and affective symptoms related to test anxiety. The chart is a visual way to comprehend the outreaching effects of test anxiety.

Figure 2

Possible Symptoms Associated With Test Anxiety

TABLE 1. Possible symptoms associated with test anxiety		
PHYSICAL SYMPTOMS	BEHAVIORAL SYMPTOMS	AFFECTIVE SYMPTOMS
Excessive perspiration	Difficulties with concentration, attention, and memory that interfere with: <ul style="list-style-type: none"> • Reading and understanding test directions and items • Retrieving words, facts, and concepts • Organizing thoughts and answers 	Making negative self-statements
Sweaty palms		Having pessimistic expectations (e.g., "I'm going to fail this test.")
Unexplained headache or stomachache	Performing poorly on tests when the content: <ul style="list-style-type: none"> • Has been studied • Has been mastered previously as demonstrated via nontesting performance assessment activities 	Being apathetic and unmotivated
Nausea		Negative comparisons of self to others (e.g., "I'm not as smart as others.")
Shaking body parts	Off-task behaviors such as inappropriate comments, fidgeting, squirming, pacing, staring, tapping, crying, and rapid speech during testing	Making excuses for poor test performance (e.g., "I don't do well on tests because I have test anxiety.")
Rapid heartbeat		Expressing avoidance and fear of testing situations
Dizziness and light-headedness	Asking numerous unnecessary questions about test	
Muscle tension	Experiencing repeated mental blocks and forgetting	
Tics	Feeling overwhelmed during testing	
Flushed skin color	Complaining about test items (e.g., "We didn't cover this in class.")	
Difficulty sleeping, eating, or using the toilet before tests	Seeking unnecessary assistance from others	
	Cheating on tests	
	Feigning illness and being absent on testing days	

Source: Salend, S.J. (2011, November/December). Addressing test anxiety. *Teaching Exceptional Children*, 44 (2), p. 61. © 2011 Council for Exceptional Children. Reprinted with permission.

Note. See Appendix B for permissions.

Looking at the chart by Salend (2011) helps to see how test anxiety affects students in a variety of ways. The diagram shows that test anxiety can lead to distracting physical symptoms such as shaking, tension, and increased heart rate. These symptoms then can lead to self depreciating thoughts which can be overwhelming during tests (Salend, 2011). Researchers as early as the 1950's explored why test anxiety affected students the way the diagram by Salend (2011) shows.

Test Anxiety as a Multidimensional Construct

A prominent researcher in test anxiety named Moshe Zeidner has been publishing in psychology books and has written scholarly articles on test anxiety for the last 25 years. According to Zeidner (1998), many academic models of test anxiety have been advanced including the drive model, the cognitive-attentional model, the skills-deficit model, the self-regulation model, the self-worth model, and the transactional model; but presently, there is no particular descriptive model that explains all of the convoluted factors that stimulate test anxiety or that is reliable with the bulk of test anxiety inquiry. Zeidner (1998) believes that test anxiety includes mental, biological, and behavioral responses that arise in association with apprehension about the negative results of perceived failure or lowly performance in testing situations.

Test anxiety is challenging to fully grasp, since it is both psychological and physiological (Sarason, 1984). Research has confirmed this, showing that test anxiety is physiological, including emotional arousal, and cognitive, including worry that interferes with the task (Lowe et al., 2008; Pekrun et al., 2004; Sarason, Sarason, & Pierce, 1990).

Early researchers in the field of test anxiety were the brothers Seymore and Irving Sarason. Seymore and Irving Sarason have shown that testing circumstances create a sense of internal threat for those facing test anxieties, and those anxieties disrupt attention and memory functions (Sarason, 1957; Sarason, 1959; Sarason, 1963; Sarason, Sarason, & Pierce, 1990; Sarason, Sarason, Pierce, 1995).

Some researchers believe test anxiety can be explained by two types of learned drives within humans competing during evaluation situations (Hagtvet, 1983; Morris and Liebert, 1970; Sarason, 1975; Wine, 1971). Those types of drives were either task-relevant or task-irrelevant. The responses defined as irrelevant were:

- worrying about performance of self and the performance of others
- fear of failing
- low confidence in self
- feelings of inadequacy
- loss of self-esteem
- heightened awareness of increases in their own autonomic nervous activity (Hagtvet, 1983; Morris & Liebert, 1970; Wine, 1971).

These findings and other research has consistently shown that behaviors of students with high-test anxiety are not focused on the task being evaluated; rather, anxious students focus on their internal symptoms that are irrelevant to task completion (Sarason, 1975). Thus, students who are anxious do not focus on necessary aspects of testing, which can result in poor performance (Sarason, 1975). The attention on task-irrelevant items instead of on the actual test is both physical and cognitive. Physically, test anxious students concentrate on their body's response to the test anxiety itself:

- heart beat
- muscle tightness
- stomach sensations
- seating
- differences in breathing (Sarason, 1975).

Along with bodily symptoms, Hagtvet (1983) supported that thought process of anxious students is one that does not lead to testing success. Along with physiological experiences, cognitions during the experience of test anxiety tend to be self-demeaning (Hagtvet, 1983). The

concentration on the duo of body/mind distractions interferes with concentration and leads to poor performance for test takers (Sarason, 1975).

Morris and Liebert (1970) confirmed that test anxiety consists of two pieces, but called them the cognitive and emotional components. The cognitive component is related to thinking about the test and its results, whereas the emotional is related to the physiological experiences (Morris & Liebert, 1970). Their study affirmed that the cognitive portion, which they deemed worry, was related to how students expect to perform on tests. Physiological reactions, which were deemed emotionality, varied quickly before a test and hastily after (Morris & Liebert, 1970). Morris and Liebert (1970) posited that various measures of physiological arousal were valid indicators of anxiety, such as: pulse rate, skin temperature, blood pressure, galvanic skin response, and respiration rate.

Morris and Liebert (1970) further tested the implications of the worry-emotionality distinction on high school and college students' reactions to an actual classroom examination and found that worry, the mental element of anxiety, affected performance on testing. The researchers found that emotionality showed increased pulse rate, but that worry affected grades more than emotionality, and pulse rate did not impact test performance (Morris & Liebert, 1970).

Personal and situational variables contribute to test anxiety (Bateson, Brilot, & Nettle, 2011; Putwain, Woods, & Symes, 2010). Putwain et al. (2010) aimed to gain understanding of the relationship between test anxiety and individual experience, principles, achievement targets, academic self-concept, and perceived test competence. Situational variables of teacher's achievement objectives and parental pressure/support were also explored in relation to test anxiety (Putwain et al., 2010). Building on research by Morris and Liebert (1970) and Sarason

(1984), the researchers found that test anxiety can be expressed as both worry and tension, and that there were intercorrelations between the two variables.

Anxiety has been theorized to be an evolved human trait (Bateson et al., 2011). Researchers confirmed that as a species, humans have anxiety like responses, or stress, related to perceived threats. As stated earlier, college is a stressful time of life where test anxiety is often experienced (Hurst, Baranik, & Daniel, 2013; Salend, 2012). Biological anxiety responses include physiological responses such as differences in breathing, blood flow, and sweating (Bateson et al., 2011) in order to prepare humans cognitively, biologically, and behaviorally for perceived threats. Bateson et al. (2011) expressed that anxiety is a natural protective function that is sensitive to the probability of negative events happening and an individual's ability to deal with those events if they do happen. The researchers proposed and supported two claims in their theory: As the objective possibility of observed threats rises, the level of a person's anxious symptoms will also rise; and as the susceptibility of people to threats rises, so should the symptoms of anxiety.

Physiological Test Anxiety

It is an exciting time for the crossroads of understanding anxiety neurologically and treating it clinically (Boehme et al., 2014; Etkin, 2012;). In the recent years, technology has opened the door for modern ways to measure physiological responses to test anxiety (Boehme et al., 2014; Etkin, 2012; Lupien, Maheu, Tu, Fiocco, & Schramek, 2007; Martinek, Oberascher-Holzinger, Weishuhn, Klimesch, & Kershbaum, 2003; Ponzi et al., 2015; Spangler, Pekrun, Kramer, & Hofmann, 2002).

Psychological stress has the ability to produce physiological effects (Takai et al., 2004). The stress of test anxiety has been consistently shown to affect student's biological stress levels,

which impacts student cognitive functioning (Lupien et al., 2007; Martinek et al., 2003; Spangler et al., 2002). Lupien et al. (2007) showed extensive history of testing conducted on humans and rodents positing a negative effect of stress on memory and learning.

Etkin (2012) stated that neuroscientific advances with humans, such as FMRI, offer advancement for general understanding and treatment of stress related disorders. The researcher found that the amygdala and insula were associated with measuring and understanding anxiety neurobiologically. It was proposed that by having a grasp of the networks of the brain involved with anxiety, it may be translated into solutions that can help people with different forms of stress (Etkin, 2012). Boehme et al. (2014) designed an experiment to use FMRI testing to determine the areas of the brain activated during anticipatory anxiety for people with diagnosed social anxiety. Boehme et al. (2014) used trigger words of 'speech' and 'computer test' to illicit an anxious response from participants. The testing showed that the two groups (social anxious and healthy individuals) showed an increase in unpleasantness, anxiety, and arousal in the face of a performance situation. Results of the testing showed that the insula and amygdala are activated in the brain during testing anxiety, as shown by other studies (Etkin, 2012; Lupien et al., 2007).

Yet, more research is needed on anxiety from a neurobiological point of view (Peterson, Thome, Frewen, & Lenius, 2014; Takai et al., 2004). Peterson et al. (2014) affirmed that studying the resting state of brain networks involved with anxiety could show relationships among anxiety disorders. In the study by Peterson et al. (2014), multiple neurobiological studies of anxiety were analyzed. It was found that there were similarities in the resting state brain regions of the bilateral amygdalae, amygdalar sub regions, insula, the default mode network, central executive network, and salience network in anxiety disorders (Peterson et al., 2014).

To determine how the stress of test anxiety affects students, biomarkers are frequently used (Kirschbaum & Hellhammer, 2000; Ng, et al., 2003; Spangler et al., 2002). Biomarkers are the measureable biological effects that psychological stress produces. Test anxiety is multidimensional construct (Zeidner, 1995) that has been shown to produce physiological responses such as perspiration, rapid heartbeat, rapid/shallow breathing, and increases in salivary cortisol and salivary alpha amylase (Liebert & Morris, 1967; Morris & Liebert, 1969; Spielberger & Vagg, 1995).

Stress is a pressure that can be a real or perceived threat and in humans follows a biological track: a perceived stressor, a hypothalamus response, a pituitary response, and then an adrenal response (Chrousos, Kino & Charmandari, 2009; Lupien et al., 2007). The adrenal cortex releases glucocorticoids, which affected the brain regions of the amygdala, frontal lobes, and hippocampus. These parts of the brain are related to learning and memory.

Two main systems are involved in producing biomarkers related to psychological stress: the hypothalamus-pituitary-adrenocortical (HPA) axis and the Sympathomedullary (SAM) system (Takai et al., 2004; Chen et al., 2014). Two primary biomarkers that are used to determine the stress levels in clinical research participants are cortisol and alpha-amylase (Allwood et al., 2011). The differences in the levels of the HPA axis and the SAM system arousal can be inferred non-invasively by analyzing saliva (Granger et al., 2012).

According to Granger et al. (2012) modern research is centered on the idea that biological variations can impact behavior and vice versa. It has been found that studies focusing using salivary analytes have grown vastly (Granger et al., 2012). Since salivary measures of stress are accurate, non-invasive, and can be stored for long periods of time--they are an ideal way to measure the stress response of research subjects (Kirschbaum & Hellhammer, 2000).

Kirschbaum and Hellhammer (2000) identify salivary tests as less invasive than blood tests, and affirm that they stimulate less anxiety than the blood test process itself, which often confounded results of stress tests. According to the research, measuring salivary stress levels is now the primary method to collect data on stress.

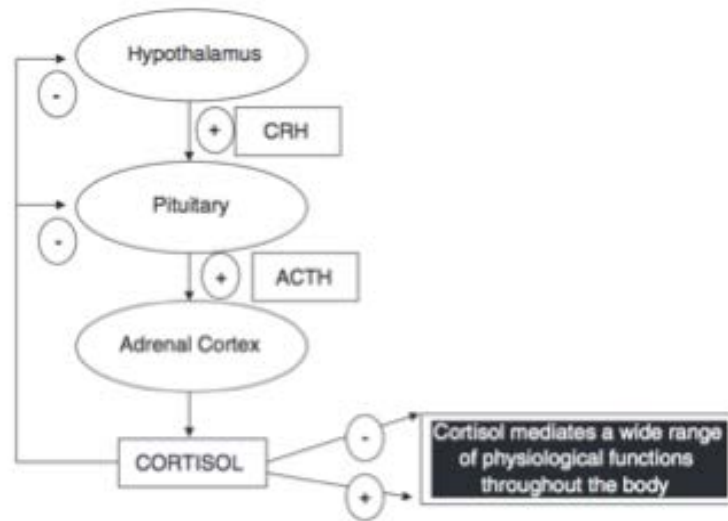
Granger et al. (2012) agree that saliva receives much attention as a bio specimen since it is easier to work with than blood. Granger et al. (2012) completed a review of literature to provide a guide that assists researchers using oral fluids in health research.

Salivary Cortisol

Kirschbaum and Hellhammer (2000) posit that the hormone cortisol is the primary hormone responsible for stress responses in humans and animals, and according to Smyth et al. (2013), cortisol is the primary stress hormone in the human body and is vital for living.

Research by Kirschbaum and Hellhammer (1994) indicate that salivary cortisol signifies Hypothalamic Pituitary Adrenal (HPA) activity and implies that psychological stress increases the body's salivary cortisol levels above baseline. The researchers believe measuring cortisol in saliva is an efficient way to determine the amount of stress a person is experiencing at any given time. Smyth et al. (2013) also affirms that stress can be evaluated by measuring activation of the HPA, which leads to salivary cortisol. Smyth et al. (2013) explained the biological cortisol response, also known as the Hypothalamic Pituitary Adrenal (HPA) axis, as follows: The nervous system secretes cortisol based on an internal/external stressor, the hypothalamus is activated, the pituitary gland sends to the adrenal cortex, which then leads to secretion of cortisol into the bloodstream. This process is shown in the figure below.

Figure 3

The HPA Axis in Human

Note. See Appendix E for permissions.

According to the research, the HPA axis responds immediately to stress, but takes roughly twenty minutes to peak, and returns to baseline after roughly an hour (Smyth et al., 2013). Kirschbaum and Hellhammer (2000) found consistent results, showing that after the elimination of a psychosocial stressor, cortisol levels are heightened for roughly twenty minutes (see Figures 4 & 5). The following charts are provided to see the time span of salivary cortisol after a stressful event.

Figure 4

Stress and Salivary Cortisol

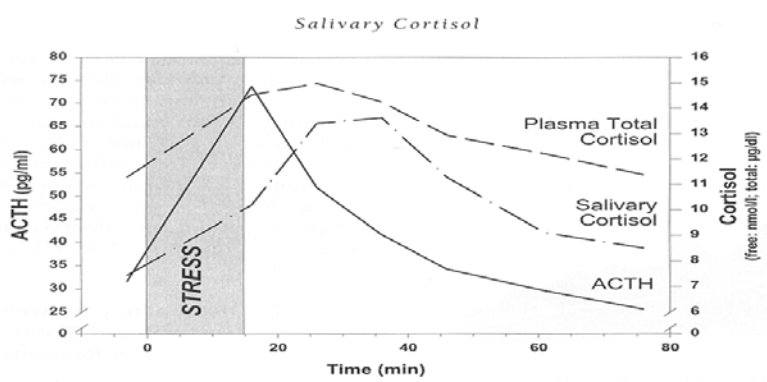


FIGURE 2 Mean ACTH, total plasma cortisol, and salivary cortisol responses to a brief psychosocial stress test (Trier social stress test). Note that there are different units of hormone concentrations for total plasma and salivary cortisol.

Note. See Appendix F for permissions.

Figure 5

Stress and Salivary Cortisol (2)

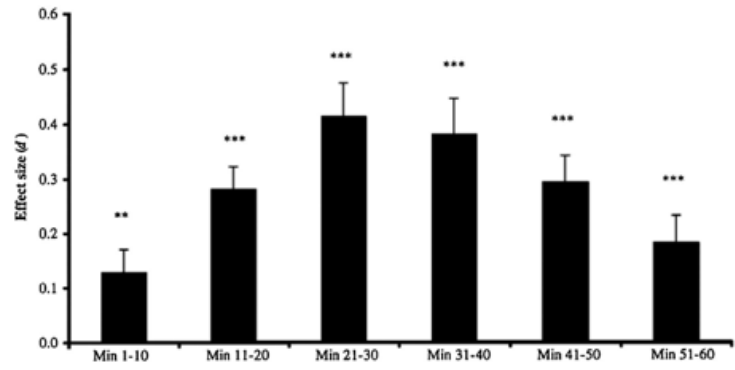


Figure 3. Mean (\pm SEM) effect size (d) for salivary cortisol response to stress in 10-min epochs from stressor onset. Taken from the meta-analysis of Dickerson and Kemeny (2004). The figure shows that the peak cortisol response to an acute stressor occurs between 20 and 30 min after stressor onset. ** $p < 0.01$. *** $p < 0.001$. Copyright American Psychological Association, permission granted.

Note. See Appendix E for permissions.

Kirschbaum and Hellhammer (2000) note that salivary cortisol levels change throughout the day, with peaks in the morning and around lunchtime (see Figure 6) indicating that so testing of subjects during the same time of day is ideal.

Figure 6

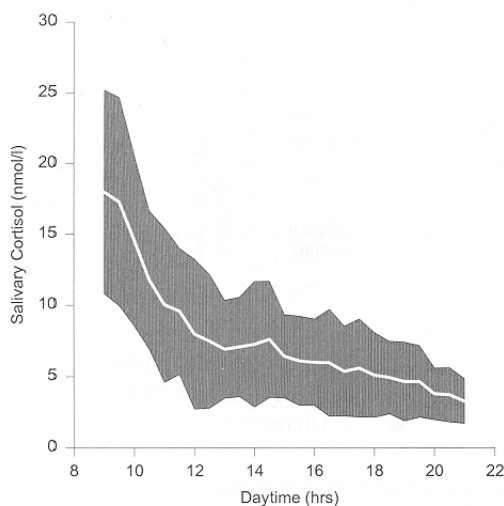
Salivary Cortisol Timeline

FIGURE 1 Normal values of salivary cortisol during the day (white line: mean levels; shaded area: means \pm 1 SD).

Note. See Appendix F for permissions.

Research by Ng et al. (2003) showed that graduate students who rated their pre-test stress as higher had higher levels of salivary cortisol—along with lower examination scores. It was hypothesized that raised cortisol could affect the retrieval of information in students, thus leading to lower examination scores. Martinek et al. (2003) completed a study to determine if cortisol increased during familiar and novel stressful academic evaluations. The researchers confirmed that cortisol levels spiked before written and oral examinations for test takers. Interestingly, the researchers found that self-reports of anxiety levels did not correlate with cortisol levels, showing that increased cortisol may not actually create a feeling of stress itself.

Spangler et al. (2002) conducted a study examining cortisol levels among test anxious students. Participants were videotaped during a test and then asked to report on their emotions and coping strategies during the testing. Spangler et al. (2002) measured participant cortisol and found that anxiety was greater in the first part of the test when compared to the second part.

Cortisol levels were revealed to be uppermost in test-anxious students preceding the exam, while average test-anxious students had a peak rise in cortisol after the exam, and low-test anxious students did not have noteworthy cortisol changes (Spangler et al., 2002).

According to new research by Choi et al. (2014), smartphones can now even be used to help people grasp their salivary cortisol levels and subjective stress levels in their own homes.

Salivary Alpha Amylase

Salivary alpha amylase (SAA) has been studied as a biomarker for stress over the last 30 years (Allen, 2014). Currently, the enzyme alpha amylase (SAA) is a useful biomarker for measuring the response of the SAM/ANS system (Chen et al., 2014; Walsch et al., 1999; Skosnik et al., 2000). The Sympathetic Adrenal Medullary (SAM) system is different from the HPA system noted above. In the SAM system, noradrenaline in the blood comes from an overage in the nervous system, which indicate increased sympathetic system activity (Lake et al., 1984; Kennedy et al., 2001). In the SAM system, norepinephrine is released into the blood (Chrousos & Gold, 1992), and it has been noted that SAA can be more accurate in relation to the effects of stress on the human body and can recover quickly from stressful events (Ali & Pruessner, 2012).

Psychological stressors can elevate adrenaline levels in the blood, which leads to an enzyme known as salivary alpha-amylase (SAA) being produced (Gallacher & Petersen, 1983). According to research by Chatteron et al. (1996), there is a relationship between blood levels of salivary alpha-amylase (SAA) and blood adrenaline/noradrenaline (stress). Nader and Rohleder (2009) explained how the preparation of the flight/fight system could benefit by short term increases in SAA—since it leads to starch breakdown and an increase of glucose availability for

energy. Research has also shown that salivary amylase can be as much as doubled by a psychological stressor (Bosch et al., 1996).

SAA is an exciting biomarker of stress with many new studies being conducted every year (Allen, 2014; Breines et al., 2015; Nader et al, 2005; Nader et al, 2006). Research done by Nader et al. (2006) examined 30 healthy men in their 20's to determine the relationship between cardiovascular response, SAA levels, and cortisol levels among other biomarkers. In order to induce stress, mental arithmetic and a speech in front of an audience were directed. Nader et al. (2006) found that the stressful situations resulted in significant increases in SAA and SC existed. Nader et al. (2006) indicated that SAA can be used a reliable and valid way to measure stress. In her dissertation, Allen (2014) undertook a study to determine if SAA could successfully be an indicator of biological stress in the human body. Allen (2014) found that SAA levels showed significant differences between those who were at rest and those who had jumped for twenty minutes.

Modern research on SAA has been conducted (Breines et al., 2015). In their study, it was hypothesized that people with self-compassion would have lower SAA levels with a psychosocial stressor presented. The findings of the researchers showed that self-compassion was negatively related to the size of the SAA response when presented with a stressor. The researchers said this may be due to the fact individuals who are self compassionate may be less likely to acknowledge stressors as self-threatening. The researchers suggest that individuals who are self-compassionate may build a buffer against biological stressors over time.

Studies utilizing Salivary Alpha Amylase (SAA) and Salivary Cortisol (SC)

Different studies have been used to determine stress levels of participants by measuring cortisol and alpha-amylase (Allwood et al., 2011; Gordis et al., 2008; McGraw et al., 2013; Takai et al., 2004).

McGraw et al. (2013) looked at the nature, concomitants, and effects of biological reactivity/regulation to stress amongst nurses in the Army. The researchers used heart rate, blood pressure, and saliva as biomarkers for the research. The finding showed that SAA, cortisol, heart rate, and blood pressure had large increases after being presented a challenging physical/social stressor.

Allwood et al. (2011) studied 56 young adults to determine if stressful tasks increased salivary cortisol (SC) and salivary alpha-amylase (SAA). Allwood et al. (2011) confirmed that SAA is more responsive to laboratory stressors than cortisol. The researchers also found that SAA peaked quicker (10 min) and returned to baseline faster than cortisol. Allwood et al. (2011) found that SAA was related to trait anxiety in children, with higher baseline SAA in children with trait anxiety.

Takai et al. (2004) researched the affects of watching stressful videos on patient salivary cortisol and alpha-amylase levels. The researchers found that over 95% of participants had both cortisol and alpha-amylase raised when watching a stressful video. Takai et al. (2004) found that alpha-amylase rose faster than cortisol. The researchers found the alpha-amylase may be more precise than cortisol as a measure of the HPA system. The study by Takai et al. (2004) also attempted to measure the effects of a soothing video on salivary cortisol and alpha amylase-- finding that cortisol was unresponsive, but that amylase was significantly decreased. Takai et al. (2004) referenced other studies on the effect of relaxation and meditation on cortisol levels. A

study by Jin (1992) showed no effect of meditation on cortisol and a study by Field et al. (1992) on massage that produced similar results.

Gordis et al (2008) examined forty-seven maltreated youth to determine the effects of a stressor on their SAA and salivary cortisol levels. The stressor was to have the youth create an improvisational story and have that story be judged by small panel. Saliva was collected at six different times; two times before the stressor and four times after the stressor. The findings of the study showed that salivary cortisol had a slower peak and recovery to stress than did SAA. The finding also showed that in non-maltreated youth, SAA and salivary cortisol showed symmetry in the rise and fall pre/post stressor (See Figure 7).

Figure 7

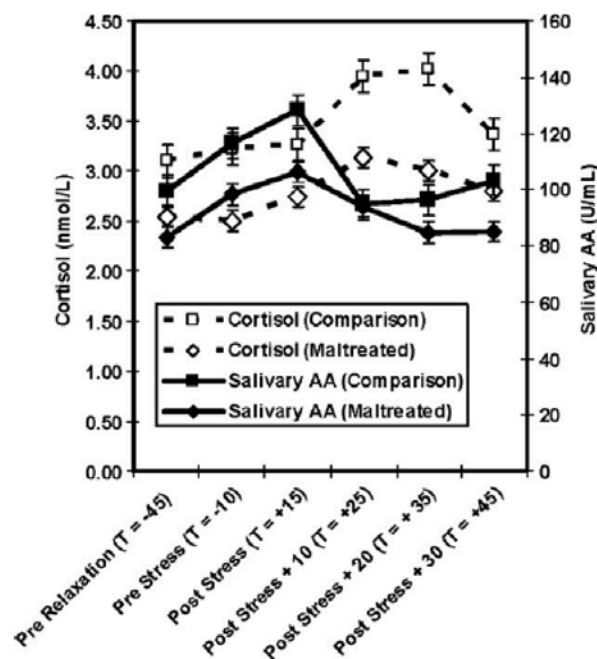
Cortisol and SAA Levels in Maltreated and Comparison Youth

Fig. 1. Cortisol and sAA at pre-relaxation ($T=-45$), pre-stress ($T=-10$), and at 0 ($T=+15$), 10 ($T=+25$), 20 ($T=+35$), and 30 ($T=+45$) min post-stress in maltreated and comparison youth. *Note:* For sAA, repeated measures ANCOVA (within subjects factor saliva sample controlling for group, time of day, pubertal status, and ethnicity) Wilks' $\lambda=0.83$, Exact $F(5,74)=2.99$, $p<0.05$. Levels were lowest at pre-relaxation, increased after relaxation, peaked immediately post-stressor, and returned to baseline levels by 10 min post-stressor. For cortisol, repeated measures ANCOVA (within subjects factor saliva sample controlling for group, time of day, pubertal status, and ethnicity) Wilks' $\lambda=0.88$, Exact $F(5,74)=1.97$, $p<0.10$. Cortisol peaked at 10 min post-stressor and returned to baseline levels at 20 min post-stressor.

Note. See Appendix H for permissions.

Averse to the symmetry presented by Gordis et al. (2008), Keller et al. (2012) examined the relationship between SC, SAA, and the cognitive and academic functioning of children. Keller, et al. (2012) found unique data showing that relationships between cortisol and SAA is not always linear in relation to learning and cognitive abilities. The study was unique in that it showed lower cortisol and higher SAA to be associated with greater ability across math and language in children.

Fischer et al. (2016) examined how pain in fibromyalgia patients related to SC and SAA. It was found in the research that pain in patients increased if perceived stress levels increased and that higher momentary cortisol levels were positively related to higher momentary pain levels in participants. Pain levels were not found to have a relationship with SAA levels.

A unique study by Chatterton et al. (1997) examined the SAA and SC levels of college students who had never been skydiving and did so. The control group for the study did not jump, but rather watched TV at the skydive center. SAA was shown to be significantly higher in the jump group the morning of the jump, when compared to the control group. SC levels only increased after the jumpers had landed. Nader et al. (2006) analyzed 24 healthy adults exposed to a psychosocial stressor. The biomarkers used to measure psychosocial stress were SC, SAA, and HR. The researchers found significant differences between psychosocial stress and resting conditions in SAA, SC, and HR. The increases of SC, SAA, and HR levels were found to exist before and after the stressor. More recently, Payne et al. (2014) examined 231 children and showed that children with higher levels of social anxiety showed significantly higher levels of SAA. The researchers indicate that SAA may be an important biomarker of stress in people who are sensitive to social evaluation.

Recently, research by Ponzi et al. (2015) examined forty children to see if there was a relationship between SC/SAA and children's perceptions of their social networks. The researchers noted that cortisol levels increased on days children were interviewed versus days there were not. The researchers indicated that SAA could be elevated in children by simply the presence of a stranger and a video camera, since the same interview without a camera/cameraman did not increase SAA. The researchers also found that children with perceived dense social networks has lower levels of pre-interview cortisol and lower levels of

SAA reactivity to the interviews. Children's SAA and SC levels were also studied by Ursache and Blair (2015). The researchers set out to determine if SAA and SC levels were predictive of attention to threatening stimuli. The researchers found that children who had higher levels of SAA and SC had higher attentional biases to presented threats. Ursache and Blair (2015) affirm that cortisol and SAA interact to predict a range of results, which can include academic skills. The researchers state that using SAA and SC together is better than using only one. The study confirmed that differing levels of SAA and SC, known as asymmetrical profiles, are generally associated with higher use of behavioral and cognitive self-regulation--while symmetrical profiles were generally associated with more reactive behaviors.

Cognitive Attentional Theory as a Framework for Test Anxiety

As stated in chapter one, a theoretical framework can help guide and shape the understanding of the phenomenon being studied (Cresswell, 2013). The theory selected for understanding test anxiety is the Cognitive Attentional Theory (CAT), which has been added to by multiple researchers (Culler & Holahan, 1980; Weinstein, Cubberly, & Richardson, 1982; Wine, 1971; Sarason & Mandler, 1952; Sarason, 1972, 1980). According to Zeidner (1998), the CAT left the path of motivational and arousal theories and concentrated on the division of attention during evaluations. The framework is based on the idea that students who have high test anxiety are influenced by their lack of attentional focus and thought types in the presence of an evaluation (Carver & Sheier, 1991; Meichenbaum & Butler, 1980; Sarason, 1972, 1980, 1984, 1988; Wine, 1971, 1980). According to the CAT, physiological responses alone are not the most effective way to wholly grasp the concept of test anxiety (Wine, 1971).

Sarason (1980) suggests that the underlying center of test anxiety is the process of becoming preoccupied during evaluations. The CAT is based on the idea of test anxiety creating

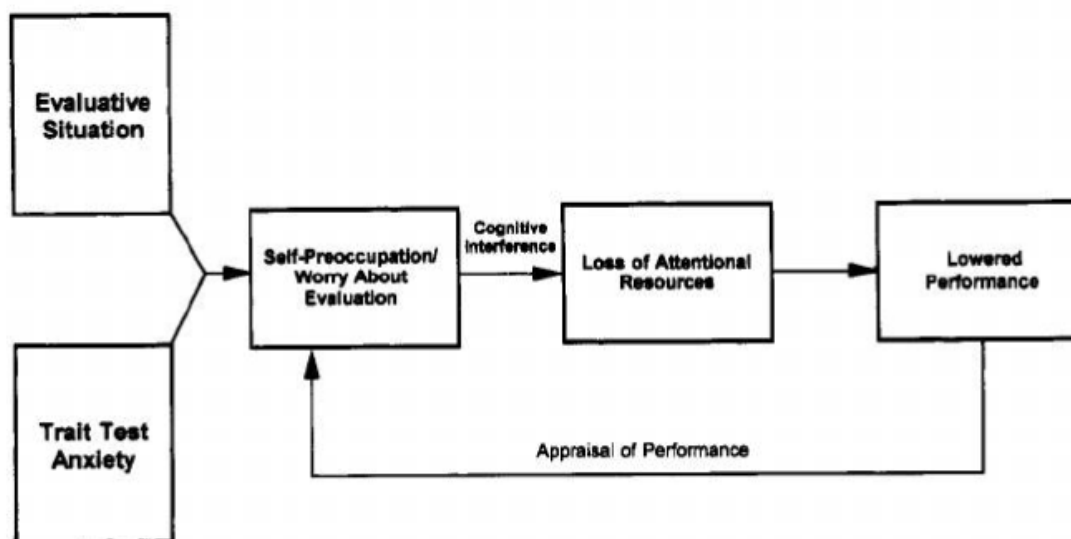
what Sarason (1987) deemed cognitive interference. Cognitive interference can be understood as cognitions that come to a person's mind during evaluation, but have little relation to helping solve the evaluative task (Zeidner, 1998). According to Deffenbacher (1978), people who are highly anxious during evaluations spend only 60% of the task time on the task itself, and the other 40% on distracting cognitive activities not related to evaluation completion. Thought processes related to apprehension, thought intrusion, and negative self-talk are present in testing situations (Sarason, 1984) and are viewed as cognitive excesses (Smith, Ingram, & Brehm, 1983). The elevated levels of test anxiety during evaluation's correlated with personal concerns, negative focus on the self, negative self-talk/evaluations, and task irrelevant thinking (Wine, 1980; Wine, 1982).

The cognitive phenomenon of test anxiety was initially studied at Yale by Sarason and Mandler (1952) who indicated that high-test anxiety was demonstrated by those being tested feeling they were in a dangerous situation due to the negative thoughts of perceived potential failure. Mandler and Sarason (1952) completed studies on students at Yale and defined two different cognitive drives that impact a subject's performance on evaluations. The first, being the task drive, which was internal to subjects being tested, and related to the student's response to the test's nature, materials, and instructions. This drive is what pushed people to take and finish an evaluation. The second drive was the anxiety drive, which is a learned response that has been reinforced by testing experiences at different points in the subject's life. The anxiety drive can produce responses that are unrelated to the evaluation situation, such as negative self-talk, helplessness, somatic reactions, fear of punishment, or loss of social status. Mandler and Sarason (1952) proposed the interfering response hypothesis that claimed situations where evaluation is present create elevated levels of the anxiety drive in students with high test anxiety,

which leads to more worry and physiological responses. Sarason's cognitive-interference model can be seen in a chart here:

Figure 8

Sarason's Cognitive Interference Model of Test Anxiety



Note. See Appendix D for permissions.

The Cognitive Attentional Theory, which was initiated by the beginning work of Sarason and Mandler (1952), was supported by Wine (1971), who claimed that during evaluations, students with high anxiety focused their attention internally on negative cognitive self-evaluations and physiological symptoms. This focus was said to take concentration off the evaluation task at hand and depreciate performance (Wine, 1971). The theory was built on the initial studies (Sarason & Mandler, 1952) that differentiated people having both learned task and learned anxiety drives that compete during testing; with the anxiety drive either leading to task completion or task interference. Task interference manifests itself as an absentminded state that impacts evaluation performance (Wine, 1971). Wine (1971) stated that, “the highly test-anxious person responds to evaluative testing conditions with a ruminative, self-evaluative worry and, thus, cannot direct adequate attention to task-relevant variables” (p. 99). Wine expressed that the

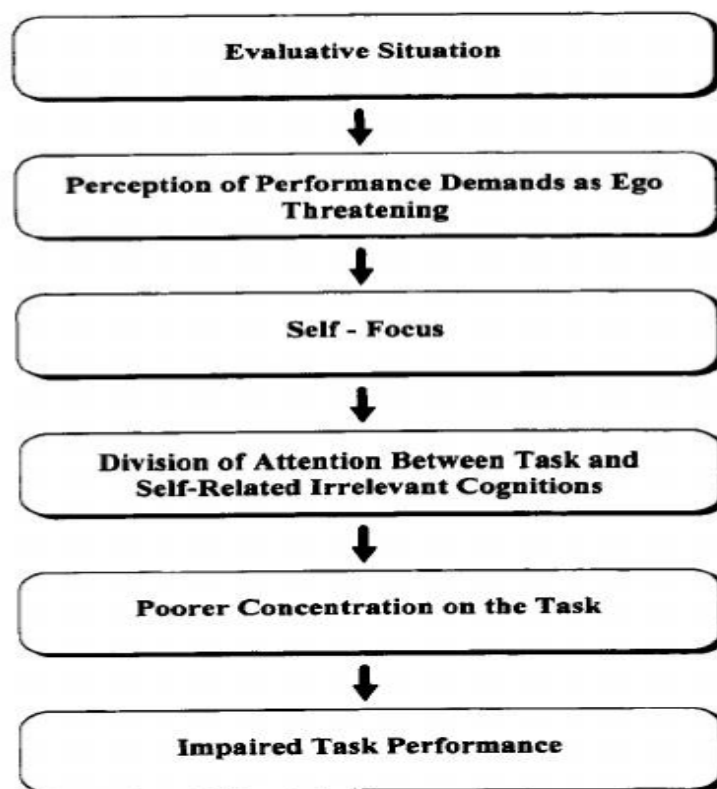
work done by Liebert and Morris (1967) on worry and emotionality paved the path for understanding. The researcher expressed that there are three implications of attentional analysis of test anxiety:

1. The Cognitive Attentional Theory of test anxiety is concerned with how the subject uses his cognitive attentiveness during testing.
2. The Cognitive Attentional Theory supports that physiological arousal is concerning if, and when, it becomes attentional worrying.
3. The Cognitive Attentional Theory supports that a subject's evaluative performance can be improved by focusing attention on the task at hand, and not negative cognitions.

(Wine, 1971).

Mandler and Sarason (1952) and Wine (1971, 1980) viewed cognitive "interference" as a primary cause of test anxiety in the Cognitive Attentional Theory. According to Wine (1971), students with elevated levels of test anxiety go inward and focus on themselves, which interrupts their ability to focus on the evaluations. Wine (1971) proposed that students who were anxious in evaluative situations distributed their attention between worries and the test itself, which impacted performance. Wine (1971) provided a chart of the Cognitive Attentional Theory that helps to explain the relationship. The chart is listed below:

Figure 9

Cognitive Attentional Theory

Note. See Appendix D for permissions

Sarason (1987) built on Wine's (1971) theory of cognitive interference, saying that test anxiety is situational for each test taker. Test anxiety is impacted by personal factors that lead to increased internal fixation which impacts evaluation success (Sarason, 1980; Sarason, Sarason, & Pierce, 1990; Sarason et al., 1984). In testing situations therefore, students tend to focus their attention on their internal dialogues and worry about perceived performance and/or consequences of a poor performance (Sarason, 1972). Kurosawa & Harackiewicz (1995) support this in research, showing that students with test anxiety have compromised performance due to more concerns and unsettling thoughts.

Support of the Cognitive Attentional Theory

Multiple studies affirming the relativity of the Cognitive Attentional Theory have been conducted since it was established (Carver & Scheier, 1988; Caparos & Linnell, 2012; Decaro, Thomas, Albert, & Beilock, 2011; Kurosawa & Harackiewicz, 1995; Meichenbaum, 1972; Prins, Groot, & Hanewald, 1994; Putwain et al., 2010; Sarason, 1984; Sarason & Stoops, 1978; Weinstein, Cubberly, & Richardson, 1982).

Research was conducted to see if cognitive modification had an effect on test anxiety levels. Participants for the study were recruited by putting an advertisement in a college newspaper that requested people who wanted to be treated for their test anxiety. Meichenbaum (1972) compared students who suffered from test anxiety after receiving either a form of two different treatments or no treatment at all. The types of treatment were cognitive modification and desensitization. The cognitive modification, which was teaching students to be aware of their attention-distracting negative self-talk, was the most effective for lowering test anxiety. The results were confirmed at a one-month follow up after the initial procedure as well. The desensitization group showed significant improvement over the no treatment group as well, reinforcing the Cognitive Attentional Theory. Meichenbaum (1972) found that group administration of a treatment is as effective as individual administration, which can help researchers save valuable time and resources. As a support to the Cognitive Attentional Theory of test anxiety, Meichenbaum (1972) and Wine (1971) showed that negative cognitive attention in high-test anxiety subjects is subject to modification. Teaching students to modify their attention distracting thoughts is a way to help lower test anxiety (Meichenbaum, 1972; Wine, 1971).

To further support the Cognitive Attentional Theory, studies on stress, anxiety, and cognitive interference have been completed (Sarason, 1984; Sarason & Stoops, 1978). Stress, from a cognitive approach, is a “call to action” evoked by evaluations of situations and subjective states (Sarason, 1984). Related to this definition, anxiety is a self-preoccupation related a person’s inability to respond to the “call to action” that stress creates. Sarason (1984) differed between task oriented and self-preoccupied people when faced with stressful challenges or tests. Sarason (1984) affirmed that people who are preoccupied during tasks have lower performance since they are less concentrated on the tasks being performed. Interfering thoughts have been found to decrease attention and the ability to successfully complete tasks (Sarason, 1984). Situations with no evaluation present did not cause notable differences in anxiety between high/low test anxiety subjects—but when an evaluative situation was introduced, the stress created a rise in test anxiety in high test anxiety subjects. Sarason (1984) affirmed the Cognitive Attentional Theory of test anxiety, showing that people who are impacted by a lack of concentrated attention during testing can benefit from being taught to decrease self-preoccupation and focus their attention on the task at hand.

Test anxiety affects the perception of test takers, with those who have elevated test anxiety perceiving the actual time of the testing procedure and the waiting time before the test itself as longer than it is (Sarason & Stoops, 1978). This preoccupation is coupled with negative thoughts during the examination, which affects participant ability to concentrate on the testing itself, and leads to compromised performance. This affirms the Cognitive Attentional Theory of anxiety by demonstrating that high test anxious students tend to have exaggerated thinking about how much time is passing, how badly they are doing, how other students are performing, and what the test giver will think about them—which has a negative impact on test performance.

Researchers have also confirmed that test anxiety impacts learning and cognition (Cubberly et al., 1986; Prins et al., 1994; Weinstein et al., 1982). In the cognitive attention framework of test anxiety, it has been determined that negative self-talk and worry impact evaluation performance (Sarason & Mander, 1952; Wine, 1971). Weinstein et al. (1982) completed research to determine the effects of test anxiety on deep and superficial learning. To create the phenomena of test anxiety, students were told that their test scores on a word pairing activity would directly be related to their general academic intelligence and competence. The students were split into two groups, superficial and deep levels of processing. The research upheld Cognitive Attentional Theory of test anxiety. The results of the study showed that the amount of attention a task needed may be a directly related variable in predicting test performance of low and high anxiety test takers. The researchers found that those with lower test anxiety were able to score higher than students with high test anxiety on tasks that required more attention and processing.

Test anxiety begins to affect cognitions at early ages, which affects task performance (Prins, Groot, & Hanewald, 1994). A large group of elementary students with low, moderate, or high test anxiety were examined to determine student cognitions, and their effects, during high threat and low threat evaluations in the classroom. Researchers found that each test-anxious group had significant differences in their perceived levels of anxiety. It was discovered that highly anxious students rated their anxiety levels much higher than the other two groups in both the high and low threat evaluations (Prins et al., 1994). Highly anxious students had less concentrated thoughts and lower self-evaluations than the other two groups. Consistent with the Cognitive Attentional Theory of test anxiety, it was reported that off task thoughts and coping cognitions negatively affected task performance.

The fear of being evaluated can also steal test taker's attention and impact their performance (Decaro et al., 2011; Kurosawa & Harackiewicz, 1995; Putwain et al., 2010). Kurosawa and Harackiewicz (1995) completed research on the effects of public/private self-awareness, self-consciousness, and trait test anxiety on individual task functioning. Students were given the test anxiety questionnaire (TAI) to determine those with test anxiety. Four experimental conditions were tested while participants were given a word game to complete in two minutes. In the first condition, there were only instructions given on a recorder and no contact with the researcher thereafter. In the second and third, known as the self-awareness manipulations, participants were tested with a mirror next to them or a camera next to them. The researchers used mirrors to create private self-awareness and a camera to promote public self-awareness (Kurosawa & Harackiewicz, 1995). In the fourth condition, evaluation statements related to the participant's ego were added to create the phenomena of test anxiety. The researchers uncovered that situations in which participants with high test anxiety were made to be more self aware and less concentrated on the task at hand led to significant decreases in performance (Kurosawa & Harackiewicz, 1995). Putwain et al. (2010) also found that perceived academic self-competence has a prominent influence on evaluation anxiety. It was reported that test anxiety came from the motivation to avoid incompetence, but the actual test anxiety impacted competence itself. The researchers found that testing situations that induce self-awareness are detrimental for people with test anxiety. These results are supported the findings of Sarason et al. (1986) that concentrated self-preoccupied thoughts are not conducive to task performance.

A similar phenomenon that parallels the Cognitive Attentional Theory and impacts learning is the idea of "choking under pressure" studied by Decaro et al. (2011). Choking under

pressure is a scenario that can happen in any arena, from testing to musical performance. The phenomenon happens when different features of stressful situations lead to distractions that can alter performance of working memory and individual's control of their attention (Decaro et al., 2011). Pressure creates catastrophes in two ways. Since attention is directed away from proper execution of working memory during stressful situations, performance is compromised. Pressure also increases internal self-monitoring, which can disrupt performance (Decaro et al., 2011). Two types of pressure were explored, outcome pressure and monitoring pressure. Outcome pressure is the subjects concern over the results of their testing. Monitoring pressure is concerned about being monitored during/after testing. The researchers had their subjects complete tasks and increased the amount of pressure in the experimental groups telling them they could either win money (outcome pressure), or that their task session would be video recorded and possible disseminated to other students and professors (monitoring pressure). The two groups under the pressure inducing situations reported experiences of high pressure. Both the outcome pressure and monitoring pressure affected learning, suggesting that worry about outcomes of testing and concerns of being observed affected the attention of the test takers. It was acknowledged that many facets of stress often come together in pressure inducing situations.

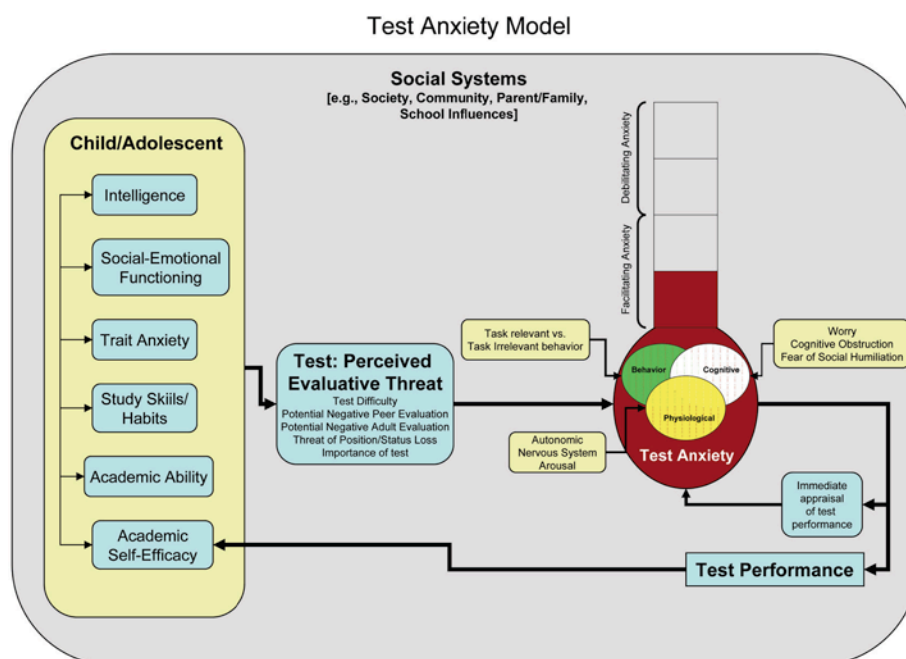
Modern Notable Models of Test Anxiety

Lowe et al. (2008) confirmed Zeidner's (1998) statement that no consistent model for test anxiety exists. Lowe et al. (2008) thus created the Test Anxiety Inventory for Children and Adolescents (TAICA) based on the psychosocial model, which encompasses the role of social systems in the development of test anxiety. In their model, Lowe et al. (2008) show six within-child variables that have been studied to show a significant role in the perception of the peril of an imminent test: social-emotional functioning, intelligence, study skills, trait anxiety, academic

ability, and academic self-efficacy. Lowe et al. (2008) cited Hancock (2001), showing the amount to which the exam is observed as a risk (difficulty, likelihood of undesirable assessment from others, prominence of the exam) seems to sway the amount of test anxiety. In their theory, Lowe et al. (2008) show that when test anxiety occurs, an individual's behavior, cognitions, and physiology are affected. Lowe et al. (2008) cited classic studies on test anxiety in undergraduates (Alpert and Haber, 1960; Yerkes and Dodson) 1908) showing test anxiety's ability to degrade performance at high levels. Lowe et al. (2008) use the following diagram to explain their model.

Figure 10

Biopsychosocial Test Anxiety Model



Note. See Appendix C for permissions

Most recently, Segool, von der Embse, Mata, and Gallant (2014) did an exploratory study where they applied a cognitive behavioral model of test anxiety in a high-stakes context. The researcher's timeline acknowledged three major test anxiety model revisions starting in the 1950's. Their timeline included:

1. Sarason and Mandler (1952) creating the Test Anxiety Scale for Children (TASC) based on the idea that test anxiety was considered to be an expression of trait anxiety in situations with evaluation present.
2. Morris and Liebert (1970) proposing the model that test anxiety is a unique construct comprised of worry and emotionality associated specifically with testing. Worry affecting the mental processes of test anxiety and emotionality affecting the physiological responses.
3. Lowe, et al. (2008) developing a biopsychosocial model of test anxiety that hypothesizes the expression of test anxiety (with cognitive, behavioral, and psychological symptoms) comes from biological, psychological, and social system factors. (Segool et al., 2014)

The researchers claimed to be the first in this area of study to simultaneously and empirically evaluate a hypothesized cognitive behavioral model of test anxiety. It was hypothesized that cognitive perceptions (self-efficacy), learning experiences (special education status and academic achievement), demographic characteristics (gender, minority status, and socioeconomic status), social context (school climate), and contingencies (test importance and career goals) would be significant predictors of test anxiety (Segool et al., 2014). The model tested by the researchers suggested cognitive perceptions (self-efficacy), learning experiences (academic achievement), demographic characteristics (gender), and social context (climate) directly affect the expression of test anxiety in a high-stakes context.

Casual-comparative research on a model of anxiety taking into account different personality types; more specifically, perfectionism has been done as well (Kandemir, 2013). The researcher affirmed the pressure the perfectionist character types try to accomplish generates test anxiety. Kandemir (2013) found that students' great perfectionist awareness about themselves

and students' observing families, as perfectionists, were some of the reasons why they have test anxiety. The researcher's model projected that test anxiety increases parallel to perfectionist qualities and performance goals (Kandemir, 2013).

A notable theory that runs parallel to the CAT, but provides a unique perspective, is the Control-Process perspective on anxiety (Carver & Scheier, 1988). According to the researchers, human behavior is controlled by a system of feedback control. Anxiety happens when that system is not functioning well and people have reference points they think they should meet, but do not. The researchers agree with the model of the CAT that anxiety affects working memory, which impacts cognitive focus.

Carver and Scheier (1988) however believe that anxiety arousal is less related to attention to physical changes in the body, but rather about how the person experiencing the anxiety orients and responds to it. Their critical point is that if an individual expects to be able to cope with the anxiety or not. For those who expect a bad outcome (negative cognitions), more an impulse to cognitively disengage is hypothesized to exist. The disengagement can present in self-distraction or off task thinking, which creates more anxiety, and more self-focus (Wine, 1971). Carver and Scheier (1991) feel that researchers such as Wine and Sarason have explained test anxiety well in test anxiety settings, but argue that simplifying anxiety as "self-focus" could be misleading.

The researchers posit that self-focus is two pronged, invading both task engagement and a dysfunctional response to anxiety. Carver and Scheier (1991) claim that self-focus can be helpful, even for those with high test anxiety, if there are favorable expectations from individuals are expected in those anxiety provoking situations. The researchers express that a person with positive expectations for themselves, while task-focused, even though self-focused. Carver and Scheier (1991) believe that people cannot be task-focused without being self-focused on some

level--especially on the evaluation of intended response to anxiety and actual responses. It is argued then those who's performance suffers from test anxiety are self-focused, but just on a different aspect of the self, more clearly stated as the deficits of the self.

Measuring Test Anxiety: Current and Historical Survey Measurement Tools

Measuring test anxiety has been around for more than fifty years (Zeidner, 1995). There have been many different methods developed for measuring test anxiety (Lowe et al., 2008; Pekrun et al., 2004; Sarason & Gordon, 1953; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

One of the first ways developed to measure test anxiety was the test anxiety questionnaire (TAQ) (Sarason & Gordon, 1953). Sarason and Gordon (1953) were two of the first researchers to study test anxiety, and in 1951 and 1952, they developed the Test Anxiety Questionnaire (TAQ) and piloted it on Yale University Students. Sarason and Gordon (1953) examined many test anxious subjects on anxiety/learning by having them answer the developed questionnaire. Sarason and Gordon (1953) demonstrated the reliability of the TAQ to show similar findings across two distinctive sample populations. The TAQ has been established as reliable and valid, and has been used in studies to determine test anxiety levels (Sarason & Gordon, 1953; Topp, 1989).

Another way to measure test anxiety is with a Likert questionnaire called the test anxiety inventory (STAI) by Charles D. Spielberger based on his state trait anxiety theory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Multiple studies have used the test anxiety inventory, or TAI, (Chappell et al., 2005; Damer & Melendres, 2011; Dehghani et al., 2012; Harris, Schoneman, & Carerra, 2002; Prato & Yucca, 2013; Stowell, Tumminaro, & Attarwala, 2008) and found it to be reliable and valid. Ali and Moshin (2013) compiled an impressive list

of different research studies that have shown the TAI to be valid and reliable. Ali and Moshin (2013) reported that many studies in different countries have used the TAI (test anxiety inventory) over the years since its development. Ali and Moshin's (2013) research was based on translating the TAI in the Urdu language, and then testing its reliability and validity. The findings showed internal consistency reliability (Cronbach alpha coefficient) and discriminant validity in the Urdu version of Test Anxiety Inventory (TAI), thus showing it to be valid and reliable even when translated into other languages.

Validated with the help from the TAI is the Test Anxiety Inventory for Children and Adolescents (TAICA) created by Lowe et al. (2008). The TAICA is a 45-item self-report measure that is made up of a Total Test Anxiety scale, four debilitating test anxiety subscales (Cognitive Obstruction/Inattention, Physiological Hyperarousal, Social Humiliation, and Worry), a facilitating test anxiety scale (Performance Enhancement/Facilitation Anxiety), and a Lie scale (Lowe et al., 2008). The TAICA scores have been shown to have very a stout internal consistency reliability as well as temporal stability. There is also evidence supporting the construct validity of the majority of TAICA scores (Lowe et al., 2008).

Test emotions experienced during test anxiety are also of research interest (Pekrun et al., 2004). Pekrun et al. (2004) hypothesized that there are many emotions that occur during the time of testing. Pekrun et al. (2004) developed a scale known as the Test Emotions Questionnaire (TEQ) that identified joy, hope, pride, relief, anger, anxiety, shame, and hopelessness. The scale was created since the researchers felt worry and emotionality (Morris & Liebert, 1970) were overgeneralizations of test related feelings. This built on the multidimensional construct idea explained previously. In the study, anxiety was the solitary emotion stated; yet reports of anxiety accounted for only a portion of the feelings experienced by those tested. Pekrun et al. (2004)

found that even in the stressful, critical life event of an important examination, anxiety is not the only emotion experienced; but rather positive emotions like hope, relief, and joy can play major roles. The questionnaire developed by Pekrun et al. (2004) helped to define affective, cognitive, physiological, and motivational emotion components; and the scales could be utilized to recognize both trait and state test emotions (Pekrun et al., 2004). Pekrun et al. (2004) created, evaluated, and revised the scales of the TEQ, with correlational and confirmatory factor inquiry, showing that the scales are reliable, organizationally valid in terms of representing diverse test emotions and mechanisms within emotions, and externally valid in terms of associating significantly with personality, learning, academic achievement, and perceived health problems.

Most recently, and of special interest to this researcher is the Westside Test Anxiety Scale (WTAS, see Appendix L) (Driscoll, 2007). The WTAS is a ten-question tool used to identify students that have anxiety impairments and could use help from anxiety reducing techniques (Driscoll, 2007). An example from the WTAS would be, “During important exams, I think that I am doing awful or that I may fail” (Driscoll, 2007). The WTAS is comprised of items including self-assessed impairment from anxiety and the anxiety relevant cognitions that decrease performance (Driscoll, 2007). The scale uses six items related to testing impairment, with four pieces on dread and worry, and no pieces related to physiological arousal. The scale was validated with diverse samples of college students and elementary students and found to be valid and reliable (Driscoll, 2007). The WTAS is used widely in research to measure test anxiety amid student populations (Ali et al., 2015; Onyeizugbo, 2010; Wong, 2008; Driscoll, 2007). The WTAS is unique in the fact that it is easy to use and is free of charge to schools and the general public.

Methods to Lower Test Anxiety

Literature has shown that people with higher levels of anxiety in their lives are more susceptible to suffering from test anxiety (Keogh et al., 2004). Kondo (1996) express that people who suffer from the unpleasant experience of test anxiety should be motivated to determine its causes. There have been many attempts studied as ways to lower test anxiety (Ahern & Norris, 2011; Damer & Melendres, 2011; Hembree, 1988; Johnson, 2013; Kondo, 1996; Plante, Marcotte, Manuel, & Willemsen, 1996; Prato & Yucha, 2013; Topp, 1989).

Since it is impossible to define one absolute treatment for test anxiety (McCordick et al., 1979) many anxiety reduction techniques are available that can be utilized by people who suffer from test anxiety before, after, or during the testing process (Kondo, 1996; Whitaker, Sena, Lowe, & Lee, 2007). Kondo (1996) found five general strategies for coping with test anxiety: positive thinking, relaxation, preparation, resignation, and concentration.

Research has shown that test anxiety is multidimensional construct, but less research has been shown how the phenomenon is actually coped with (Blankstein & Flett, 1992). Coping strategies are a way to reduces stress and prevent stressful events and situational stressful thoughts/behaviors (Grasha, 1987). According to Grasha (1987), stress can be relieved by being more assertive, setting priorities, using quick relaxation techniques, readjusting expectations, seeking small wins, focusing on achievements using coping self-statements, seeking social support, developing a plan for change, being considerate of those you interact with, and disputing irrational beliefs. Grasha (1987) advises that coping with stress should involve using a combination of the strategies mentioned, and using them in both personal and professional realms of life.

Problem focused and emotion focused coping skills have also been studied (Blankstein & Flett, 1992; Stober, 2004). It was hypothesized that there would be a decrease in problem focused coping due to test anxiety affecting an individual's ability to remain focused during evaluation (Blankstein & Flett, 1992; Sarason & Stoops, 1978) and an increase in emotion focused problem solving since the emotional experience is often quite an interference during evaluations. Blankstein and Flett (1992) used the study to evaluate the relationship between self-appraisals of problem solving and test anxiety as well. The scholars studied the same topic three years earlier (Blankstein, Flett, & Batten, 1989) and found that decreased confidence in problem solving was related to higher test anxiety. In the present study, the researchers found that those with high test anxiety tended to avoid problem-focused coping and lacked self-confidence in their ability to solve problems since they viewed them as out of their control. Blankstein and Flett (1992) found that emotion focused coping was correlated with increased test anxiety. The researchers advised a multidimensional approach for understanding both test anxiety and the coping processes of the phenomena. Stober (2004) built on this by examining specific coping strategies for coping with the multidimensional nature of test anxiety. University students were given a test anxiety measure and coping survey that measured coping as: task preparation, seeking social support, and avoidance. Stober (2004) found that overall test anxiety was primarily coped with by seeking social support. The researcher indicated that different components of test anxiety were related to different types of coping however. Stober (2004) found that female students who were worried and/or experienced emotionality were related to test preparation coping strategies, males who had emotional responses to test anxiety sought social support, and females who lacked confidence coped by avoiding testing. The study by Stober (2004) indicated that different aspects of test anxiety relate to different coping methods

for both male and female students. The following are interventions that have been studied in their attempts to lower test anxiety.

Skill training has been shown to be effective when teaching subjects to attend to pertinent stimuli instead of extraneous variables (Wine, 1970). Wine (1970) claimed that, "It seems plausible that test-anxious subjects should be susceptible to attentional instructions directing them to selectively attend to task-relevant variables and ignore self-relevant variables" (p. 100). Attentional training on test-anxious undergraduate students was studied and found to produce significant positive results on testing (Wine, 1970). Little and Jackson (1974) conducted research on lowering test anxiety by combining attentional and relaxation training. 7th and 8th grade students who scored in upper percentile of test anxiety were tested. The students were given different forms of training, including relaxation training and attentional training (not focusing on irrelevant cognitions related to testing). Little and Jackson (1974) found that test anxiety decreased significantly with a combination of relaxation and attentional training. Little and Jackson (1974) related their findings to the theory by Liebert and Morris (1967) that distinguished between emotionality and worry related to test anxiety. The researchers postulated that the relaxation calms the emotionality and the attentional training relaxes the worries of test takers.

Cognitive behavioral modification and modeling on test anxiety have been studied (McCordick, Kaplan, Finn, & Smith, 1979). According to the self-reports, students found that each treatment improved their test anxiety, though none of the experimental conditions showed significant improvement in academic performance.

Imagery and sentence elaboration with students have been studied (Cubberly, Weinstein, & Cubberly, 1986). Students were assessed for test anxiety levels with a self-report anxiety

Likert scale. The researchers fostered test anxiety by giving specific instructions related to the children's ego before taking the test, such as "the test will show how good you are at when it comes to learning". Testing was given, and results showed that imagery training increased evaluation performance with students who were grouped with high test anxiety, whereas sentence elaboration did not (Cubberly et al., 1986). In the cognitive attention framework of test anxiety, it is determined that negative self-talk and worry impact evaluation performance. Cubberly et al. (1986) elaborated that since worry involves verbal modes of thinking, which sentence elaboration attempted to utilize, it makes sense that it was less effective than imagery training. Results did show that both imagery and sentence elaboration training lowered test anxiety for students. Cubberly et al. (1986) suggested that the research supported modifying a student's cognitions might lower physiological symptoms of test anxiety

Exercise, music, breathing, aromatherapy, and imagery have also been studied to see if they affect test anxiety (Cohen, 1980; Johnson, 2013; Plante, Marcotte, Manuel, & Willemsen, 1996; Topp, 1989). Plante et al. (1996) hypothesized that suggesting to participants that the aforementioned methods would decrease their anxiety would increase the effects of the methods themselves. Subjects in the study were instructed to not drink caffeine, exercise, or smoke before testing since it could affect the results (Plante et al., 1996). Testing subjects were put into four groups:

- Exercise activity with/without suggestion: these groups were either told or not told of the benefits of exercise on test anxiety and then told to pedal on a bike for fifteen minutes and break a sweat, but avoid exertion that lead to discomfort or pain.

- Soothing music nature scenes with/without suggestion: these groups were either told or not told of the benefits of exercise on test anxiety and then watched a video with soothing music and images (Plante, et al, 1996).

Subjects were tested for anxiety levels pre-relaxation method, post relaxation method, and post intelligence test. The study by Plante et al. (1996) provided evidence that both exercise and suggestion may provide some stress inoculation effects for test anxiety. In her dissertation, Topp (1989) analyzed the effects of relaxation and exercise on test anxiety and found that test anxiety lowered with regular exercise and relaxation over a seven-week period. Cohen (1980) viewed test anxiety as a breathing challenge and offered right brain approaches for coping with test anxiety in her study. Cohen (1980) suggests that guided fantasy, deliberate laughing, progressive relaxation, deep breathing, and exaggerating feelings then reversing them are different ways to cope with test anxiety. In a recent dissertation, Johnson (2013) studied the effects of diffused aromatherapy on test anxiety. A cognitive test anxiety survey was used pre and post test to determine if diffusion of lemon oil aromatherapy lowered the test anxiety of college nursing students. Johnson (2013) found a significant decrease in test anxiety for those who's room has diffused lemon oil aromatherapy.

Skills training workshops have been researched as a method for lowering test anxiety (Damer & Melendres, 2011; Hart & Hart, 1996). Hart and Hart (1996) conducted a workshop with 28 students to clarify what examination anxiety was and ways to decrease it. The methods the researchers chose to include were improved study habits, positive self-talk, improving assurance, and learning to relax mentally and physically with hypnosis. Self-hypnosis tapes were given to the students to use over a four-month period before an important test. It was found that 96% of the sample expressed satisfaction with the workshop and every student that

participated expressed more confidence in being able to use skills to manage their test anxiety. After the exam four months later, survey results showed 59 percent of students had less pre-test anxiety and 53% less anxiety during testing. Hart and Hart (1996) also found that 53% of students reported using the self-hypnosis tapes from 2-5 times per week. Damer and Melendres (2011) created a group to help with student's suffering from test anxiety. The researchers reported that skill-focused approaches, such as study skills training and test-taking skills training paired with strategies related to cognitions, such as rational emotive therapy, and cognitive restructuring, reduced test anxiety. The study showed the same results with skill focused approached being paired with behavioral approaches like systematic desensitization, relaxation training, biofeedback and anxiety induction (Damer & Melendres, 2011). Putwain et al. (2010) suggested that instructors need to take an active role in working with school psychologists to help students gain mastery and learn not to fear testing situations. The researchers suggested that a way to limit test anxiety could be to enable students to not fear testing situations though pastoral and student support groups.

Hypnotherapy has been tested as well (Mathur & Waheeda, 2011). The researchers defined test anxiety by its symptoms of headaches, high body temperature, nausea, feelings of fear, feelings of helplessness, fidgeting, pacing, avoidance, racing thoughts, blank thoughts, poor concentration, dreadful feelings, talking negatively to self, and problems with thought organization (Mathur & Waheeda, 2011). A pre/post test anxiety evaluation was given to children with test anxiety that used hypnosis techniques of relaxation, positive suggestions, and psychoeducation to calm their stress. Every student in the study showed a decrease in test anxiety and an increase in test performance.

Understanding Prayer

The word “pray” originates from the word *precari* in Latin, which means to entreat or to ask (Das & Anand, 2012). Prayer has since been defined in many different ways, since it is a term that can be used among a plethora of different contexts and cultures (Finney & Maloney, 1985; Giardini, 1987; Levin & Taylor, 1997; Pargament, 1990). James (1904) gave a generalized and historically well-accepted definition of prayer, defining it as every kind of internal communication with a power recognized as divine. Dehghani et al. (2012) more recently defined prayer as human communication with divine and spiritual entities. The point of that communication is to create meaningful relationships with the deity being prayed to (Park, 2005; Silberman, 2005). Stanely (2009) defined prayer as different than meditation in that it is singularly focused on God and losing oneself into God through love and grace. Das and Anand (2012) further express that prayer can be either individual or in groups, and is an essential tool of spiritual practice.

Ladd and Spilka (2002) believed that the work by Laird, Snyder, Rapoff, and Green (2004) and others who have developed prayer measurements have semantic overlap. Ladd and Spilka (2002) contend an unclear definition of prayer is prominent and prayer, like test anxiety, is a complex multidimensional construct. The researchers build on Foster’s (1992) theoretical framework that all prayer variations merge due to their purpose of linking the one who prays with a specific truth/deity. Foster (1992) proposed three unique, yet intertwined directions of prayer: inward, outward, and upward.

- Inward prayers were said to highlight self-examination.
- Outward prayers were said to concentrate on strengthening human-human relations.

- Upward prayers were said to focus on the human-divine connection.

Ladd and Spilka's (2002) study applied Foster's (1992) outline to cognitions linked to prayer. The researchers created a 153-item scale determining inward, upward, and outward prayer types associated with unique cognitions. The study provided a theoretically feasible model of the multipart web of associations among inward, outward, and upward directions of mental activities during prayers, thus showing that prayer is unique to each individual that partakes in the practice.

Ladd and Spilka (2006) explain that there are a lack of models for grasping the role of prayer in faith, so they remedied the situation by proposing a theoretical basis for understanding prayer as a means of making mental associations. The researchers validated their model of prayer among three main factors and eight subgroups. The model was shown to be valid with a confirmatory factor analysis and convergent/divergent validation from a selection of measures in social psychology and its subfield. Ladd and Spilka (2006) again advanced that there were three types of prayer described: inward, outward, and upward and different factors lend themselves to each type of prayer. Ladd and Spilka (2006) maintain that understanding and grasping prayer as connectivity is a theme expressed in music, nature, and theology.

Christian prayer has historically been a vital element for a life of transformation and essential to a life journey towards stability, honesty, and completeness (Stanley, 2009). Christian prayer is a type of prayer that believers of Jesus Christ use to stay in communication with God, who shows Himself and speaks to humans through Jesus and the books in the Holy Bible (Constable, 2003). Christians believe prayer is a form of concentrated communication with God that is often preferred in times of stress and anxiety by followers of Jesus Christ (Weld & Eriksen, 2007). Christians, through this prayer, experience a personal relationship with God and

are able to seek help and reassurance directly, feeling as if God is an advocate or trusted friend (Pargament, 1997; Poloma & Gallup, 1991) Some prayer types are less focused and more meditative, with the person praying not going in any particular direction, but concentrating on the feeling of God's presence (Breslin & Lewis, 2008; Pargament, 1997).

The Use and Benefits of Prayer

Researchers have attempted to measure and quantify prayer and its benefits (Benson et al., 2006; Boelens, Reeves, Replogie, & Koenig, 2009; Stanley, 2009; Tloczynski & Fritzsich, 2002; Vannemreddy, Bryan, & Nanda, 2009; Whittington & Scher, 2010). The results determining the effects of prayer in times of need are mixed (Benson et al., 2006; Boelens et al., 2009; Stanley, 2009; Tloczynski & Fritzsich, 2002; Vannemreddy et al., 2009)

Research reviewing the nature of different types of prayer and their potential to create better health has been conducted (Breslin & Lewis, 2008). All individuals are said to pray to some degree, but in different ways including: adoration, contemplation, devotional, sacrificial, invocation, resignation, thanksgiving, objective, subjective, meditative, ritual, petitionary, colloquial, attunement, praise, tears, relinquishment, examine, suffering, rest, radical, intercession, reparation, and lamentation (Ameling, 2000; Clark, 1958; Foster, 1992; Goehring, 1995; Heiler, 1932; Ladd & Spilka, 2002; McKinney & McKinney, 1999; Richards, 1991). There are many ways that different types of prayer can positively affect health, and future researchers need to take heed of the prayer type selected when they choose the direction of their study (Breslin & Lewis, 2008).

The affects of six different prayer types on subjective well being of individuals was conducted (Whittington & Scher, 2010). Prayers of adoration, thanksgiving, supplication, confession, reception, and obligation were studied. Prayers of thanksgiving were noteworthy

predictors of personal well-being, self-esteem, and hopefulness (Whittington & Scher, 2010). Prayers of reception were revealed as positive predictors of positive self-esteem and optimism. The research showed that prayer types with positive effects on well-being are less centered on the person praying and more on the figure being prayed to.

Person-to-person prayer is one type of prayer that has been studied, especially in regards to anxiety, depression, optimism, and stress levels (Boelens et al., 2009, 2012). Participants that received prayer intercessions showed noteworthy improvement in symptoms of depression and anxiety, as well as surges in daily spiritual practices and hopefulness. The findings uphold the idea that “prayers significantly lower the level of depression and anxiety while they concomitantly elevate the level of optimism and spirituality” (Boelens et al., 2009, p. 389). A one-year follow up study was completed (Boelens et al., 2012). In the original study, there were six one hour prayer sessions performed in an office setting conducted by a single lay prayer minister who was a non-denominational Caucasian college graduate. ANOVAs were used to compare the findings of pre-prayer, post prayer groups, one month post prayer groups, and one-year post prayer groups. Boelens et al. (2012) found that subjects post-prayer at one month and one year showed considerably less depression and anxiety, increased optimism, and higher levels of spiritual experience than did the baseline (pre-prayer) measures. Boelens et al. (2012) concluded that it is conceivable that participants activate a form of prayerful self-directed neuroplasticity, and the effects of prayers maintained over time could lead to permanent structural changes in the brain. The researchers suggested that direct person-to person prayer provides a modality of treatment worthy of future studies (Boelens, et al., 2012).

It has been proposed that prayer has healing health benefits, but that research has been confounded by the notion that all prayer types are interchangeable (Stanely, 2009,

Vannermreddy et al., 2009). Research on patients with head injuries was conducted to determine if prayer had an effect on healing. Results showed significantly more recovery from brain injuries in the group with regular prayer habits (Vannermreddy et al., 2009).

Stanley (2009) hypothesized that a person's relational approach to prayer relates to overall well-being. Stanley (2009) believed that measuring heart rate variability is one way to determine autonomic nervous system balance, which indicates a person's physical health. Five volunteers were chosen to pray with five different prayer styles, including: supplication, devotion, intercession, gratefulness, and contemplative. Results of the study by Stanley (2009) showed that prayers of supplication, devotion, and intercession were associated with higher levels of autonomic nervous system balance, which suggested a stress-neutralizing shift in the body. Stanley (2009) affirmed that his study parallels assumptions of ancient Christian healing beliefs, showing that prayer is a way to promote homeostasis in the body, and thus increase well-being.

People unknowingly being prayed for have reported decreases in anxiety (Tloczynski & Fritsch, 2002). Upper level college students were unknowingly prayed for by an undisclosed experimenter for seven weeks. Participants were given a pre/post-test that measured their anxiety/depression levels. Daily prayer included a ten-minute meditation period followed by a two-minute minimum intercessory period by the experimenter. The study findings revealed a significant decrease in anxiety for those prayed for versus those who were not prayed for (Tloczynski & Fritsch, 2002). Prayer is also a desired by those who are seeking mental health care (Weld & Eriksen, 2007). Clients in clinical counseling have been shown to want audible prayer in the counseling sessions, preferred the subject of prayer be brought up by clinicians, expected prayer to be a part of the counseling process, and wanted the counselor to pray for them outside of sessions (Weld & Eriksen, 2007).

Prayer is a technique that is used by coaches as well. Egli et al. (2014) conducted research on Christian coaches utilizing prayer as part of their profession. The researchers explained that prayer is used frequently by athletes to cope with difficulties in sports, but that coaches have not been studied. Four qualitative themes came to existence from the study of six coach's interviews. They were: reliance upon God's guidance, roles of coaching, prayer types, and subtle influence (Egli et al., 2014). The study found that prayer was a way of life for the subjects and a determining factor of their individual identity and coaching identity. Participants in the study reported Christian prayer to be rewarding and a source of energy for their overall well-being.

Prayer and the Brain

There has been detailed neurological research on where exactly prayer is located in the brain and how it affects the brain (Beauregard & Paquette, 2006; Borg, Andrée, Soderstrom, & Farde, 2003; Owen et al., 2011; Schjødt, Stødkilde-Jørgensen, Geertz, & Roepstorff, 2008). A correlation between self-transcendence (which was synonymous with spirituality) and serotonin receptor density has been established (Borg et al., 2003). It was indicated that the serotonin system might serve as a possible biological basis for spiritual experiences (Borg et al., 2003). The neural underpinnings of religious experiences in Carmelite Nuns were studied and several brain regions/systems were associated with religious experiences (Beauregard & Paquette, 2006). It was hypothesized that the right middle temporal initiation during the religious state was linked with the subjective impression of communicating with a spiritual reality (Beauregard and Paquette, 2006).

Spiritual prayer is capable of exciting the dopaminergic reward system in practicing persons (Schjødt et al., 2008). Analysis revealed a noteworthy main outcome of religious

praying in the right caudate with peak stimulation in the head. Results suggested that, “intrinsic belief in God and a high confidence that God reacts to one’s prayer may have similar effects” (Schjødt et al., 2008, p. 167). The findings provide respected insight on how prayer is reinforced at a neuronal level, and it could be an important rung towards understanding why dedicated believers succeed in motivating a range of recurrent behaviors (Schjødt et al., 2008).

Prayer has also been shown to possibly have a negative effect on the brain. Owen et al. (2011) measured brain changes of elderly men and women who were diagnosed with depression and consider themselves active in their religious lives. The participants were chosen, interviewed every two years, and given an MRI every two years. The study results showed that life changing religious experience at baseline was related to atrophy of left and right hippocampi at follow up (Owen et al., 2011). Born again protestant populations were shown to have more atrophy than non-born again protestant groups (Owen et al, 2011). Catholic groups were also shown to have more atrophy in the left hippocampus over time when compared to non-born again Protestant populations (Owen et al, 2011).

Prayer and Anxiety

Since God is an important attachment figure for many people who may suffer from anxiety (Ellison, Burdette, & Hill, 2009), researchers have studied the interrelation between prayer and anxiety (Das & Anand, 2012; Harris, Schoneman, & Carrera, 2002; Koenig, George, Blazer, & Pritchett, 1993; Meany, McNamara, & Burks, 1984; Zeng, 1996).

Zeng (1996) expressed that exams generate a tremendous amount of anxiety and hope, in which religion can be a response to both. The relationship between anxiety and religion amongst 1,299 older adults has been conducted (Koenig et al., 1993). The researchers affirmed that studying religion and anxiety typically follows three hypotheses. The first is that religion

increases anxiety due to religious practices supporting the idea that conflict comes from the restraint of human drives. The second is anxiety decreases and/or is moderated with religiousness since scripture and worldviews are supportive and comforting for believers. The third hypothesis is religion stirs up anxiety and then calms it. The study found the first, second, and third hypotheses were not fully supported—but partially supported and changed with different variables such as religious denomination and physical health. Koenig et al. (1993) proposed a new fourth hypothesis that individuals with ill health or recent trauma would turn to religion to seek relief from anxiety. The study found that the more difficulties an individual faced, such as injury, poverty, or being a minority--the more likely they were to turn to religious activities as a coping mechanism in their lives.

Prayer has been found to be a key coping source for persons facing elevated levels of emotional suffering, and this is particularly the case when other possible coping responses are unreachable or unsuccessful (Das & Anand, 2012; Ellison, Burdette, & Hill, 2009). The physiological effects of praying to Jesus have been studied by thermal biofeedback (Meany et al., 1984). Research has demonstrated a difference between body temperatures and physiological stress levels (Meany et al., 1984). Subjects held a thermometer between their thumb and middle finger for the thermal biofeedback readings. Compared to other prayer types, the Jesus prayer was shown to be the most relaxing since it had the highest temperatures associated (Meany et al., 1984). The researchers hypothesized that trying to relax can potentially be less relaxing than prayer, which is “a goal far beyond relaxation” (Meany et al., 1984, p. 66). Das and Anand (2012) proposed the question of whether or not prayer had an effect on stress by testing for galvanic skin responses in university students. The researchers chose the galvanic skin response (GSR) test since it is a test that accurately measures psychological and/or physiological arousal.

GSR scores were measured pre/post prayer for 3 days straight. Pre/post testing showed significant differences between pre prayer GSR scores and post prayer GSR scores. GSR scores among the twenty university students being tested showed that prayer increased relaxation and decreased stress. It is indicated that prayer, due to its potential to decrease stress related problems, is an important research topic.

Prayer has been shown to lower anxiety (Dehghani et al., 2012; Harris et al., 2002). It has been found that concentrated and related religiousness (i.e. prayer and commitment to faith) related to significantly lower levels of trait anxiety in undergraduate college students (Harris et al., 2002). Students who were active with their religious relationship with God (i.e. more prayer) had lower levels of trait anxiety (Harris et al., 2002). Cancers are one of the most common diseases that cause fear and anxiety in children and their and their families, and praying is one of the methods that can be used for reducing anxiety (Dehghani et al., 2012). The effects of prayer on anxiety in mothers whose children had cancer were studied and it was found that mothers who prayed for three weeks (three times a day, 10 minutes per session) had less anxiety (Dehghani et al., 2012). The mean score of anxiety in mothers was significantly reduced after praying, affirming that religion, belief and spirituality played an important role in management of anxiety.

Conclusion

Test anxiety is a phenomenon that has been academically studied since the 1950's that still affects many college students today (Gallagher & And, 1992). Students are impacted by test anxiety, which impacts their collegiate success (Ackerman & Heggstad, 1997; Bonaccio & Reeve, 2010; Casbarro, 2004; Hembree, 1988; Putwain, Seipp, 1991; Woods, & Symes, 2010). It has been established that students not only suffer from test anxiety, but also want assistance with coping with it (Gallagher & And, 1992; Sarason & Mandler, 1952; Zeidner & Nevo, 1992).

With the amount of pressure students face in college, new research is necessary on techniques to lower test anxiety. Test anxiety affects both thoughts and physiology of test takers (Sarason, 1984) but research has moved toward the cognitive aspects of test anxiety, concentrating on the view that test anxiety is correlated with thoughts unrelated to evaluations themselves (Caparo & Linnell, 2012; Decaro et al., 2011; Hagtvet, 1983; Morris & Liebert, 1970; Weinstein, 1982; Wine, 1971).

The Cognitive Attentional Theory (Sarason & Mandler, 1952; Sarason, 1984; Wine, 1971) as a framework helps to gain clarity on the phenomenon of test anxiety. At this time, limited research has been done on the topic of Christian prayer and test anxiety. Test anxiety is a phenomenon that is present from grade school to college, in which research is needed on potential ways to eliminate the negative effects it creates. By framing test anxiety as a lack of concentrated attention on the task at hand, it can be supported that a form of concentrated attention, such as Christian prayer, may be a successful method for lowering test anxiety and is worthy of study investigation.

Chapter III

Design and Methodology

Introduction

Test anxiety has been shown to have a negative impact on individual's test performances by impacting their ability to concentrate (Chappell et al., 2005; Salend, 2012; Weinstein, Cubberly, & Richardson, 1982; Wine, 1981). The purpose of this study is to test focused Christian prayer as one hypothesized option for lessening test anxiety in college students. This research is concerned with the relationship between test anxiety and prayer, as understood within the scope of the Cognitive Attentional Theory (CAT) of test anxiety. The questions for this research study are aimed at evaluating the effect that Christian prayer has on test anxiety in college students.

Research Design

According to Zeidner (1998), "Experimental design serves to guide the test anxiety researcher in the process of collecting, analyzing, and interpreting observations in order to answer critical questions at the heart of the research as validly and accurately as possible" (p. 101). To gain clarity, oftentimes more than one type of data can be interwoven to give a better understanding of the research (Ivancova, Creswell, & Stick, 2006). Since the topics of prayer and test anxiety are exclusively subjective, the methodology best suited for this study is an explanatory sequential, mixed methods study (Creswell, 2012). Research has shown that mixed methods studies are a unique way to gather information on a topic (Ivancova et al., 2006; Spratt et al., 2004). When conducting research, quantitative data collection followed by qualitative data collection is can be referred to as explanatory design (Creswell, 2012). The idea is that the qualitative portion of the research study will be used to help explain the quantitative data that is

collected beforehand (Creswell, 2012). It is important to note that the inference can go either way, but priority of the data in relation to the topic needs to be established (Creswell, 2012).

Ivancova et al. (2006) created a visual model for helping to simplify the mixed-methods sequential explanatory design procedures that progressed as follows:

- Quantitative Data Collection
- Quantitative Data Analysis
- Connective Quantitative and Qualitative phases
- Qualitative Data Collection
- Qualitative Data Analysis
- Combination of the Quantitative and Qualitative Outcomes (Ivancova, Cresswell & Stick, 2006)

Qualitative and quantitative sections can be reversed, but there needs to be consideration in doing so, making sure the information gathered can best answer the research questions being proposed (Ivancova, Cresswell & Stick, 2006).

Participants

In this study, 52 college students from a Christian University in the Northwest United States signed up for initial participation. Permission was granted from the college research board (See Appendix G) and the Biosafety Committee (See Appendix I). Participants in the study signed an informed consent form before participating in the research (See Appendix L)

For the quantitative portion of the study, 52 participants were recruited as volunteers by the lead researcher (See Appendix J) in four different disciplines (psychology/biology/history/kinesiology) on campus. The 52 students were selected with the assistance of four professors from the university. Each professor offered students a small

amount of extra credit for their participation in research on campus, which was said to be less than ten percent of the final grade for the course. The professor and lead researcher told students there was a chance to win \$100 by participating in the research study. The lead researcher attended the class settings and gave out a sign up list (See Appendix K) asking for student names, email addresses, and telephone numbers if they were interested in participating. Students from each list were emailed and asked to participate in the study, of which 52 agreed to participate. Students were informed that participation was voluntary and if they signed up to help, they could leave the research process at any time. Four students did not complete the study, thus making the sample of participants 48.

For the qualitative portion of the study, two focus groups (n=7, n=4) of students were determined based on the subjective importance of prayer in student lives. The focus groups were scheduled and conducted face to face with participants. The participants selected were students who were determined during the quantitative portion to value prayer in their lives as very important or somewhat important. There was hope to have a third focus group that labeled prayer as not important at all, but of the three students who determined prayer to be unimportant, zero agreed to discuss their position in more depth. This fact is addressed in the limitations section of the study. The qualitative focus group interview guide can be found in the appendices (See Appendix T).

Physiological Measures of Test Anxiety

Physiological measures of test anxiety have been used as a way to understand the phenomena (Zeidner, 1998) and measures of breathing, muscle tension, heart rate, blood pressure, and brain scans have been increasing over the years (Morris, Kratochwill, & Aldridge, 1988). Salivary measures of stress are accurate and non-invasive, making them an ideal way to

measure the stress response of research subjects with test anxiety (Kirschbaum & Hellhammer, 2000). There are many ways to collect saliva of individuals with the most common being passive drool collection, suction devices, and absorbent materials (Nader & Rohleder, 2009). According to research, measuring salivary stress levels is now the primary way to collect data on stress in humans and animals (Kirschbaum & Hellhammer, 2000). Since other research (Nater et al., 2005) has shown psychosocial stressors increased heart rate (HR), salivary alpha-amylase (SAA) and salivary cortisol (SC) , the three biomarkers were used to evaluate testing anxiety.

Heart Rate

Research by Kantor, Endler, Heslegrave, and Kocovski (2001) has shown a correlation of increased HR and test anxiety. The researchers measured the anxiety levels of students during and after a presentation using the trait anxiety questionnaire and heart rate monitors. The researchers found that heart rate was elevated during the presentation with anxiety peaking within the first fifteen minutes of the presentation. Kantor et al. (2001) found that heart rate was correlated with self-report of anxiety scores, and thus a predictor of anxiety in subjects.

For the current study, heart rate was measured by a fingertip heart rate/pulse oximeter by Gurin Santamedical, know as the SM-110 finger pulse oximeter (see Appendix 19). Twenty heart rate monitors were purchased and tested before the experimentation took place. The HR monitors were said to be accurate with a standard deviation of 2bpm (see Appendix 19).

Heart rate was taken a total of four times during the study, each by the student.

1. A baseline measurement of HR was gathered by taking a HR measurement one week prior to experimentation.
2. HR was again measured upon arrival to the experimentation meeting.
3. HR was taken upon introduction of the stressor.

4. HR was taken after the experimental conditions were initiated.

Salivary Cortisol (SC) and Alpha Amylase (SAA)

Researchers (Smyth et al., 2013; Kirschbaum & Hellhammer, 2000) posit that the hormone cortisol is the primary hormone responsible for stress responses in humans and animals, and that measuring cortisol in saliva can be a way to determine the amount of stress a person is experiencing. Kirschbaum and Hellhammer (2000) identify that salivary cortisol tests are much less invasive than blood tests, and stimulate less anxiety than the blood test process itself, which often confounded results of stress tests. The researchers claimed salivary testing for cortisol levels is now the primary way to collect data in humans and animals. The enzyme of SAA is a useful biomarker for determining the response of the SAM/ANS system, which is aroused at the presentation of stressor (Chen et al., 2014; Kennedy et al., 2001; Lake et al., 1984; Skosnik et al., 2000; Walsch et al., 1999). Payne (2014) express that SAA levels may be an important biomarker of stress in people in evaluation situations.

Granger, et al. (2012) suggested that gathering saliva by “passive drool” minimized risks of losing validity and the optimal design for measuring salivary cortisol and SAA is a pre/pre/task/post/post/post sampling scheme. For the current study, there was a pre/pre/stressor/post/post sampling scheme used. Students had their saliva taken a week before the stressor, prior to the stressor, immediately after the stressor was taken, and twenty minutes post stressor after an experimental condition (prayer/meditation/study guide) was introduced.

The measurement s looked as follows:

1. A baseline measurement of SC and SAA was gathered by taking a saliva sample measurement one week prior to experimentation.

2. SC and SAA was again measured through saliva samples taken upon arrival to the experimentation meeting.
3. SC and SAA was measured a thirist time after saliva was taken upon introduction of the stressor.
4. SC and SAA were measured after saliva was taken a final time at the conclusion of the experimental conditions.

A research assistant and PhD biology professor were utilized to run the Elisa testing on the assay testing kits provided by Salimetrics since the primary researcher is not trained in saliva analysis or saliva testing. The research assistant held training in biological ELISA testing, which was used to analyze the saliva collected.

For the collection and analysis of the saliva samples, instructions were shipped with the saliva collection kit from Salimetrics (see Appendix V/23), which were adequate training for collecting saliva specimen. A representative of Salimetrics was also contacted along the process to confirm the results of the assay tests.

The lead researcher in both the baseline and experimental meetings gathered saliva samples. The lead researcher wore gloves in each collection scenario and put the saliva samples in containers provided by Salimetrics. Saliva samples were then stored for 1 week in a low temperature refrigerator. Saliva samples were assayed for SAA guided by the kinetic reaction assay kit from Salimetrics (Salimetrics, State College, PA) (see Appencix 22/23). The assay kit utilizes a chromogenic substrate, 2-chloro-p-nitrophenol linked with maltotriose. The enzymatic action of SAA on the substrate produces 2-chloro-p-nitrophenol that can be spectrophotometrically valued at 405 nm using a plate reader in a biology lab. The quantity of SAA activity existent in the sample is directly relative to the surge in absorbance at 405 nm.

Results were computed in U/ml of SAA using a formula provided by Salimetrics (see Appendix 20). Intra-assay variation (CV) computed for the mean of the replicate tests was less than 5%. Inter-assay variation computed for the mean of average duplicates for 16 separate runs was less than 6%. Samples were also assayed for salivary cortisol using a highly sensitive enzyme immunoassay US FDA (510 k) accepted for use as an in vitro analytic gauge of adrenal function (Salimetrics, State College, PA). The evaluation used 25 μ l of saliva (for singlet determinations), had a lower limit of sensitivity of 0.007 μ g/dl (0.19 nmol/L), range of sensitivity from 0.007 to 1.8 μ g/dl (0.19 to 49.7 nmol/ L), and average intra- and inter-assay coefficients of variation of less than 5% and 10%, respectively.

Data Collection—Baseline Meeting

According to Zeidner (1998) experiments in test anxiety research need to be carried out in realistic situations. To do this, students from four disciplines were offered the opportunity to participate in research where they were told they could have a chance at winning \$100. Prize money was offered as a way to increase the perceived importance of the test, and thus increase the level of pre-test anxiety.

Students were informed there would be two meetings. Students were randomly distributed from the lists obtained in the classes and put into three groups unique groups. Students were then emailed one week prior to the first meeting date and invited to attend the study. The three different groups of students were selected to meet on three separate occasions: 4pm, 5pm, and 6pm. In that email, students were told that they could not eat one hour prior to attending the research, as well as not consume alcohol 12 hours before the meeting. During the first meeting, to determine a baseline HR, SC, and SAA—the following took place:

1. An introduction by the researcher and a verbal thank you.

2. Students were each given a water bottle twenty minutes before the saliva was first obtained and asked to wash out their mouths if they had eaten food within one hour of the meeting.
3. A packet was given to the students (see Appendix L) containing the consent form, and heart rate/saliva collection procedures.
4. A script was followed in each meeting by the lead researcher (see Appendix M).
5. Students took their own heart rates with electronic fingertip heart rate monitors and wrote them down on the paper.
6. Students then collected their saliva in a small tube and set it aside.
7. Students completed the Westside Test Anxiety Scale (WTAS) (Driscoll, 2004).

The Westside Test Anxiety Scale (WTAS) is free to the public for use in test anxiety research and has been evaluated both validity and reliability (Driscoll, 2004; Onyeizugbo, 2010). The WTAS (Driscoll, 2004) was validated through the correlation of anxiety reduction and test performance improvement across two diverse samples: college students and fifth graders. Anxiety reduction interventions were given to the experimental groups in each sample and anxiety/test scores were taken prior to the study and post interventions (Driscoll, 2004). The anxiety lessening profits measured by the WTAS correlated .40 and .49 with gains on test scores for fifth grade and college students, showing a respectable validation coefficient ($r=.44$). An unpublished study by Onyeizugbo (2008) also found the WTAS to have an alpha of .78, with a split half reliability of .77 as well as a concurrent validity of .51, $p < .001$, when correlating the WTAS with trait anxiety (Spielberger et al., 1983).

A question related to prayer importance was added after the WTAS for the purpose of creating focus groups in the qualitative portion of the study and for further examination of the

quantitative data. The question simply asked students how important prayer was in their lives: very (1), somewhat (2), or not at all (3).

The WTAS categories were broken down as follows:

- (1) 1.0—1.9 Comfortably low test anxiety
- (2) 2.0—2.9 Normal or average test anxiety/High normal test anxiety
- (3) 3.0—3.9 Moderately high/High test anxiety
- (4) 4.0—5.0 Extremely high anxiety (Driscoll, 2004)

Data Collection—Experimental Meeting

Three groupings of students were randomly created based on results from the WTAS. The goal of creating the groups was to have an equal amount of Low, Low Normal, Moderate High/High and Extreme High test takers in the experimental groups. It would not provide sound research to have all high test anxiety students in one group and all the low in another. After the students were put into stratified groups, they were emailed of their second meeting time. The meeting times were all within 2 hours of the original meeting time as not to disrupt any diurnal readings of SC, SAA, or HR. The researcher made sure to take saliva samples twenty minutes after the stressor, since according to research, the HPA axis responds immediately to stress, but takes roughly twenty minutes to peak (Smyth et al., 2013). Students were also recruited for their second meeting using a text message.

The three different groups of students were selected to meet on three separate occasions: 4pm, 5pm, and 6pm. The groupings looked as follows

Table 2

Research Groupings

Group	Group Explanation
One: Prayer (4 pm)	HR measured/Saliva Collected, Stressor introduction, HR measured/Saliva Collected, Focused Christian Prayer time (20 min), HR/ Saliva Collected.
Two: Meditation (5 pm)	HR measured/Saliva Collected, Stressor introduction, HR measured/Saliva Collected, Guided meditation time (20 min), HR/ Saliva Collected.
Three: Study Guide (6 pm)	HR measured/Saliva Collected, Stressor introduction, HR measured/Saliva Collected, Study guide time (20 min), HR/ Saliva Collected.

The experimental process went as follows:

1. Upon arrival, students were told that if they had eaten within 12 hours of their time, they needed to wash their mouths out with water again.
2. Students were given another packet for the day of experimentation (see Appendix N).
3. A script was followed by the lead researcher (see Appendix O).
4. Students collected saliva in the first of three small tubes and measured their HR.
5. After roughly twenty minutes reviewing the procedures for HR and saliva collection, students were told, deceptively, that they would be taking a new IQ test, and that not only would the highest two scores get a \$100 gift card, the results would be published on campus for the student body to see.
6. Student then immediately collected their saliva and HR again.

7. Students, depending on their group (meditation, prayer, or study guide), then received a handout containing pertinent instructions. The handouts were each printed and passed out individually (see Appendices 16, 17, and 18).
8. After the twenty minutes, heart rate/saliva were taken a final time.
9. Students were then debriefed and told that there was no test. Students were reminded that if any stress/anxiety continued after the research, the counseling office on campus and lead researcher were available.

Extra credit was awarded and two random students in the study were selected and given a \$100 gift card.

Intentional Deception

It is important to note that a key component of this study was deception. Deception was used to inform students they would be taking an "IQ test" and that scores were going to be published in an area for all test takers to see. The point of the deception was to create test anxiety in the testing individuals, since according to a meta analysis on studies of acute laboratory induced stressors, Dickerson and Kemeny (2004) found that the studies that have participants actively engage in tasks (i.e testing) and experience some loss of control and have a socially evaluative threat are the more reliable in producing biologically measureable stressful responses. Research on test anxiety has also shown that fear of negative reaction to poor test results is associated with higher levels of testing anxiety (DeCaro et al., 2011).

Experimental Conditions

Three different experimental conditions were chosen to assist in evaluating student test anxiety by the changes of HR, SC, and SAA. They were, as mentioned previously, focused

Christian prayer, guided meditation, and an IQ test study guide. Each experimental condition had a packet that was passed out to students (Appendices 12, 13, and 14).

For the focused Christian prayer section, four different prayer times happened in five minute intervals. The four sections were as follows:

1. Recitation of The Lords prayer (Matthew 6:9-13, New International Version).
2. An improvised personal prayer time.
3. A prayer based on research by Harris et al. (2005) written by the lead researcher that focused on asking Jesus for help in the current testing situation was read aloud by the group.
4. A second improvised prayer time.

The Lords Prayer is an improvised prayer and used frequently in Christianity. The study by Harris et al. (2005) used a correlational study to examine favored styles of prayer with trait anxiety and subjective anxiety control. A large group of college students took a prayer scale as well as two anxiety questionnaires. The study showed that the prayer type to give an increased sense of anxiety control and lower trait anxiety was the “provides assistance prayer function” (Harris et al., p. 409). This type of prayer was said to include asking God to help with challenging situations and to put things in God’s hands when they are too much to handle on a person’s own.

According to Harris, et al. (2005) the type of prayer that limited a college student’s anxiety and helped them feel more in control of their anxiety was asking God for assistance in prayer. As noted above, during the prayer time with the experimental group, a prayer was read together that asked God for assistance with the test that was being taken.

For the guided meditation section, a twenty minute guided meditation was gained from The Guided Meditation Website (<http://www.the-guided-meditation-site.com/subscribers-only-download-blissful.html>). The website's free twenty-minute guided meditation was said to "use guided imagery to help you relax and open your heart to a natural state of inner joy. It will leave you feeling calm, centered and rather wonderful indeed!" (<http://www.the-guided-meditation-site.com/subscribers-only-download-blissful.html>). The students were encouraged to take the guided meditation seriously as it played over the speakers in the room they were sitting.

The study guide section was created by using two practice exams gathered by Malhotra (2013) and displayed on two blogspot.com websites (<http://saveandmakemoremoney.blogspot.com/2013/04/check-your-iq-with-free-and-printable.html>; <http://allabout2011.blogspot.ca/2013/03/how-to-shine-in-gre-entrance-exam-and.html>). Both of the exams were put into a handout and used to help students focus for their perceived upcoming IQ test.

Qualitative Data Collection

The qualitative portion of the study is one that is phenomenological (Creswell, 2007). The purpose of the phenomenological portion of the study is to help clarify unique individual experiences to grasp an essence (Creswell, 2007). The unique subjective experiences of test anxiety and prayer were explored as ways to understand interrelation of the phenomena.

For the qualitative portion, students were expected to be in three different groups based on their answer to the question about prayer importance at the end of the WTAS given during the first meeting. Due to the fact that there were only three participants who labeled prayer as not important at all, and all three rejected to be interviewed, two focus groups were created based on

the categories of prayer importance in student lives. Student were randomly selected with the use of Microsoft Excel and two focus groups took place in the campus library.

Much information was gained when doing the qualitative portion of the research. For the purpose of structure and efficiency, transcendental phenomenology (Moustakas, 1994) was used as a guiding method. Transcendental phenomenology is one way of seeing everything for the first time, and consists of:

- Identifying the phenomena to study
- Bracketing out one's own experiences
- Collecting data from several persons who experience the phenomena
- Reducing the experiences to significant statements or quotes and creates themes
- Creation of a textual description of the experiences of the persons
- Creation of a structural description of how the phenomena is experienced
- Creation of an overall essence of the phenomena/experience (Moustaka, 1994)

Two focus groups were conducted based on the guidelines by Moustakas's (1994)

Transcendental phenomenology. The two main questions being asked were:

- What have you experienced in terms of test anxiety?
- What contexts or situations have typically influenced or affected your experiences of test anxiety?

Some of the open-ended follow up questions were:

- What is prayer/meditation to you?
- Do you pray and or meditate before a test? If so, what does prayer and/or meditation do for you before a test?
- Do you think prayer helps with your test anxiety?

- Do you feel that prayer is a common strategy used before tests?

The questions were piloted one month previous to the interviews in order to gain clarity on the topic matter and question composition. The interviews were recorded on video with a secure computer and a secure audio device. A research assistant who signed a consent form transcribed the data from the interviews (see Appendix U).

Confidentiality

Participants were initially assigned a testing code by the researcher as their identifier number from the email addresses they provided on their sign up lists. The researcher assigned the codes, and thus had some knowledge about the identity of the participants and their testing codes. Data was kept confidential on a password protected excel document on a password protected computer. The names list was coded from the initial sign-up sheet. No individual identities were used in any reports or publications that resulted from the study. All data from notes, audio files and discs were encrypted with a password known only to the researcher. In compliance with the Federal wide Assurance Code, data from this study will be kept for three years, after which all data from the study will be destroyed (45 CFR 46.117). The other professionals who had access to the data in the study each signed an informed consent in order to maintain the confidentiality of the data (See Appendix U). Those who had access were: the dissertation committee chair, one biology student and one biology professor, and one data transcriber.

Analytical Methods

For the current mixed methods study, the researcher used two different types of data analysis. For the quantitative section, the researcher used SPSS (IBM SPSS, 2014) to analyze the data. The researcher chose to use an inferential analysis (Creswell, 2012; Tanner, 2012) and an

ANOVA to look at HR, SC, and SAA between groups who prayed, meditated, and studied before a test.

For the qualitative section, in order to conceptualize and analyze the qualitative results, the researcher had interviews recorded on audio, and then transcribed (Creswell, 2012). The researcher then coded the information and identified common words and phrases to build themes--in order to make a cohesive analysis of the themes of the interviews/group (Creswell, 2012). Moustakas (1994), in relation to phenomenology, calls the process horizontalization. This was done so an overall essence could be gained from the data.

Risks

Students email addresses were coded in the initial phases of data collection. Students were informed of their right to withdraw at any point of the research process. All links of persons to the data was eradicated and saliva samples were destroyed at the end of the research. Data was saved on password-protected documents and on a password protected computer at all times. If any data was printed out, a professional shredding company destroyed it. Saliva was gathered in professional testing tubes and evaluated by an upper division biology student, trained in ELISA testing methods under the supervision of a PhD level biology professor. The testing supplies and saliva were disposed of in the biology lab by their procedures for eliminating biological specimens.

Participants were given a copy of the consent form on their first meeting, which gave the researcher's information in the event of trauma. In the event of trauma, the campus had a wellness center with free counseling. The primary researcher is an experienced licensed clinical social worker in the area, with multiple contacts in mental health field if the wellness center was not able to meet student needs.

For the quantitative portion, students had their heart rates measured, their saliva taken, and were given a questionnaire and IQ test. The risks, as outlined in the HRRC handbook, are the collection of human saliva and the use of deception. Students giving their email addresses and having them linked to test scores may be linked to a risk of embarrassment if not confidentially stored. Student saliva samples, if not handled properly or destroyed, could pose some risk to those who handle them.

For the qualitative portion of the study, students were asked to meet for a short interview related to test and anxiety and prayer. Students were informed that they could leave the interview at any point. If the student were to see someone they knew, or have a stranger over hear the conversation, confidentiality could be compromised.

Limitations

Each study has different ways that it can be limited. According to Zeidner (1998), a large concern with test anxiety research is if results can be generalized to populations at large. A few of the ways this study can be limited are mentioned here.

The fact that the students were tested in a controlled setting makes the situation artificial, and could either induce or decrease test anxiety for test takers. The sample size could have been larger for the study, with an idea number being over 80 participants. The fact that the study took place on a Christian campus also provided some limitation. It is easy to note that the groups were not equally sized when looking at prayer values. This is assumedly due to being on a Christian campus. Possibly on a non-Christian campus there would be more students who did not value prayer as highly. Students may have felt a pressure to pray, since they were being analyzed. Students may also have actively avoided prayer as a way to object to the cultural themes at the college they attended. The idea that anxiety levels may differ for students in

different fields could also be a potential limitation. In a dissertation by Johnson (2013), it was affirmed that nursing students have higher testing anxiety than other students. This may be true of other fields as well. It was also hard to grasp if students who were not instructed to pray, did so on their own.

Chapter IV

Results

Introduction

Studying the impact of Christian prayer as a potential method to limit test anxiety is valuable due to the impact that test anxiety has been shown to have on college students (Chappell et al., 2005; Salend, 2012; Weinstein, Cubberly, & Richardson, 1982; Wine, 1981). A proposed method to limit test anxiety is worthy of research since college students are stressed and many options are either not utilized or under-utilized (Gallagher & And, 1992; Robotham, 2008).

The purpose of the current study was to examine if focused Christian prayer had an impact on student test anxiety. Studying the effects of Christian prayer on test anxiety yielded interesting results. The findings from the research are found in the following chapter. The first research question was evaluated using quantitative data analysis, whereas the second question was investigated with two qualitative focus groups. The research questions that guided this dissertation study were:

1. Is there a difference in the physiological responses (Heart Rate, Salivary Cortisol, Salivary Alpha Amylase) to test anxiety of students who use focused Christian prayer compared to students who use meditation or a study guide?
2. How do college students believe focused Christian prayer impacts test anxiety?

As discussed in the previous chapter on the research methods, the data collection was completed using an explanatory mixed method design with the quantitative portion of

the study being conducted first, followed by the qualitative portion of the study. The quantitative portion consisted of measuring salivary biomarkers of test anxiety in college students including heart rate (HR), salivary alpha amylase (SAA), and salivary cortisol (SC). The qualitative portion consisted of conducting two focus groups with students that had different levels of test anxiety as determined by the Westside Test Anxiety Scale (Driscoll, 2004).

The following chapter goes on to highlight the results of the current research. The data is organized to first show the quantitative results in response to research question one, followed by the qualitative results in response to research question two. It has been stated by Mills (2007) that research strength can be improved by triangulating data sources from different bases. The mixed methods study design attempted to successfully triangulate both quantitative and qualitative data to help gain answers to the research questions proposed.

Research Question One: Quantitative Portion

Participant Demographics

Initially, the study had 52 students sign up for participation. Four students did not complete the entire study; therefore the sample for the quantitative portion was 48 students. The students were broken into three experimental groups: Prayer (18), Meditation (14), and Study Guide (16). There were 17 males and 31 females that participated. The mean age of the participants was 20.15 years old and the average score on the Westside Test Anxiety Scale was 2.89. The following table shows a summary of the demographics.

Table 3

Quantitative Portion Participant Demographics:

Demographics	
Participants (<i>n</i>)	48
Gender ratio (m:f)	17:31
Mean Age	20.15
Mean Test Anxiety Score	2.89

The Westside Test Anxiety Scale (WTAS) published by Driscoll (2004) is a valid and reliable method used to measure test anxiety in students. Studies that have used the WTAS indicate that the tool is a reliable way to measure different levels of test anxiety amongst students (Ali et al., 2015; Rajiah and Saravanana, 2014).

The WTAS measures different levels of test anxiety that interfere with testing capabilities, being split into six different levels, ranging from comfortably low test anxiety to extreme high test anxiety scores (Driscoll, 2004). For the current research, the categories were moved into four levels, broken down as follows:

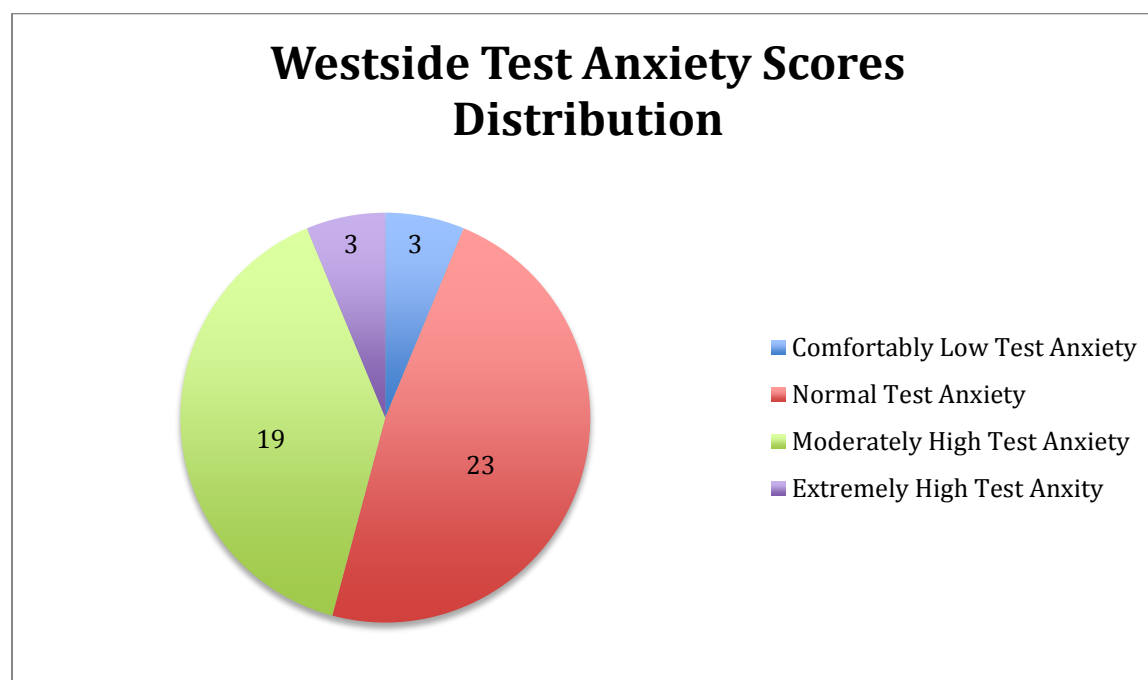
- (1) 1.0—1.9 Comfortably low test anxiety
- (2) 2.0—2.9 Normal or average test anxiety/High normal test anxiety
- (3) 3.0—3.9 Moderately high/High test anxiety
- (4) 4.0—5.0 Extremely high anxiety (Driscoll, 2004)

As with other studies, there are variations of each WTAS anxiety level dependent on the participant group selected (Ali et al., 2015; Rajiah and Saravanana, 2014). The mean WTAS scores for the study by Ali et al. (2015) for each of the two groups was 2.4 and 2.6—which is almost in the direct center of the spectrum. Due to the labeling of the categories by Driscoll (2004), it can be determined that normalized test anxiety rests between 2 and 2.9.

The following pie chart shows the distribution of the scores of the 48 participants on the WTAS, which was taken on the initial baseline meeting with the students. The students who showed comfortably low and extremely high test anxiety levels on the WTAS were each at 6.25% of the entire sample, or 3 students for each group. 39.58%, or 19 students, of the entire sample of student's scores showed moderately high test anxiety. The final group was the students that scored in the normal test anxiety range, this was the largest group at 47.92%, or 23 students. The following figure depicts the distribution of WTAS scores.

Figure 11

WTAS Distributions

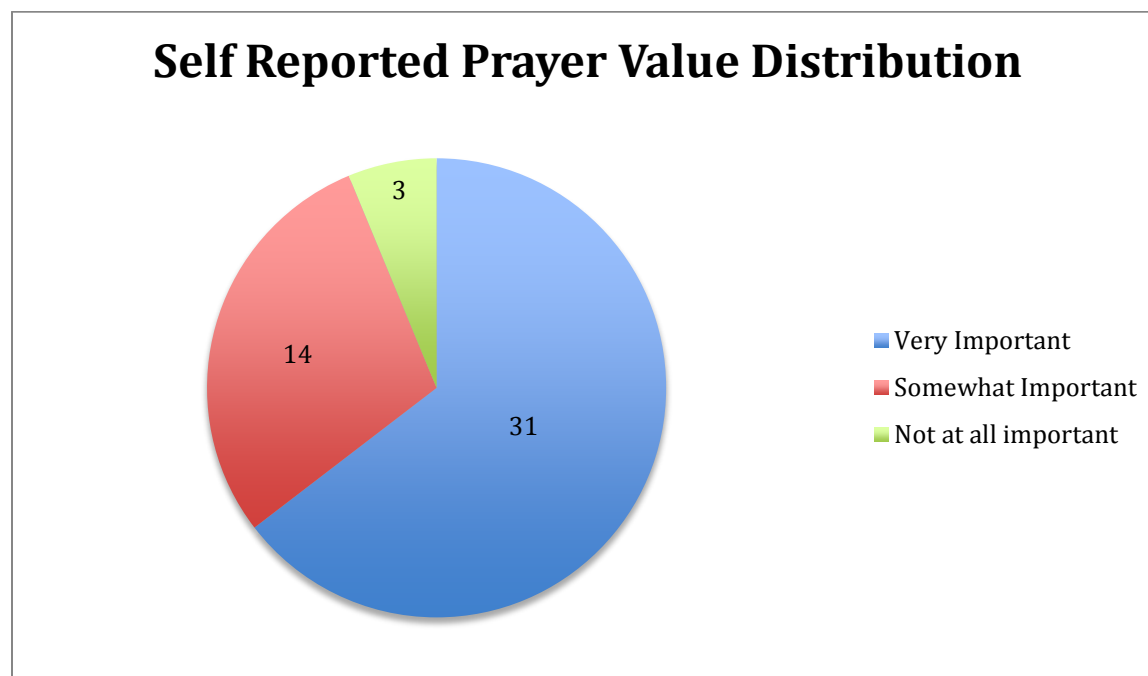


Students were asked at the end of the WTAS to rate the importance of prayer in their lives. There were three options given to the students: very important (VI), somewhat important (SI) not at all important (NI). The following figure shows the distribution of the self-reported

importance of prayer of the 48 participants. The largest category was the “very important” with 31 participants, with “somewhat” at 14 participants, and “not important” at 3 participants.

Figure 12

Prayer Importance Distributions



Results: Research Question One

For the quantitative data, the physiological biomarker measures were taken at four different times. The physiological biomarker measures were of heart rates (HR), salivary cortisol (SC) levels, and salivary alpha amylase (SAA) levels. The first set of measurements was taken during the baseline meeting at Time one; the following three measurements were taken during the experimental meeting at Times two, three, and four. The two meetings were one week apart from one another. The times were placed twenty minutes from one another in week two in order to help see SAA and SC changes, since they are not as quickly responsive as HR. The table below was created to help demonstrate the protocol for quantitative data collection.

Table 4

Meeting Time and Measurements Diagram

Baseline Meeting Week 1 (10/2/15)	Experimental Meeting Week 2 (10/9/15)
Time One: Heart Rate (HR) Salivary Cortisol (SC) Salivary Alpha Amylase (SAA)	Time two (Entrance): Heart Rate (HR) Salivary Cortisol (SC) Salivary Alpha Amylase (SAA) twenty minutes Time three (Stressor Presented): Heart Rate (HR) Salivary Cortisol (SC) Salivary Alpha Amylase (SAA) twenty minutes Time four (Directly after Experimental Conditions): Heart Rate (HR) Salivary Cortisol (SC) Salivary Alpha Amylase (SAA) (Hypothetical Test Time)

For the first question of the research, differences in physiological measures were obtained. Measurements of HR, SC, and SAA were taken at four different times. A test anxiety stressor was presented at Time three, and experimental conditions (prayer, meditation, study guide) were carried out between Time three and Time four. The test anxiety stressor was the student groups being told they were going to take a new form of an IQ test, where the two highest scores would be given a hundred dollar gift card. Students were also told the entire score sheet would be published on campus for anyone to see and potentially criticize. Research has shown consistently that test anxiety is increased with high stakes testing and the fear of

perception of inadequacy by others (Decaro et al., 2011; Kurosawa & Harackiewicz, 1995; Putwain et al., 2010).

In order to help determine if focused Christian prayer had any significant effects on test anxiety in college students, the changes in their heart rates and salivary biomarker levels were examined in SPSS using ANOVAs (IBM SPSS, 2014). ANOVAs were used as way to determine if there were differences among each test for the unique variables (experimental condition, WTAS scores, reported value of prayer importance) being measured. If the ANOVA revealed a significant p-score of less than .05, then SPSS was used to run Fisher's Least Significant Difference (LSD) test to determine where the differences between the groups were exactly. Along with the significance, effect size was calculated using a Cohen's D test and was reported as *d*. Cohen's D is used when comparing two means and is the difference of two group means divided by the average of the group's standard deviations. According to Walker (2008), "Cohen suggested that $d=0.2$ be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size. This means that if two groups' means don't differ by 0.2 standard deviations or more, the difference is trivial, even if it is statistically significant."

The following is a list of what was measured as part of the quantitative analysis:

1. HR measurements amongst students.
2. Salivary Cortisol measurements amongst students.
3. Salivary Alpha Amylase measurements amongst students.

HR measurements amongst students

Heart rates varied amongst the participants. The total range of HR's for all participants over the 4 times had a range of 50 bpm to 113 bpm. The average HR amongst the group, at baseline measurement (Time One), was 74.31 bpm. HR was looked at within the variables of

experimental condition (prayer, meditation, study guide), WTAS scores (comfortably low test anxiety, normal test anxiety, moderate high test anxiety, extremely high test anxiety), and Prayer Values (not important, somewhat important, very important).

For the experimental conditions, it was interesting to note that HR's did increase amongst each group when they came to the experimental session (Time two) from baseline (Time one). Not surprisingly, average HR did increase for each group from the baseline reading (Time one) to the presentation of the stressor (Time three). It was also not surprising to see the average HR drop after the experimental conditions had been applied for twenty minutes (Time four) after the stressor was presented (Time three).

The HR's, when looked at in terms of WTAS scores, also showed similar trends as the experimental groups. The heart rates amongst every group besides one test anxiety group (Moderate High) showed an increase in HR from Time one to Time three. As with the experimental groups, it was interesting again to see that HR's amongst all WTAS subgroups increased from Time one to Time two. Predictably, there was also a drop in HR amongst each subgroup from Time three to Time four.

Lastly, when looking at HR differences from the lens of how much prayer was valued by the participants (very important, somewhat important, not important), it was noted that those who valued prayer had lower heart rates across each measurement than the other two groups. Another pattern that emerged was that HR increased with prayer value for every time.

To help grasp the said differences in HR changes between the groups, the following table was created.

Table 5

Initial HR Data amongst Participants

Group	Average Heart Rate Time 1	Average Heart Rate Time 2	Average Heart Rate Time 3	Average Heart Rate Time 4
All Experimental conditions	Mean: 74.31 SD: 12	Mean: 77.50 SD: 10	Mean: 78.02 SD: 12	Mean: 75.91 SD: 11
Prayer	Mean: 76.17 SD: 9	Mean: 77.5 SD: 9	Mean: 79.61 SD: 10	Mean: 73.72 SD: 9
Meditation	Mean: 70.86 SD: 12	Mean: 77.57 SD: 11	Mean: 73.36 SD: 12	Mean: 71.43 SD: 13
Study Guide	Mean: 75.25 SD: 16	Mean: 77.44 SD: 12	Mean: 80.31 SD: 12	Mean: 76.13 SD: 13
WTAS—CL	Mean: 59 SD: 15	Mean: 64.66 SD: 10	Mean: 70.33 SD: 7	Mean: 65.33 SD: 10
WTAS—N	Mean: 71.74 SD: 12	Mean: 75.83 SD: 10	Mean: 76.95 SD: 12	Mean: 73.65 SD: 10
WTAS—MH	Mean: 79.53 SD: 9	Mean: 80.95 SD: 10	Mean: 79.42 SD: 12	Mean: 75.37 SD: 10
WTAS—EH	Mean: 76.33 SD: 16	Mean: 81.33 SD: 8	Mean: 85 SD: 10	Mean: 74.33 SD: 26
Prayer Value—NI	Mean: 78.33 SD: 14	Mean: 82.67 SD: 2	Mean: 81.67 SD: 13	Mean: 77.67 SD: 2
Prayer Value—SI	Mean: 74.85 SD: 17	Mean: 79.71 SD: 10	Mean: 77.79 SD: 9	Mean: 77.29 SD: 14
Prayer Value—VI	Mean: 73.67 SD: 10	Mean: 76 SD: 11	Mean: 77.77 SD:13	Mean: 71.94 SD: 10

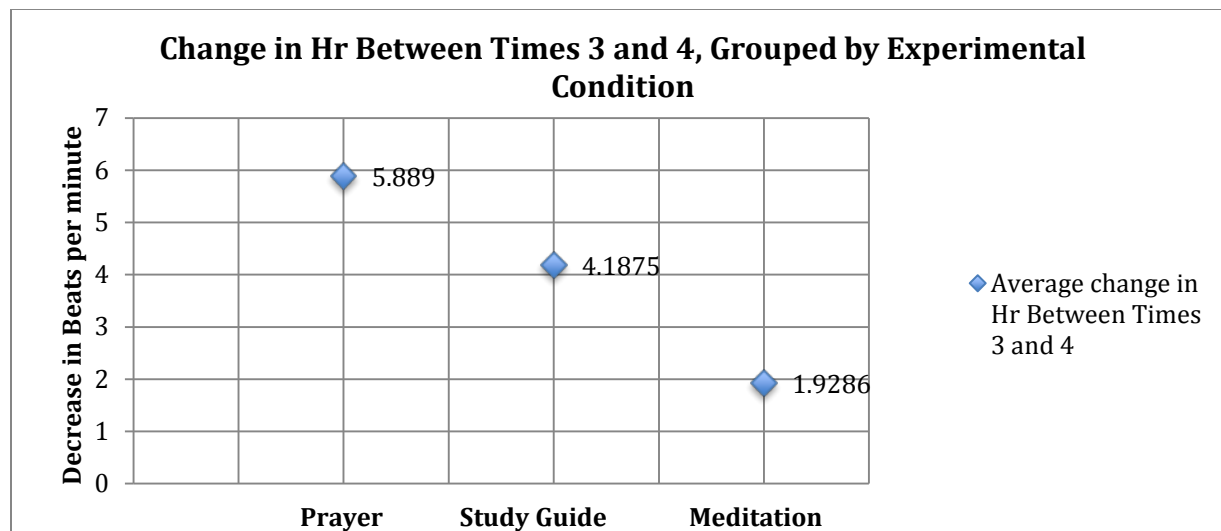
In an attempt to further understand the differences in mean changes in HR's between time frames for the participants, a multitude of ANOVA tests were performed. An ANOVA was first run to determine if there significant differences between student HR changes on times 3 and 4, when the stressor was presented to the different groups of students and then they were given the experimental condition (prayer, meditation, study guide) as a way to potentially alleviate the stress. The number of students in each group was: 18 prayer, 14 meditation, and 16 study guide.

In relation to the theme of the study, the researcher hypothesized that HR changes amongst students who prayed would be significantly less than those who meditated or used a study guide. Using a 95% confidence interval, with anything being less than $p=.05$, results from the ANOVA were examined.

Opposed to the researcher's hypothesis, the ANOVA showed the differences between student HR changes on times 3 and 4 between the three groups to have a *p-value* of .634, indicating that there was not a significant difference between the HR changes of students who prayed, meditated, and used the study guide after being presented with a test anxiety stressor. It is of value to note though that the prayer group did have the largest decrease in student HR change of the three experimental conditions. Levene's test (Levene, 1960) in SPSS revealed a .025 significance, which indicated there was a violation of homogeneity of variance between the three groups. Due to this, the researcher used SPSS to conduct subtests under the ANOVA test to adjust for variances in the homogeneity of the data. The tests that SPSS (IBM SPSS, 2014) included in their software were the Tamhane, Dunnet T3, Games-Howell, and Dunnet C. Each were run and no significant differences were found within these tests. A figure is provided below of the differences in heart rate of prayer, meditation, and study guide groups between times 3 and 4 to give a visual understanding.

Figure 13

Differences in Heart Rate of Prayer, Meditation, and Study Guide Groups Between Times 3 and 4



In order to gain a more robust understanding of the HR data, and to see if there were significant changes between the other time frames, other one-way ANOVAs were conducted to determine if there were significant differences between HR measurements of the three different groups between times 1 and 2, as well as between times 2 and 3.

There was one significant difference found between the meditation and study guide groups, between times 2 and 3. No differences were found between the prayer group and other two groups. Time two was upon arrival to the experimental meeting and time three was immediately upon introduction of the stressor. When looking at the post-hoc LSD test to understand the specific differences of the means of each group, a significant difference was noted. The LSD test showed the difference between the groups of Meditation and Study Guide, with a *p-value* of .049 (sig at .05) and *d* of .67, showing a significant difference and a medium effect size of the means of HR changes between the two groups. This data, however significant it

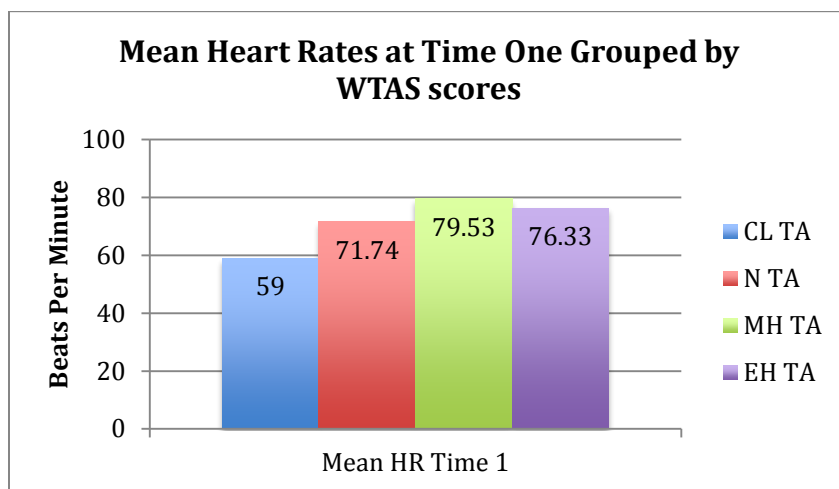
is, does not affirm the idea that the experimental condition affected the change in HR, since it was not introduced until Time three.

To examine the variable of the Westside Test Anxiety Scale (WTAS) scores in relation to the heart rate data, multiple ANOVA tests were also conducted. The WTAS variable was broken into four levels: comfortably low test anxiety (CL), normal test anxiety (N), moderately high test anxiety (MH), and extremely high test anxiety (EH). The number of students in each WTAS category is shown in Figure 11 above. When looking at the HR differences amongst the participants from their scores on the WTAS, interesting findings were discovered.

An ANOVA showed a significant difference of the baseline heart rates (Time one) with a *p-value* of .025. An LSD post hoc test determined where the significant differences of the baseline heart rates (Time one) of participants were shown. Significant differences between students whose scores indicated they had comfortably low test anxiety (CL), normal test anxiety (N), and moderately high test anxiety (MH) were present. The difference between the CL group and the MH group was found to be significant ($p=.007$) with a large effect size ($d=1.66$). A significant difference ($p=.032$) with a medium effect size ($d=.64$), was also found between the N group and the MH group. The following Figure shows the differences in HRs for time one.

Figure 14

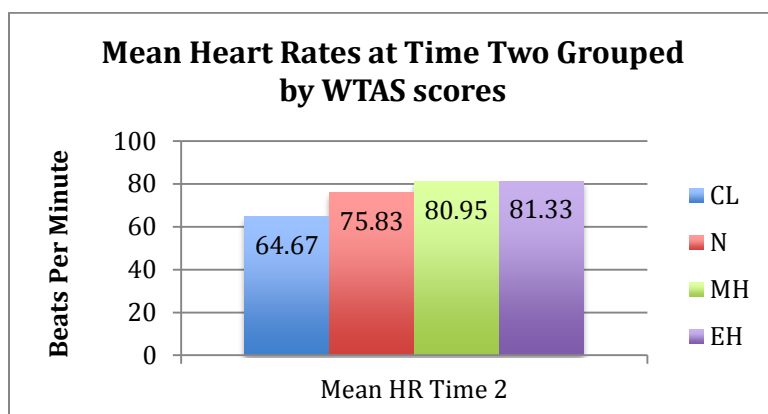
Mean Heart Rates for WTAS Groups at Time 1



An ANOVA test was ran looking at Time two, showing a significant difference among means of the group with a *p-value* of .049. Using the LSD test to determine where the significant differences and large effect sizes were found, showed them to be between students in the CL group and the MH group ($p=.011$), as well as students in the CL group and the EH group ($p=.044$, $d=1.78$). The following figure shows the differences of mean HR's at time two.

Figure 15

Mean Heart Rates for WTAS Groups at Time 2



No significant differences of HR measurements were found during times 3 or 4 when using an ANOVA. It was visually apparent that there were patterns amongst the WTAS variable in relation to the heart rates at times 3 and 4 however. The most obvious pattern is the difference between the CL and EH HR's on both times 3 and 4. The HR's of those with EH test anxiety were consistently higher than those with CL test anxiety. It is also telling that HR went up incrementally per category on time three (introduction of test anxiety stressor) for each WTAS category. The following Tables show the mean heart rates for each group at times 3 and 4.

Figure 16

Mean Heart Rates for WTAS Group at Time 3

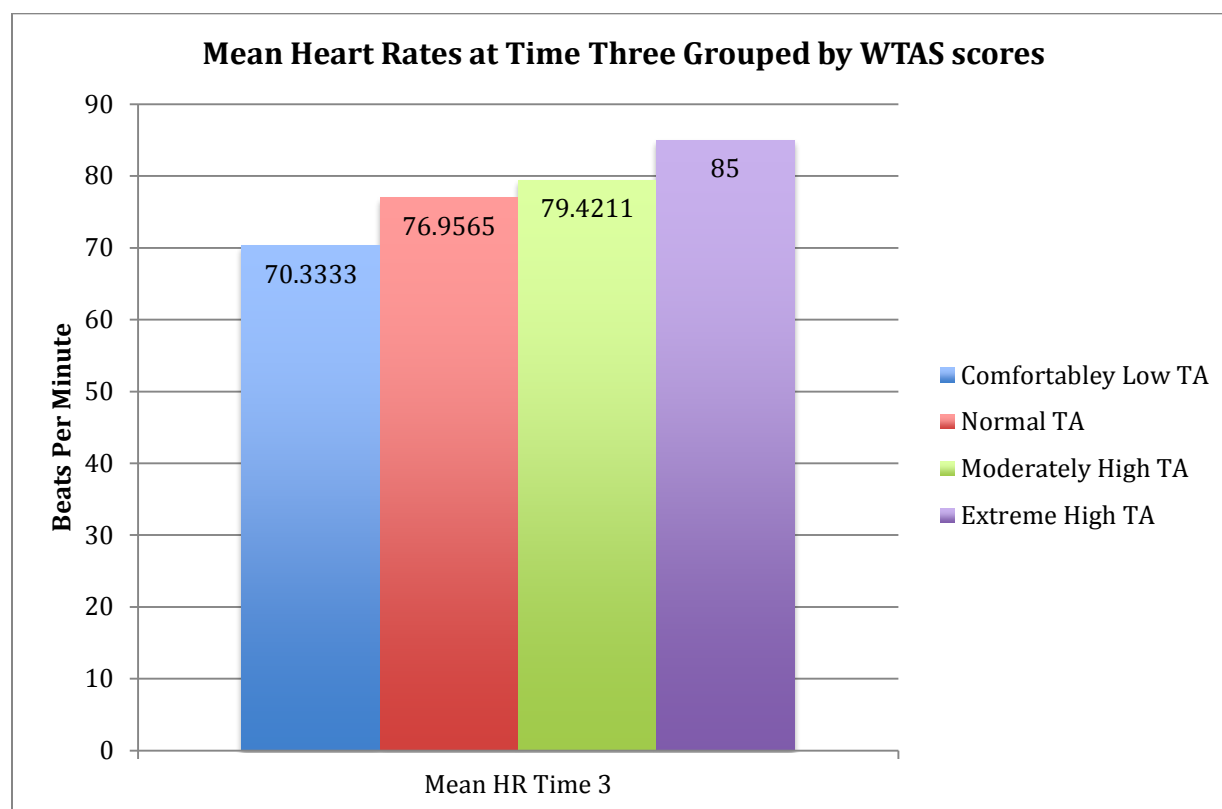
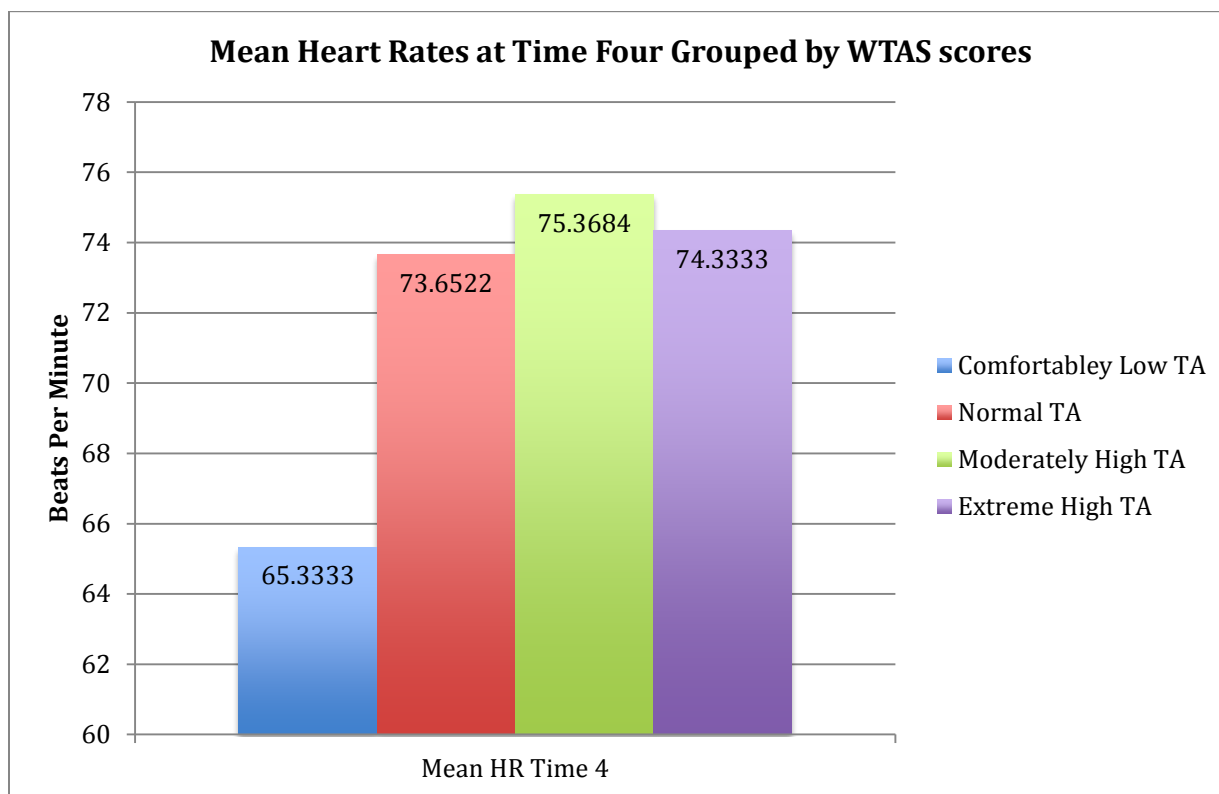


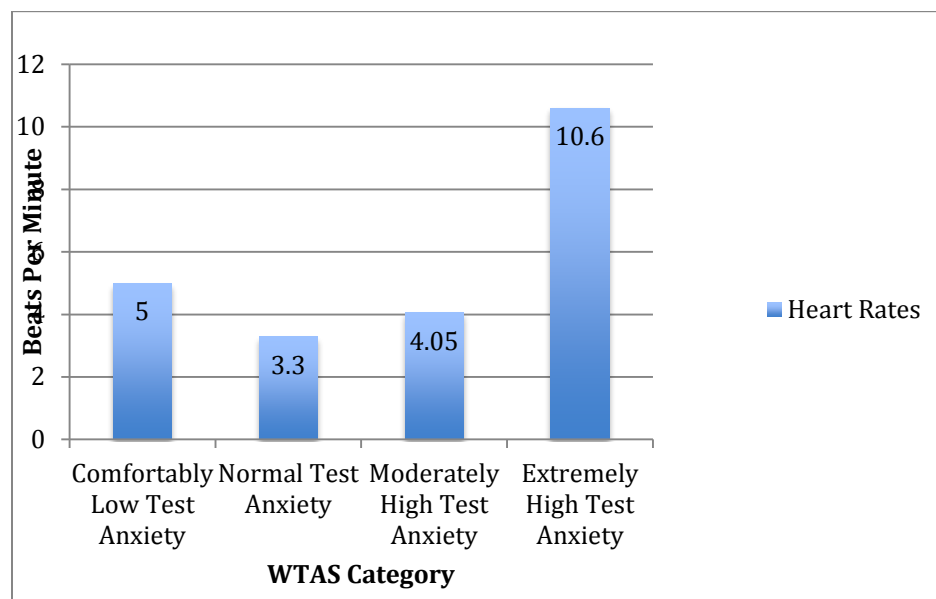
Figure 17

Mean Heart Rates for WTAS Group at Time 4



When running ANOVA tests on the differences of change in HR between each HR time measurement, no statistically significant results were presented. There was a visually noticeable difference between times 3 and 4, with the HR's of those in the Extremely High group (10.6 bpm) compared to the other groups (Normal Test Anxiety, 3.3; Moderately High Test Anxiety, 4.05; Comfortably Low Test Anxiety, 5). The figure below shows this data.

Figure 18

WTAS and Differences of HR Between Times 3 and 4

Looking at HR's from the grouping of the Prayer Values (VI, SI, NI) did not reveal any significant findings. It is of interest however that, as 4 showed above, the students who valued prayer as very important had lower heart rates across the board for each time.

Overall, the HR's yielded interesting results that will be further elaborated upon in the discussion section of this dissertation.

Salivary cortisol (SC) measurements amongst students

SC levels varied amongst the participants. According to the saliva collection kit literature from Salimetrics, the average adult SC levels range over a day from .094 $\mu\text{g/dL}$ to .359 $\mu\text{g/dL}$ (See Appendix W). The total range of SC levels for all participants over all four times had a range of .021 ($\mu\text{g/dL}$) to .47 ($\mu\text{g/dL}$).

The average SC amongst the group, at baseline measurement (Time one), was .19 ($\mu\text{g/dL}$). As with HR, SC levels were looked at within the subgroupings of experimental

conditions (Prayer, Meditation, Study Guide), WTAS scores (CL, N, MH, EH), and Prayer Value (NI, SI, VI). Cortisol values did not show any distinct patterns amongst the experimental and WTAS groupings, but showed that those who found prayer to be very important had lower salivary cortisol levels than those who did not.

Table 6

Initial SC Levels Data amongst Participants

Group	Average SC Level Time 1	Average SC Level Time 2	Average SC Level Time 3	Average SC Level Time 4
All Experimental conditions	Mean:0.19 SD: .10	Mean:0.20 SD: .09	Mean:0.19 SD: .10	Mean:0.18 SD: .08
Prayer	Mean:0.19 SD: 0.09	Mean: 0.21 SD: 0.09	Mean: 0.21 SD: 0.08	Mean: 0.20 SD: 0.09
Meditation	Mean:0.20 SD: .13	Mean: 0.14 SD: .10	Mean: 0.09 SD: .10	Mean: 0.04 SD: .80
Study Guide	Mean: 0.16 SD: .09	Mean: 0.18 SD: .08	Mean: 0.16 SD: .09	Mean: 0.16 SD: .07
WTAS—CL	Mean: 0.24 SD: .07	Mean: 0.20 SD: .07	Mean: 0.23 SD: .06	Mean: 0.26 SD: .07
WTAS—N	Mean: 0.17 SD: .11	Mean: 0.20 SD: .10	Mean: 0.19 SD: .08	Mean: 0.18 SD: .08
WTAS—MH	Mean: 0.22 SD: .10	Mean: 0.19 SD: .08	Mean: 0.18 SD: .12	Mean: 0.17 SD: .09
WTAS—EH	Mean: 0.15 SD: .04	Mean: 0.24 SD: .10	Mean: 0.21 SD: .09	Mean: 0.21 SD: .03
Prayer Value--NI	Mean: 0.25 SD: .18	Mean: 0.23 SD: .05	Mean: 0.23 SD: .10	Mean: 0.20 SD: .03
Prayer Value--SI	Mean: 0.22 SD: .13	Mean: 0.25 SD: .12	Mean: 0.22 SD: .10	Mean: 0.19 SD: .08
Prayer Value--VI	Mean: 0.17 SD: .07	Mean: 0.17 SD: .06	Mean: 0.17 SD: .09	Mean: 0.18 SD: .09

In an attempt to further understand the differences in mean SC changes amongst the participants, a multitude of ANOVA tests were performed. An ANOVA was run to determine

the differences between student mean SC changes on times three and four, when the stressor was presented to the different groups of students (prayer, meditation, study guide). The researcher hypothesized that SC changes amongst students who prayed would be significantly less than those who meditated or used a study guide. Using a 95% confidence interval, with anything significant being less than $p=.05$, results from the ANOVA tests were examined.

The ANOVA in SPSS revealed that SC level changes on times three and four between the three groups showed a *p-value* of .942, indicating that there was not a significant difference between the SC levels of students who prayed, meditated, and used the study guide after being presented with a test anxiety stressor.

ANOVAs were used to look at the four independent collection times of SC to see if differences existed between the three experimental groups. Using the LSD post hoc test, SC levels at time two showed a statistical significance between the prayer and study guide groups ($p=.008$) and the meditation and study guide groups ($p=.048$). At time three, the same test showed a significant difference between the prayer and study guide groups ($p=.039$).

To understand the differences in SC levels changing between the different times (T1, T2, T3, T4), each time frame (T1-T2, T2-T3, T1-T4, T1-T3, T2-T4, and T3-T4) was examined with an ANOVA.

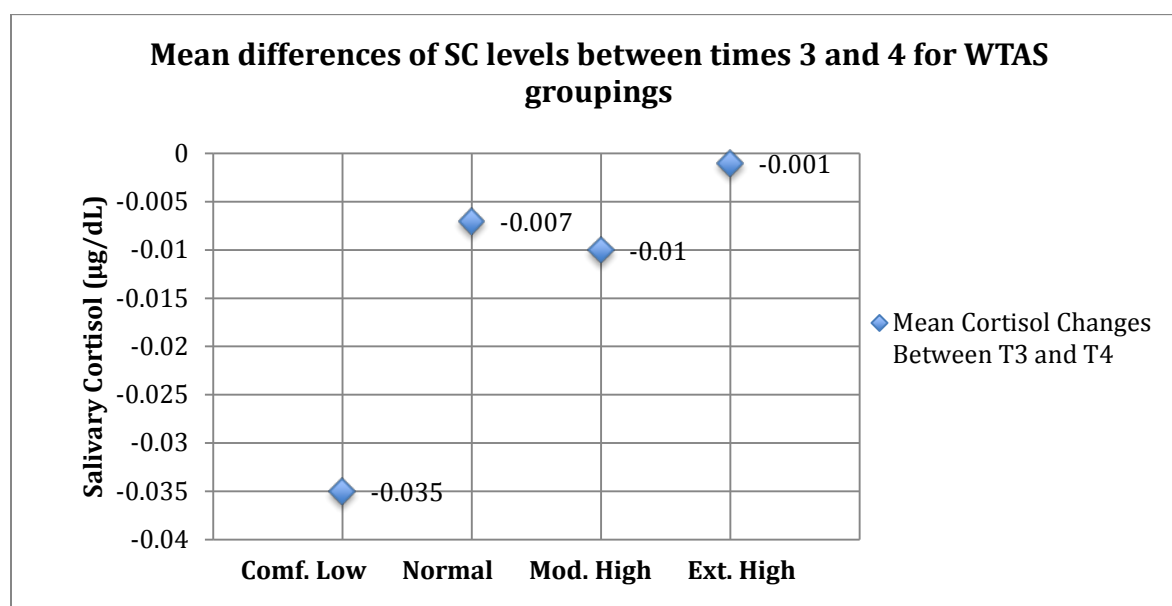
Out of the six time significant changes in student SC level changes, only one showed a significant difference (Time two to Time three). According to the LSD test, when analyzing the SC differences between times 2 and 3 (pre stressor and introduction of stressor), a significant difference and medium effect size was found between the prayer and study guide group ($p=.05$, $d=.65$).

An ANOVA was again used to look at the independent measures of SC levels at the four times to see if differences existed between the WTAS subgroupings (CL, N, MH, EH).

Interestingly, although not significantly significant, looking at the difference of times 3 and 4 from the WTAS variable showed a larger difference in the change of SC levels between those with CL TA than the other three groups. The figure below shows the difference.

Figure 19

WTAS Mean Differences of SC Levels Between Times 3 and 4



Students SC levels who valued prayer differently were analyzed with ANOVA tests.

First on the individual times, and then on the time frames mentioned above.

ANOVA testing on individual times revealed a significant difference and large effect size ($p=.011$, $d=1.60$) between the groups on Time two. To determine where the difference was, the LSD test was used. There was a significant difference and large effect size ($p=.004$, $d=.86$) between the VI group and the SI group. ANOVA testing on the time frames revealed two significant differences: between times 1 and 2 ($p=.047$), as well as between times 2 and 4

($p=.029$). LSD tests were run to determine where the differences were between the prayer categories. Between times 1 and 2, a significant difference and medium effect size ($p=.015$, $d=.78$) was found between the VI and SI groups. The same two groups were found to have a significant difference and large effect size between times 2 and 4 ($p=.009$, $d=.86$).

Salivary Alpha Amylase (SAA) measurements amongst students

SAA levels varied amongst the participants. According to the saliva collection kit literature from Salimetrics, the average adult SC level ranges are from 3.1 $\mu\text{g/dL}$ to 423.1 $\mu\text{g/dL}$ (see Appendix V). The total range of SAA levels for all participants over all four times had a range of 3.772 ($\mu\text{g/dL}$) to 571.7 ($\mu\text{g/dL}$).

The average SAA amongst the group, at baseline measurement (Time one), was 162.27 ($\mu\text{g/dL}$). As with HR and SC levels, SAA levels were looked at within the subgroupings of experimental conditions (Prayer, Meditation, Study Guide), WTAS scores (CL, N, MH, EH), and Prayer Value (NI, SI, VI). It was immediately apparent that large differences in SAA levels existed between those who value prayer as important (lower SAA levels) and those who did not (higher SAA values). It was also clear that the lowest SAA readings upon introduction of the stressor were that of the comfortably low (CL) WTAS group. It was also of note that the experimental prayer group and VI prayer value group had the lowest SAA levels at time four in each of their respective categories.

To help grasp the said differences in SC levels between the groups, the following table was created.

Table 7

Initial SAA Levels Data amongst Participants

Group	Average SAA Level Time 1	Average SAA Level Time 2	Average SAA Level Time 3	Average SAA Level Time 4
All Experimental conditions	Mean: 162.27 SD: 132	Mean: 99.70 SD: 72	Mean: 105.26 SD: 105	Mean: 124.26 SD: 112
Prayer	Mean: 132.96 SD: 116	Mean: 88.26 SD: 60	Mean: 83.53 SD: 77	Mean: 103.33 SD: 111
Meditation	Mean: 159.78 SD: 126	Mean: 93.93 SD: 75	Mean: 113.71 SD: 99	Mean: 116.28 SD: 89
Study Guide	Mean: 197.43 SD: 154	Mean: 117.63 SD: 82	Mean: 122.31 SD: 137	Mean: 154.78 SD: 132
WTAS—CL	Mean: 148.58 SD: 29	Mean: 101.79 SD: 23	Mean: 79.97 SD: 30	Mean: 103.48 SD: 12
WTAS—N	Mean: 165.71 SD: 126	Mean: 108.91 SD: 77	Mean: 104.29 SD: 85	Mean: 138.03 SD: 122
WTAS—MH	Mean: 161.38 SD: 158	Mean: 91.26 SD: 75	Mean: 111.37 SD: 140	Mean: 110.67 SD: 118
WTAS—EH	Mean: 155.31 SD: 112	Mean: 80.47 SD: 47	Mean: 99.38 SD: 60	Mean: 125.46 SD: 79
Prayer Value--NI	Mean: 324.55 SD: 74	Mean: 238.57 SD: 55	Mean: 238.46 SD: 74	Mean: 223.75 SD: 96
Prayer Value--SI	Mean: 157.53 SD: 136	Mean: 93.82 SD: 65	Mean: 104.88 SD: 80	Mean: 138.10 SD: 126
Prayer Value--VI	Mean: 148.71 SD: 127	Mean: 88.9 SD: 63	Mean: 92.54 SD: 111	Mean: 108.38 SD: 106

In an attempt to further understand the differences in mean SAA level changes amongst the participants, a multitude of ANOVA tests were performed. As with the HR and SC evaluations, an ANOVA was first run to determine the differences between student mean SAA changes on times 3 and 4, when the stressor was presented to the different groups of students (prayer, meditation, study guide). The ANOVA test showed a *p-value* of .404, indicating that

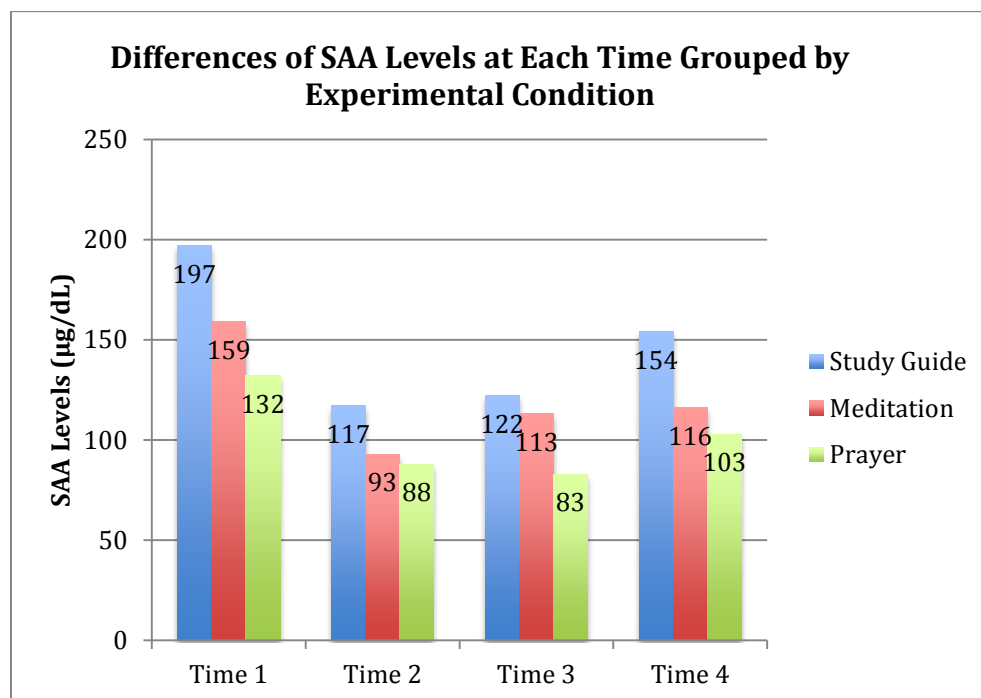
there was not a significant difference between the SAA's of students who prayed, meditated, and used the study guide after being presented with a test anxiety stressor.

An ANOVA was used to look at the independent measures of SAA levels at the four times to see if differences existed between the three experimental groups. The ANOVA test did not show a difference at each time amongst the three experimental groups. To understand the differences in SAA levels changing between the different times (T1, T2, T3, T4), each time frame (T1-T2, T2-T3, T1-T4, T1-T3, T2-T4, and T3-T4) was also examined with an ANOVA. Again, there were no significant differences found at any of the time frames mentioned.

As stated above, although not statistically significant, it was noted that the levels of SAA were lower for the prayer group than the other two groups at every time point. Although not reported as significantly significant as well, there was a notable difference between the SAA levels of the three experimental groups upon reading of times three and four. The following figure helps to visualize the differences amongst all the groups and times.

Figure 20

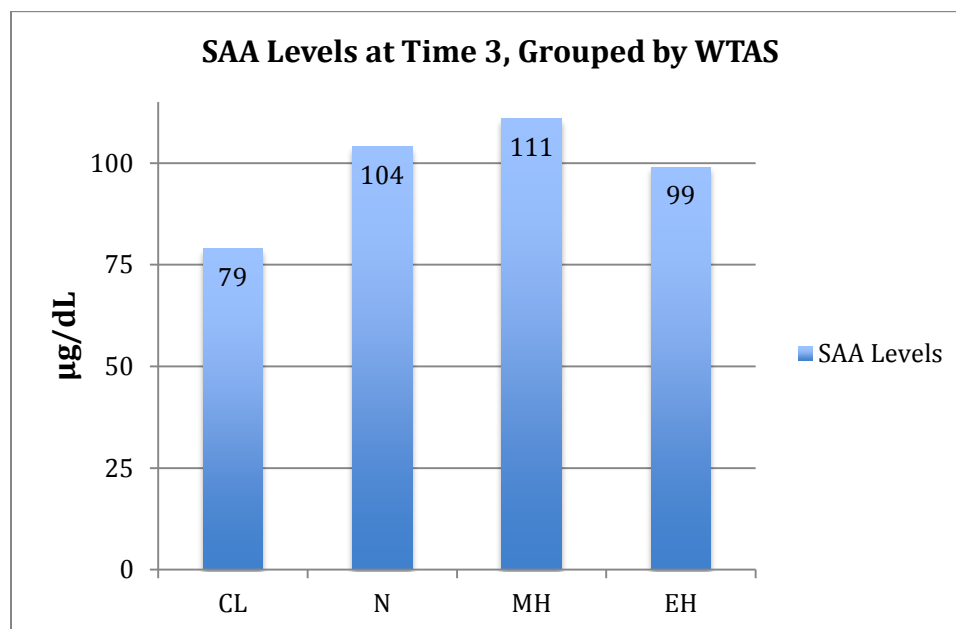
Differences of SAA Levels Four Different Times for Experimental Conditions



An ANOVA was again used to look at the independent measures of SAA levels at the four times to see if differences existed between the WTAS subgroupings (CL, N, MH, EH). The ANOVA test showed no significant differences among the WTAS subgroupings. It was notable that those with comfortably low (CL) test anxiety showed a much lower SAA reading when the stressor was presented at time three than those in the other three groups. The following figure can help to visualize said finding.

Figure 21

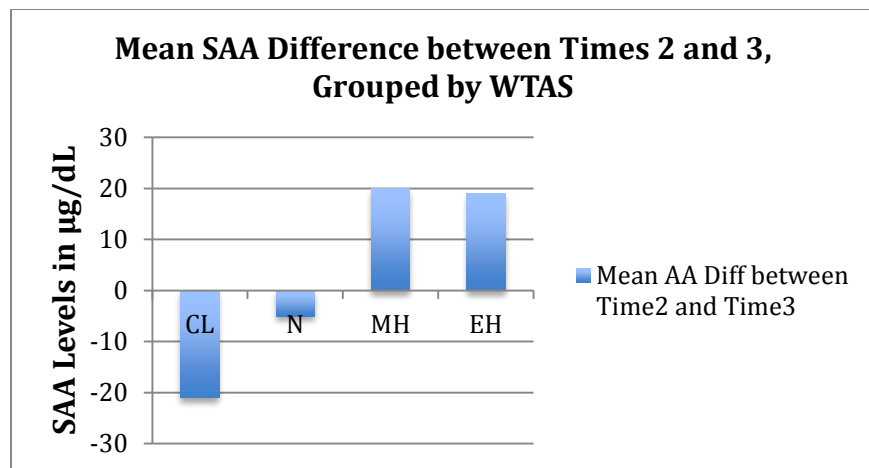
SAA Levels at Time 3, Grouped by WTAS Category



Looking at the SAA readings from the variable of the WTAS, it was suitable to find the CL TA to be lower than the other groups in each time except time two. Looking at the change of SAA levels between times two and three from the variable of the WTAS, although not statistically significant, showed a decrease in SAA amongst those with CL TA and N TA versus a rise in SAA in those with MH TA and EX TA. These are shown in Figure 22 below.

Figure 22

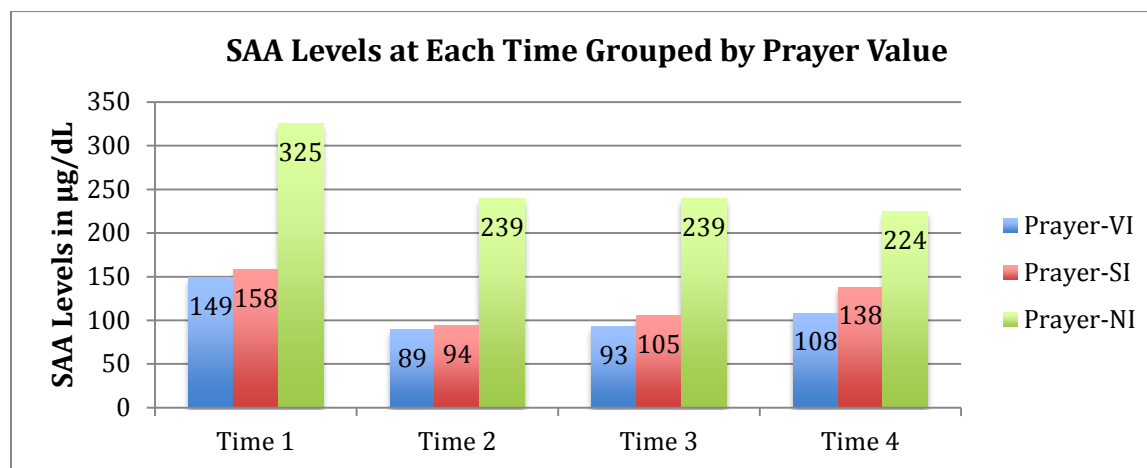
Diff of SAA Levels Among WTAS Groups at Time 2 and Time 3



Of interest to the researcher was also the difference in SAA levels based on the variable of prayer value in participant’s lives (NI, SI, or VI). In each of the four times, the SAA levels showed the same pattern, with those who valued prayer the most having the lowest SAA levels and those who valued prayer the least having the highest. The figure below shows the times and measurements.

Figure 23

Four Measurements of SAA Based on Prayer Value



When looking at the SAA from the variable of prayer value, significant differences were shown. All of the differences were found using ANOVA tests and then the post hoc data was looked at from the LSD test. For SAA levels at time one, there were significant differences and large effect sizes found between the VI and NI categories ($p=.028$, $d=1.70$), and the SI and NI categories ($p=.047$, $d=1.53$). When looking at SAA levels from the variable of prayer value, there was also a significant difference found using an ANOVA at time two ($p=.001$). Using the LSD post hoc test to determine where the differences were shown to be between those who thought prayer was very important and those who thought prayer was somewhat important ($p=.001$, $d=.08$); as well as those who thought prayer was very important and those who thought prayer was not important ($p=.000$, $d=2.52$).

Amongst time three of the SAA readings, significant differences and large effect sizes were found between the VI and NI groups ($p=.022$, $d=1.54$) and the SI and NI groups ($p=.045$, $d=1.72$).

Research Question Two: Qualitative Portion

The qualitative portion of the study is phenomenological (Creswell, 2007) and aims to help clarify unique individual experiences while grasping an overall essence of the material (Creswell, 2007). The unique subjective experiences of test anxiety and prayer were explored as ways to understand interrelation of the phenomena.

Participant Demographics

Two focus groups were created from the sample of participants. The initial aim of the primary researcher was to create three focus groups with equal numbers of participants (7) based on the answers given to the question “How important is prayer to you?” The potential three groups were very important, somewhat important, and not important. The researcher was able to

recruit seven members for a focus group from those who answered that prayer was “very important” in their lives. In order to help conceptualize the members of this group, appropriate pseudonyms and demographics are presented in the following table.

Table 8

Focus Group #1 “Prayer as Very Important” Pseudonyms and Demographics

Pseudonym	Gender	Age	WTAS Score	WTAS Category
Kyle	M	20	2.7	N
Marvin	M	18	3	MH
Mel	M	20	2.3	N
Hal	M	18	1	CL
Annie	F	20	2.1	N
Emma	F	19	3	MH
Alice	F	19	3.6	MH
Avg		19.142	2.529	N

Four participants were recruited from the “somewhat important” group. The members of this group, with appropriate pseudonyms, and demographics for this group are presented in the following table.

Table 9

Focus Group #2 “Somewhat Important” Pseudonyms and Demographics

Pseudonym	Gender	Age	WTAS Score	WTAS Category
Kira	F	27	4.5	EH
Sara	F	18	4.6	EH

Mary	F	18	4.1	EH
Myra	F	18	2.4	N
Avg		20.25	3.29	MH

Of the three participants who answered not important on the questionnaire, zero agreed to participate in a focus group and/or individual interview.

To help gain an understanding of the participants, and to make the information more relatable, a small amount of non-identifying information was gathered. The following is bit of information about each participant that was involved in either focus group.

Focus Group 1 (Prayer as Very Important)

Kyle

Kyle is a 21 junior who defines himself as curious and creative. Kyle was born in a different state than he goes to college in. He lives on campus and says that spirituality is his life. Kyle exclaimed that he loves Christ and desires to live solely a life of love for God and humanity. Kyle is a leader among his peers, considers himself mindful, and is active with college sports. Kyle enjoys song-writing, playing soccer, leading a meditation group, going on walks, and learning.

Marvin

Marvin is an 18-year-old male who is a freshman in college. Marvin refers to himself as an average student who has been successful in college so far. He was born in a large town but has lived in small towns. He lives off campus and has been a Christian his entire life. For fun, Marvin likes to play video games and hang out with his friends. Marvin is a pastor's son and has

had “great parental and religious mentors” in his life. Marvin admitted he had few Christian friends throughout his school years before college.

Mel

Mel is a 20-year-old male junior in college. Mel refers to himself as a good student who tries to participate in courses instead of just sliding by. Mel’s good grades are a reflection of his dedication, although he admits he could still try harder. Mel is from a different state and lives on campus currently. Mel refers to himself as a Christian and says that he attends Church on Sundays, as well as works daily to apply what he learns from Church in his life. Mel grew up in a church and appreciates the national community of Christians, where he has the opportunity to meet people of different walks of life. Mel likes to spend time outside fishing and hanging out with friends.

Hal

Hal is a 19-year-old male freshman in college. Hal considers himself to be an all right student. Hal is from a large city originally and now lives on campus. Although Hal has considered himself to be a Christian his entire life, he says that he is still trying to figure out what that means precisely. For fun, Hal likes to run long distances and read dystopian fiction books.

Annie

Annie is a 21-year-old female who is in her third year of college. Although she is only a junior, she is graduating this spring. Annie refers to herself as a hard working student. Out of all of her years in college, her lowest grade was an A-. Even though Annie is a hard worker, she allows herself to have free time and not to get too stressed about school. Annie lives on campus with roommates. Annie grew up in a Christian home and her Dad is a pastor. Religion/spirituality is a big part of Annie’s life and having a personal relationship with Jesus

means much to her. Annie enjoys time with friends and doing physical activities outside.

Emma

Emma is an 18 year old freshman at the college. She lives off campus and considers herself at times really ahead and sometimes puts things off to last minute. At times Emma loves school and at times she hates it. Emma considers herself polarized on stress, either very stressed or not at all. Emma does say that stress can help motivate her when she needs it to. Emma does not like the word religious, but would say that she is a Christian who follows Christ. Emma enjoys hanging out with family in her free time.

Alice

Alice is a sophomore and loves her home state. The season or the weather doesn't affect Alice; she spends every moment she can outside. Alice is a hardworking and dedicated student. Alice has a willingness to learn and explore different aspects. Alice lives on campus. Alice grew up having the Bible taught to her, but never identified with one church or denomination. Alice does refer to herself as a Christian however, just nondenominational. Reading, writing, drawing, and hanging out with friends are some of Alice's favorite things to do. Alice is adventurous and prefers to go do something outdoors rather than watch a movie inside.

Focus Group 2 Prayer as Somewhat Important

Kira

Kira is an 18-year-old freshman that lives on campus. Kira is a hard-working student who tries to do the best she can at all times. Kira prides herself on her hard work and work ethic. Kira admits to clamming up when it comes to taking tests and that she gets a mental block for some reason, but that she tries the best she can at all time. Kira admits to struggling with this test stress all through her school years. Kira was born in a small town and is a Christian that believes

in God. Kira has served missions overseas and was raised in a small church that was like her family. Kira was part of a youth group through school. Kira describes herself as community oriented and enjoys wherever she can. Kira enjoys being active and traveling in the U.S.A. and out of it. Kira finds family to be important, and enjoys the relationships she has with her sister and mother.

Sara

Sara is a 27-year-old junior non-traditional student that lives off campus. Sara refers to herself as a determined procrastinator. Sara has lived in many towns in her life. Sara refers to herself as a Christian and says that she prays 1-2 times per month, reads the bible once a month, and attends church once per year. Sara enjoys the arts and says that she was once deeply religious, but the passing of a family member has led to anger towards God.

Mary

Mary is an 18-year-old sophomore in college that lives on campus. Mary is a hardworking student that was taught that success and grades are earned, not given. Mary grew up in a small town and was an active member of her church youth group. The Church was like a second family to her because her mother was in leadership at her home Church. Mary says that she is a Christian and religion is a big part of her life. Mary is a conscious decision maker, and every day makes the choice to follow God. Mary says that she always wants to be in God's grace. Mary came from a very small hometown and truly loves the outdoors. Mary does a lot of running, hiking, skiing, going to the lake, and traveling both within and outside of the U.S. borders.

Myra

Myra is an 18-year-old freshman in college. In her opinion, she is an excellent student and excels in all of her classes. Myra was born and raised in the same town Myra lives on campus and considers herself to be a Christian. Myra affirmed that religion is constantly in her life, especially going to a religious university. Myra likes to go exploring with friends for fun, especially outdoors. Myra has traveled extensively in her life and has seen a many locations in the world. Myra considers mission work to be a large part of her life. Myra tries to do something for other people as often as she can.

Coding and Theme Development

In order to help grasp comprehension of the focus group process and its respondents, portions of the transcribed meeting are included in this chapter. Quotes are a way to give evidence for the development of emerging themes (Creswell, 1998). The information gathered provided unique student perceptions of both prayer and test anxiety. During the focus group process, the lead researcher was able to hear themes develop related to both prayer and test anxiety.

Different levels of coding were used to understand the qualitative information from the two focus groups that were conducted, recorded, and transcribed. Coding is a creative problem solving technique comes from the Greek language, meaning, “to discover” (Saldana, 2009). Coding helps researchers to organize and group similarly coded data into different categories that share similar characteristics in order to help determine patterns (Saldana, 2009). “Coding and analysis are not synonymous, though coding is a crucial aspect of analysis” (Basit, 2003, P. 145).

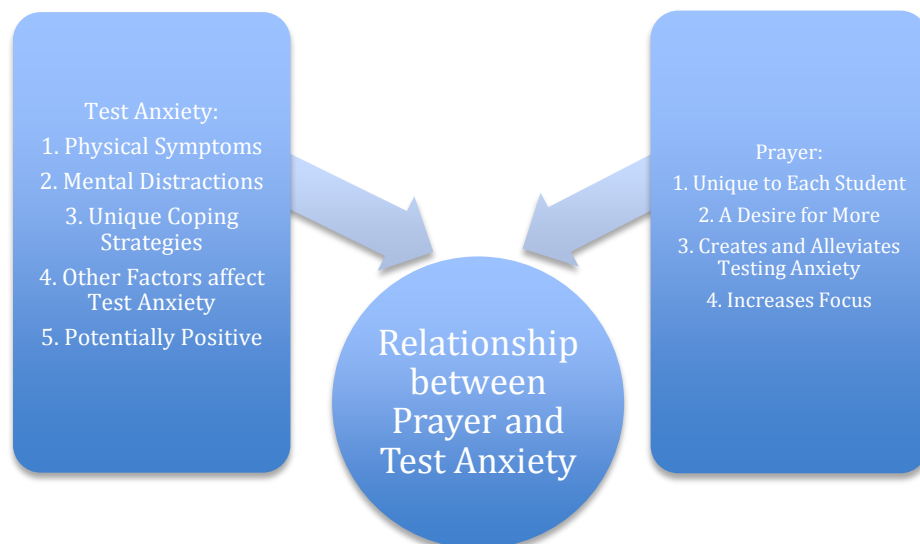
Coding can take a few attempts, known as recoding, since language and imagery often take a few reads to pick up on (Saldana, 2009). According to Saldana (2009) coding follows a process: pre-coding, preliminary coding, and final coding.

For second research question, data was initially pre-coded while the researcher listened to the interviews on audio and took notes. The data was then transcribed by a transcriptionist and preliminarily coded by the researcher into final codes related to themes. Those final codes were put into themes that attempted to summarize the answers of how college students believe focused Christian prayer impacts test anxiety. The nine themes that emerged were:

1. Test Anxiety Amongst College Students Presents Itself in Distracting Physical Symptoms
2. Test Anxiety Amongst College Students Presents Itself in Distracting Mental Thought Processes
3. Students Cope with Test Anxiety Differently
4. Factors Outside of Physical Symptoms and Mental Thought Processes Affect Student Test Anxiety
5. Test Anxiety Can be a Positive Trait
6. College Students Define Prayer Differently
7. College Students Who Value Prayer Have a Desire to Pray More
8. College Students Find Prayer to be Both Helpful and Harmful for Test Anxiety
9. Prayer Can Increase Focus

The themes are interrelated and can be viewed in a chart to help gain a deeper understanding of said relationships. The following chart helps to identify the interrelation of themes for the qualitative portion of the research.

Figure 24

Interrelation of Emerging Themes

The following table is a diagram to help conceptualize the final themes that emerged.

Table 10

Qualitative Themes

Theme	Number of Responses related to theme		Number of Students who Commented on theme	
	Focus Group #1 (Prayer as Very Important)	Focus Group #2 (Prayer as Somewhat Important)	Focus Group #1 (Prayer as Very Important)	Focus Group #2 (Prayer as Somewhat Important)
1. Test Anxiety Amongst College Students Presents Itself in Distracting Physical Symptoms	6	6	71%	75%
2. Test Anxiety Amongst College Students Presents Itself in Distracting Mental Thought Processes	10	11	71%	75%
3. Students Cope with Test Anxiety	3	1	71%	25%

Differently				
4. Factors Outside of Physical Symptoms and Mental Thought Processes Affect Student Test Anxiety	10	11	57%	100%
5. Test Anxiety Can be a Positive Trait	2	1	29%	25%
6. College Students Define Prayer Differently	8	12	71%	100%
7. College Students Experience a Desire to Pray More	8	0	86%	0%
8. College Students Find Prayer to be Both Helpful and Harmful for Test Anxiety	18	10	100%	75%
9. Prayer Can Increase Focus	12	5	100%	75%

Personalization of Themes

In order to gain comprehension of the themes and how they were developed from the perspectives of the students that participated in the focus groups, the themes are listed below with supportive quotes. To start however, one quote resonated on the theme of stress and test anxiety that permeates the study. The quote is shared here from Kyle, “I think our culture is not very conscious of the need to be aware of the stress and personally trying to reveal it or relieve it. Or, they are under the assumption that there is no way to get rid of it. I think a lot of people talk about how stress is just so natural, it’s always going to happen, and there is no escaping it. I think that’s not true, but I think people believe that.” Stress has been shown to affect many college students, and as Kyle stated, many of his peers feel that it is inescapable. The potential for prayer to be a tool to relieve that stress is valuable at the current time.

Test anxiety amongst college students presents itself in distracting physical symptoms

Test anxiety, in the literature has been shown to have a plethora of symptoms (Sarason, 1975; Salend, 2011). Students in the focus groups confirmed that test anxiety presents itself in different physical symptoms. Kira explained it as “my heart rate increasing, my vision getting

blurry, and getting really foggy”. Sara had a similar experience, saying, “ I go in to take the test and I panic”. Alice and Annie as well stated, “My heart races the moment I sit down” and “I get super nervous with my heart racing”. Alice added to that, admitting, “I can feel my adrenaline and pulse going”. Marvin continued to the theme, expressing “my heart starts to race and I have to take a couple of breaths”. Kyle’s test anxiety was in his stomach, with his “digestive system being depressed”. The students confirmed what the literature has shown, test anxiety has the ability to create a multitude of unpleasant distracting physical symptoms for students.

Test anxiety amongst college students presents itself in distracting mental thought processes

The cognitive attentional framework of test anxiety is centered on the idea that much of the anxiety from testing comes from distracting, often negative, thought processes (Culler & Holahan, 1980; Weinstein, Cubberly, & Richardson, 1982; Wine, 1971; Sarason & Mandler, 1952; Sarason, 1972 1980). Students in the two focus groups confirmed this.

Sara explained that the moment she went into a testing room, she began to panic since thought about “her grade going to drop”. Mary had a similar experience, expressing, “All of sudden I forget everything I have learned, which creates more stress, which leads to more stress”. Mel confessed he would read the same question over and over, “like five times in a row and tell myself, I am not even paying attention anymore”. These thoughts went on further.

Sara explained that her thinking snowballed into thoughts about her “GPA, and then scholarships, and then letting my family down and disappointing them”. Kira was in sync, saying, “I don’t want to disappoint my family.” Marvin admitted the same, admitting he did a lot of worst-case thinking and negative self-talk about his performance on tests. Marvin explained

that he “thought about all the repercussions of failing the test, and even in the midst of test taking calculated his grade related if I don’t do well on this test”.

Kira experienced the same slippery mental slope, saying, “I think about future medical schools and what my transcript is going to look like if I don’t do well”. Alice confirmed as well, sharing, “When I get to the first question, I have no idea what it is asking, and it’s not a hard question, it is just the fact I am taking a test and I know what score I need to get.” Alice continued, “When I get super nervous for a test, my mind wanders and I think about who is going to finish first, if I am going to be last, if I have time to finish. It’s an unnecessary waste of time”.

It was notable that the environment also impacted student’s thoughts. Alice reported that when people were “flipping through test pages, I get distracted and think I am not going to get this done in time, and my anxiety rises.” Marvin agreed, saying, “It is very distracting when people get up and leave earlier than me”. For Alice, this leads to thoughts such as, “I should have studied more, or I should have studied with them since maybe they know more”. Sara had similar thoughts, saying that she felt everyone was done fast and that “people are watching me and seeing what I am answering, and it’s wrong”. Opposed to this, Myra had anxiety getting done early and waiting for other to finish, “not wanting to be the first one to turn it in because it could me I missed a page or did something wrong”. Myra continued, “ I don’t like to be the first person since people will think, well that girl failed, they didn’t take long enough on it”. Mel summed it up well, saying, “people comparing themselves to others during testing is not good because they are still thinking about what they don’t know anything about—they just feel better about themselves because someone else doesn’t know either”.

Students cope with test anxiety differently

Students reported unique ways they coped with test anxiety. According to Kira, positive self-talk worked for her, saying, “I just have to kind of calm myself and tell myself I know this stuff, I have been studying, I pay attention in lectures”. Kyle agreed, saying, “I tell myself the worst outcome is not that bad, it’s not life threatening”. For Kyle, it is also about the process before the test. “I like to isolate myself from people who are taking the test and prepare on my own time. I tell myself, this is going to be what it is going to be, and it’s kind of an act of prayer. Even though test anxiety causes a lot of anxiety, lots of things cause anxiety”. Kyle admitted that test anxiety helped him to have better habits in his life related to sleep, eating, and time management. For Emma, she said she would just accept the scenario, since “if you can’t do anything about it, you should just move on”. Annie said that she sought the comfort of others who were in the same situation to alleviate test anxiety, saying, “Sometimes it helps relieve stress by having people in the same boat”.

Factors outside of physical symptoms and mental thought processes affect student test anxiety

Outside of the mind and body, students reported that factors such as time and class size increased their testing anxiety. Kyle reported that the worst stress was not the test anxiety stress during the actual test, but the stress leading up to the test, since it affected his sleep, his water intake, and his alertness. Marvin admitted that, “a major factor is if the test is over something I am familiar or comfortable with”.

For Annie, not being prepared for a test made her feel generally stressed out. “One of the things that creates extreme stress is time limits,” said Kira. She continued, “If I get stuck on one question, I essentially fell like I am screwing myself for the rest of the test”. Myra also said that “how much the test is worth on your overall grade” has an impact on test anxiety. Marvin

concurrent, saying that when a professor uses time limits, “they are not testing me on my knowledge of the subject any longer, rather on how fast I can do the test when I am still in the process of learning the material.” Mary admitted that she needed to just sit in the same seat to feel less anxious.

The class size was also reported to impact test anxiety. Annie said it more “nerve racking” to have an audience presence while testing, and Marvin admitted that “because I am a head taller than everyone, I stick out and that gives me anxiety”. Studying gave some students the most stress. Myra admitted to getting the most stressed when she studied and Kira added that “I constantly have 10,000 things going on, so not having enough time to really focus on my studying is stressful”.

The professor reportedly also had an impact. Myra reported that “if it is a professor that lets loose a little bit, and they create an atmosphere where you can relax and it’s not a big deal if I bomb the test” there is less stress. She went on to say, “The professor has a lot of influence on me if they are high maintenance since if they are, I feel I have to do the test perfectly or I am going to fail”. Mary expanded, adding, “If you know the professor and you know their habits, you can say, it will be a great test”. Mary also said there was difference in professors that, “encouraged you before an exam versus just walking in and telling students to take the exam.”

Test anxiety can be a positive trait

For some students, it was clear that test anxiety helped them, which has been acknowledged by research (Carver & Scheier, 1988). Carver and Scheier (1988) argue that students who expect to do well with test anxiety experience more task focus, which can improve their cognitive attention. This was shown in Myra, who said, “I excel in the face of challenges to I think tests are almost fun”. Kyle concurred, reporting that test anxiety is “good stress that feels

like preparation in performance”. Kyle said that, “I become very focused. I am sure I am experiencing adrenaline, and it is a positive thing. When I am too relaxed, I feel as if my performance is hindered. When I am not stressed, my mind tends to wander too much, but if I have just the right amount of good stress, I feel like I perform better”. Emma furthered this by admitting that she, due to being non-stressed, tended to get bad grades since she was “careless on tests and skipped entire sections completely”.

College students define prayer differently

Consistent with research, prayer is hard to define objectively (Finney & Maloney, 1985; Giardini, 1987; Levin & Taylor, 1997; Pargament, 1990). The students in the focus group had unique ways to define prayer. There were two different focus groups created based on the value of prayer, either very important (VI) or somewhat important (SI).

The SI group had unique beliefs about prayer. For Mary, prayer was “quite time with God, that is personal, and not out loud”. Mary continued, saying, “prayer is just thanking God or asking God for things, just between you and Him, and everyone else that can hear you.” For Kira, Prayer was acknowledging the good things in life and asking for help in the larger things. According to Kira, “God is always present so he is not any more present during prayer than during a test, so praying for petty items is really nonessential”. Kira said that prayer was meant to be set aside for large things, since people don’t get assistance for the little things—“so I pray for big stresses”. Myra said that prayer was often quiet and “not just asking for things, but thanking God for things as well”. Kira simply added that prayer depends on who the person is and where they are in their lives.

The VI group was more expansive on the topic. Mel said that prayer was “personally talking with God, and communication with God”. Marvin said prayer for him was mainly in his

head, and non-verbal. Annie echoed this, saying prayer is, “Just talking to Jesus, and telling Him everything I’m feeling. I want Him to be on the forefront of my mind all the time. I want to be thinking of Him constantly, I don’t want to forget to pray, or forget to talk with God. That’s how I become close and intimate with Him. I think that’s a huge part of how I live my life. When I’m intimate with God, He shines through me so I am one with the Spirit and act as Jesus would. I’m being in communication with God and knowing His heart.”

Hal said that prayer is subconscious and it happens without even thinking about it. Kyle went on to express, “prayer is more of a mind state, a way of living, so I would say I try to pray ceaselessly; It’s obviously something very rewarding and fun to be with God, but I also see it as something that takes discipline; mindful meditation, but to me that’s prayer; I sit and I try to be present as a way of acknowledging faith, or recognizing that God has everything in control. I try and go inward; it’s not routine or a ritual. It’s very much natural, but I see it as something a person can cultivate.”

Kyle added a twist saying, “For the most part, I think people think that prayer is kind of a one-time thing, and people do it too sparingly for it to be effective. They don’t really actively cultivate prayer in their lives, which takes discipline. Maybe it’s a one-time thing, and then they either feel guilty or can’t actually access God, because they are too restless. So, I think for the most part people maybe think they pray, more than they do.”

College students who value prayer have a desire to pray more

An interesting finding from the focus groups was that students from the VI prayer group had a theme all of their own—a desire to pray more.

Mel admitted he knew he needed to “rely on prayer more” and that “I need to be able to make communication with God my cornerstone because I just don’t do it all the time”. Annie

simply added that prayer was something she wanted and needed to do more. Alice said that she wanted to pray more, but that stress and other things made it harder for her to pray. Hal agreed that he wanted to pray more and that when he actually took time to pray, it was helpful.

Emma hesitantly added, “I sort of feel a little guilty, because I tend to be really busy and I come to God as a last resort. Then I feel guilty because I’m praying for a test and there are people who are barely surviving out there and I’m not praying for them--I’m praying for me to do good on a test. That makes me feel like that’s not fair, and then I feel bad. So then sometimes I don’t pray.” Alice continued this, saying “I feel guilty if I don’t pray enough. I feel like it’s wrong to pray for me. I feel like prayer is just talking to God and not just begging Him for things. It’s showing gratitude and just talking to Him. When you just ask for things, and you’re not praying for other people it’s just really selfish.”

College students find prayer to be both helpful and harmful for test anxiety

Students from both the VI and SI group reported that prayer could be helpful for their test anxiety. Alice started by saying, “Since I was really little I was always able to just pray any time I wanted and feel God near me and be able to relax and just ask for peace or comfort and get it”. Kyle agreed saying, “Prayer is very rewarding and it’s fun to be with God”. Emma spoke about the peace that came with prayer as well, adding, “I just feel peace when I talk to God because that’s what should happen, God is in control of everything. So when you talk to Him that peace that He has just radiates, being in communication with God”. Mary said that time with God is just a time of peace and knowing that she is not alone, letting her “calm down and know life is good”.

Marvin said prayer was helpful, since, “I want what His will is, more than my will because I trust His plan more than anything I could ever come up with.” In relation to Test

anxiety, Marvin says his prayers are before, during and after the test and sound like, “Please help me with this test. God, Please help me to use the knowledge I have and that also your will is done with this test...and for others.” Mel also used prayer to ask for help, praying, “God, I know this material, but I’m so stressed out right now, with everything that’s going on in my life. I’m just so nervous for this test, I don’t know if I can pass it alone. Just keep me calm in this moment so I can perform the way I need to.”

Mel offered that he prayed the night before the test and directly after, as did Emma, who said her prayer is, “God, I didn’t do everything I could have, and I wasted my time, but I need you and I can’t do it without you.” Emma elaborated, “That’s pretty much it. It’s like a step of faith in a small way.” Marvin agreed that praying directly after the test was helpful, using the quip, “Do your best, pray that it’s blessed, and God will take care of the rest.” Hal expressed that he, “just prayed for Him to help me on the test and do well,” continuing, “ I think when I actually take time to pray it helps: Like if I just take time and don’t do anything else and ask God to help me before a test, it helps.” Annie was more confident, promoting the opinion that she knew God “has me, and I can relax”.

Mel talked about the whole process, sharing, “I think talking to God is just naturally peaceful; But, before a test you’re relying on him to be there for you. Just spending any amount of time in His presence just talking with Him is peaceful; so even if it is just thirty seconds as the teacher is handing it out. Maybe you planned on praying the night before, or you planned on praying in the morning but you forgot just because the test was weighing on your mind, but you remembered thirty seconds before. I think those thirty seconds just spending time with God is a really peaceful time. As long as you don’t let distractions in.” Kira built on the idea saying that when she prayed before a test, it more of a time to just zone out and not be distracted”.

Kyle added that professor's praying could even have an influence, saying, "I personally have benefitted a lot from teachers praying on campus. I think that even before classes it just adds a level of presence and awareness that someone cares." Annie also said she likes when the professor prays, since it is, "kind of nice because then it brings you back to kind of like, hey, yeah God, I'm going to rely on you, help me--so it's good to be brought back to what's important like, your focus on God." Mary agreed that she "likes when the professors pray".

Students, but interesting from only the SI group, also reported that prayer could negatively influence their test anxiety. Myra confided that, "Spending a lot of time on things stresses me out and praying before kind of stresses me out actually." Myra added, saying, "I can't think about anything else except for the test. Because if I think about other things then that stresses me out. When I focus, I'm ok." Kira agreed, adding, "I think praying before a test increases my stress, especially if it's a teacher lead prayer. I feel like the teacher is saying, "I am expecting this class to fail, so please help them--It just seriously hangs up my anxiety." Kira offered a hypothesis saying, "It depends on where people think they are at with their relationship with God. I feel like if they're not comfortable with their relationship or if they don't know God, or if they're just not interested in prayer, then it's just going to increase their stress."

Prayer can increase focus

Focusing on prayer was the final theme presented in the focus groups. Myra started by saying, "If you're all of a sudden focused on something else like your relationship with God, whether it's good or bad, then it changes your focus." Kira, used prayer to increase focus before a test to zone out and not listen to anything else could be distracting to her learning. Myra added that, "Just being able to focus and pray helps calm me". Mel expressed that he actually prayed for focus, saying that he prayed for his, "mind to stay focused on the test and not get distracted

by the rest of the busy day that I have”. Annie agreed, saying that she prayed that she would remember, “all the information I studied”. She elaborated, saying she asked God to “Help me remember what I studied and God, help my brain to function properly.” Alice confirmed as well, saying she asked God, “Please help me calm down and remember things.” Hal said that it was quite helpful actually taking the time to just not do anything else but pray and God for help. Mel said the same thing, noting that it could even be just 30 seconds spending time with God, as long as not distractions were present. Annie enjoyed having the professor take the time to just concentrate the focus on God.

Kyle expressed the need for attention during the testing process, sharing, “Sometimes even on the walk towards class, I’ll try to say, this walk deserves my full attention. As an act of worship I want to acknowledge the beauty that is provided to me on the way to the exam. I try to not let my mind go ahead of me. The best way to describe it would be trying to be present.” Kyle went on to precisely target how prayer and focus interact for him saying, “Prayer really organizes my life. I think a few moments of presence right before an exam is definitely going to help you a lot as far as keeping your mind from wandering. I think, as far as saying a verbal prayer to God, one of the main things that it does, no matter what you say, it brings you into a state of reverence. If you truly believe you’re talking to the Almighty, it brings you into the Presence. In that moment, there is something so valuable in your midst that you necessarily stop thinking about the future or past and it brings you into a presence. That could possibly stop your mind from wandering into useless patterns of thought.”

The data from the qualitative focus groups will be discussed more fully in the next chapter.

Conclusion

In Chapter IV, both the quantitative and qualitative data were gathered and presented by the lead researcher. The purpose of gathering both types of data was to triangulate the findings and give an answer to the two research questions in the study. The data sources for the first research question were quantitative measures of biomarkers for test anxiety. The data sources for the second research question were the two focus groups conducted.

The purpose of Chapter IV was to help digest the quantitative and qualitative findings regarding the relationship between focused Christian prayer and test anxiety. The findings were looked at through the lens of the cognitive attentional theory (CAT), helping to see how the role of mental focus was related to the interaction of Christian prayer and test anxiety.

In the next chapter, the researcher offers a detailed inspection of test anxiety, focused Christian prayer, and their symbiotic relationship.

Chapter V

Discussion

Introduction

The commitment of this final chapter is to discuss the findings of the completed dissertation research. A summary of the study will be provided that gives an overview of the topics, the research questions, the methodology, and the key findings. The chapter will also include the limitations to the research as well as main conclusions, implications for practice, and research recommendations for future studies.

Study Summary

Test anxiety starts for students in elementary school and progresses into college (Casbarro, 2004; Huberty, 2010; Hurst, Baranik, & Daniel, 2013; Robotham, 2008; Zeidner, 1998). Research shows that test anxiety impacts 25% to 40% of students (Cassady, 2010; Huberty, 2010) and that testing anxiety is not an imagined psychosomatic disorder, but instead an often-debilitating set of physiological and cognitive factors that affect performance by drawing attention away from the evaluative task (Hagtvet, 1983; Loupss, 2008; Morris & Liebert, 1970; Sarason, 1975; Wine, 1971; Zeidner, 1998). Individuals cope with test anxiety in many different ways (Kondo, 1996). One way individuals choose to relieve anxiety and stress in their lives is to connect with a higher power through prayer (Harris et al., 2005; Stanley, 2009). Prayer, and more specifically, Christian prayer has not been studied as a way to alleviate college student testing anxiety. Christian prayer is a method that believers in the life and resurrection of Jesus Christ use to stay in focused communication with God, who shows Himself and speaks to humans through Jesus and the books in the Holy Bible (Constable, 2003). College is often a time for students to define themselves (Markus & Kitayama, 2003), and the research of prayer as a

way to help with test-related anxiety could have the ability to lead students to developing life changing habits that decrease stress (Harris, Schoneman & Carrera, 2002).

Problem Synopsis

Elevated standards for schools have turned into more evaluative testing, and more testing has turned into more test anxiety for students--with some students being shown to be unable to sleep the evening before a test and/or even vomit on the test day (Casbarro, 2004; Huberty, 2010). As students progress through the educational ladder, they are often reminded that graduation requires high performance on standardized testing, which causes repeated situational testing anxiety that can impact school performance (Huberty, 2010; Onyeizugbo, 2010; Salend, 2011). College students are facing test anxiety in each field of study (Zeidner, 1995) and not being taught how to cope with it (Acre-Medina & Flores-Allier, 2012). This is problematic, since test anxiety has been linked with poor educational and vocational performance (Ackerman & Heggstad, 1997; Hembree, 1988; Seipp, 1991). Stories of college students using prescription, legal, and illegal drugs to self-medicate for problems with anxiety/stress during the college years are increasing (Whitten, 2006), with illicit drug use among Americans over the age of 18 being over 23 million in 2012 (U.S. Department of Health and Human Services, 2012). Student test anxiety is a problem that has a valuable research base, but facets of study still need addressed.

Study's Purpose and Research Questions

The purpose of this study was to determine if focused Christian prayer has the ability to reduce the test anxiety of college students. For the investigation, a mixed methods study was utilized to provide an in-depth analysis of the two components. The point of clear research questions is to help completely explore the components and how they interact (Creswell, 2012). The two guiding research questions for the study were:

1. Is there a difference in the physiological response to test anxiety of students who use focused Christian prayer compared to students who meditate or use a study guide?
2. How do college students believe focused Christian prayer impacts test anxiety?

Review of Methods

An explanatory sequential mixed methods format of research was selected in order to help grasp the multidimensional construct of test anxiety (Creswell, 2012; Creswell & Garrett, 2008; Ivancova et al., 2006; Loupos et al., 2008). Mixed methods were used since they are conceptually more complex, and offer a basis for triangulation and unique ways of conceptualizing prayer and test anxiety (Spratt et al., 2004). The mixed method's design let the qualitative data help explain the quantitative data. The data collection pattern went in the following order: Quantitative Data Collection, Quantitative Data Analysis, Qualitative Data Collection, Qualitative Data Analysis, Incorporation of the Quantitative and Qualitative Outcomes.

For the quantitative portion of the study, student's test anxiety biomarkers were measured at four different times. Salivary biomarker measures of stress are accurate and non-invasive, making them an ideal way to measure the stress response of research subjects with test anxiety (Kirschbuam & Hellhammer, 2000). For the study, heart rate (HR), salivary alpha-amylase (SAA) and salivary cortisol (SC) were used as the specific biomarkers to evaluate testing anxiety. HR was taken with a fingertip heart rate monitor and SC/SAA were collected with a kit from Salimetrics. Students were randomly placed into three experimental condition groups (prayer, meditation, study guide) and had their biomarkers measured at four different times. One

measurement was taken during the first introductory meeting, and the three others a week later during the second experimental meeting. Twenty minutes were given between the measurements at the experimental meetings so that reactions of the biomarkers could be evaluated. A test anxiety stressor was presented and biomarkers were instantly measured, and then measured again twenty minutes later to determine if the experimental conditions altered student biological test anxiety levels.

Aside from biological test anxiety levels, the WTAS was given during the first meeting with the students. The Westside Test Anxiety Scale (WTAS) is free to the public for use in test anxiety research and has been evaluated for both validity and reliability (Driscoll, 2004; Onyeizugbo, 2010). The three groupings of students mentioned above were randomly created based on results from the WTAS. The goal of creating the groups was to have an equal amount of Low, Normal, Moderately High, and Extremely High test takers in the experimental groups.

A question related to prayer importance was added after the WTAS for the purpose of creating focus groups in the qualitative portion of the study and for further examination of the quantitative data. The question simply asked students how valuable prayer was in their lives: very (1), somewhat (2), or not at all (3).

The qualitative portion of the study is one that was referred to as transcendental phenomenology (Creswell, 2007; Moustakas, 1994). The purpose of the transcendental phenomenological portion of the study was to help clarify unique individual experiences to grasp an overall essence of the relationship between test anxiety and prayer (Creswell, 2007). For the qualitative portion, students were put into three different groups based on their answer to the question about prayer value given during the first meeting. All participants from the group who ranked prayer as not important declined to be part of the focus group.

The research findings were viewed from the lens of the Cognitive Attentional Theory (CAT) (Culler & Holahan, 1980; Weinstein, Cubberly, & Richardson, 1982; Wine, 1971; Sarason & Mandler, 1952; Sarason, 1972 1980). Specifically, the CAT is concentrated on the idea that students who have elevated levels of test anxiety are influenced by their lack of attentional focus and thought types in the presence of an evaluation (Meichenbaum & Butler, 1980; Sarason, 1972, 1980, 1984, 1988; Wine, 1971, 1980). Figure 9, found in chapter two, helps to see this idea visually. The figure illustrated that students are put into an evaluative situation where they expect to perform a certain way and focus on themselves instead of on the evaluation, which leads to poorer concentration and impaired task performance.

The researcher hypothesized that guiding students to focus on Christian prayer could lower testing anxiety more than through meditation or use of test study guide. According to the CAT, student test anxiety is dependent on how students use their cognitive awareness during testing and if they turn those cognitions negatively toward the testing situation and/or themselves (Wine, 1971). Research has shown that students with elevated test anxiety are more likely to use behavioral strategies than those without test anxiety (Kondo, 1996). Focused Christian prayer is a technique that takes student attention and concentration off of themselves and moves it onto God. Not only does it remove the attention off of students, but also a technique that increases hope and positivity in the testing situation. The discussion of research findings follow in the order of the research that took place, quantitative followed by qualitative, as well as the cohesion of both.

Research Question One

The first research question set out to determine if there is a difference in the physiological response to test anxiety of students who use focused Christian prayer compared to students who meditate or use a study guide. A total of 48 students participated in the quantitative portion of the study: 17 males and 31 females. The quantitative data was collected over four times during a two-week period. The researcher attempted to answer this question by measuring the test anxiety biomarkers of three different experimental groups (prayer, meditation, study guide) over the four times. The three test anxiety biomarkers were heart rate (HR), salivary cortisol (SC), and salivary alpha amylase (SAA). Tables 24-26 below depict the mean HR, SC, and SAA levels of students in the three experimental groups at times 1-4.

Figure 25

Changes in HR for Experimental Groups

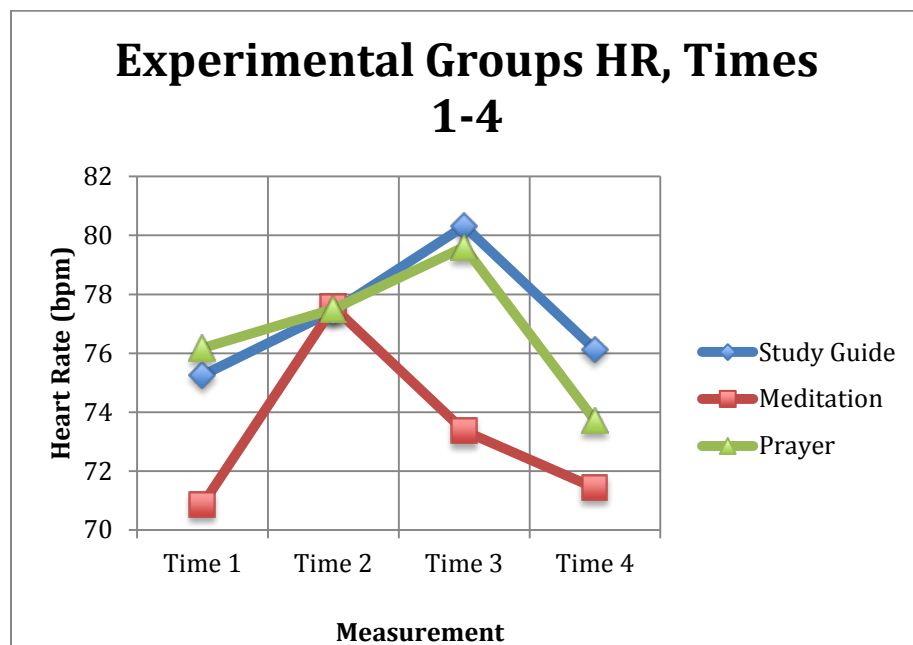


Figure 26

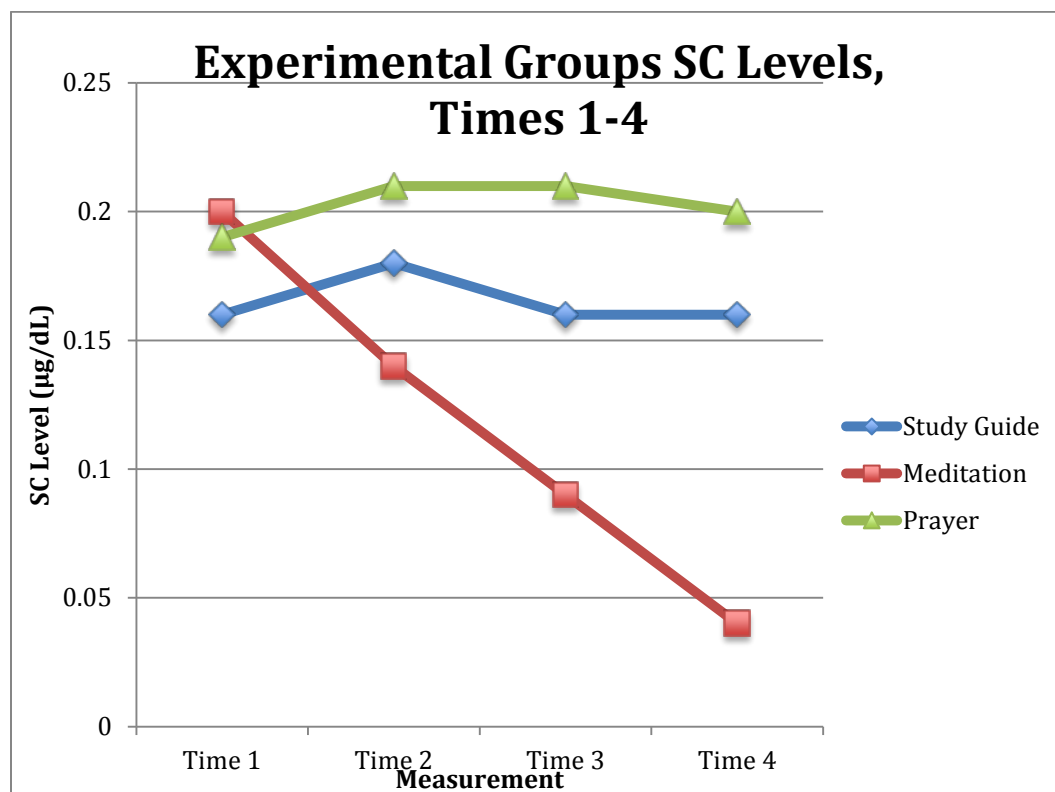
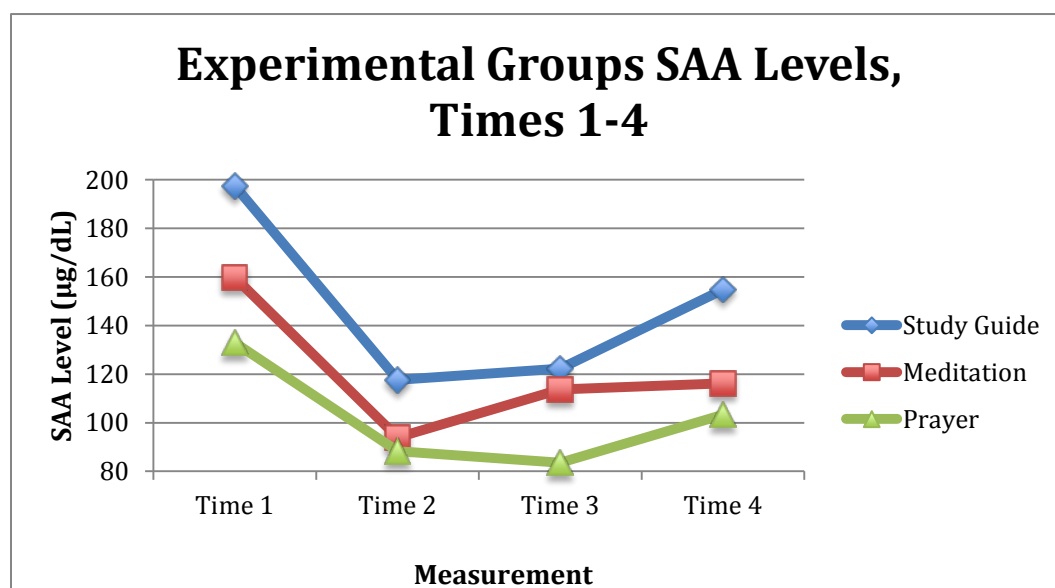
Changes in SC for Experimental Groups

Figure 27

Changes in SAA for Experimental Groups

The question proposed was if there is a difference in the physiological response to test anxiety of students who use focused Christian prayer compared to students who meditate or use a study guide. In relation to the Cognitive Attentional Theory (CAT), Christian prayer was chosen as a method to not only help students move the potentially negative focus off themselves/the test and onto Christ, but to seek a source of hope and advocate in the time of need. A guided meditation was chosen since it is closely related to prayer, but does not have the component of Christ. The study guide group was selected as a way to maintain and not lower test anxiety by giving students a scenario where they were to focus on the testing itself and the potential negative cognitions that research has shown come with testing situations (Wine, 1971).

The primary researcher ran ANOVA tests on the differences between each experimental group at the four different measurement times, as well as the different time frames in order to determine if there were a pattern of significant differences which affirmed Christian prayer as a clear alleviating agent for student test anxiety. At the current time, the study did not discover a pattern of significant findings to affirm that focused Christian prayer is a better method for lowering biomarkers of test anxiety than meditation or study guide usage. As discussed below, there were interesting findings, and some significant, within some biomarker measurement points and time frames, but as a whole, at this time the data did not conclusively affirm that focused Christian prayer was significantly more effective than the other two methods.

The data in Table 5 shows that of the three experimental conditions, the students who used focused Christian prayer had the largest decrease in heart rates after the stressor was presented (5.89 bpm). This finding was not significant but can promote the

idea that Christian prayer has a positive effect on student HR after presented with a test anxiety stressor. The larger change in HR for the prayer group may be due to the fact that focusing on Christ takes the student's attention off of their physiological symptoms, which has been shown to increase testing anxiety and decrease cognitive functioning (Lupien et al., 2007; Martinek et al., 2003; Sarason, 1975; Spangler et al., 2002), but may just be due to chance or the fact that students took twenty minutes before taking the test, since HR's amongst all three dropped during the twenty minutes after the stressor was presented.

Results indicate that all three experimental conditions had some therapeutic effect on test anxiety as evidenced by heart rates. Table 5 in the results section shows that heart rates across each category were decreased from the time the stressor was presented and the 20-minute experimental condition was utilized.

Figure 25 visually shows that the cortisol levels of the three experimental groups across the four times were each unique. The group that prayed, showed very minimal changes in mean SC levels across each of the four times (.19, .21, .21, .20). The study guide group had similar readings (.16, .18, .16, .16). The unique group was the meditation group, which showed a consistent decrease from time one to time four (.20, .14, .09, .04). The differences between the scores of SC between the experimental conditions were not significant.

The non-significant findings could be altered if more post stressor biomarker testing points were added. Based on other's research below, there are different opinions of how many biomarker measurement points yield telling results. According to Kirschbaum, Pirke and Hellhammer (1993), saliva-sampling points are usually ten to

fifteen minutes pre-stressor, immediately prior to onset of stressor, and then for three measurements post stressor. Different studies vary however, with Chatterton et al. (1997) using eight measurements at 15 minute intervals (four pre and four post stressor) to determine SAA levels after a stressor; Allwood et al. (2001) using six measurements to determine stressor impact on SC, SAA, and HR of children; and others (Allen, 2014; Payne et al., 2014) using three measurements. Granger et al. (2012) expressed that optimal design for biomarker reactivity is a pre-pre-stressor-post-post-post-post sampling scheme. Having limited post stressor data points could may have affected the ability to see a pattern/drop of biomarker stress levels.

Research has shown that SAA is more responsive to stressors than SC, can increase by small environmental changes, and may be more reactive than SC in the presence of a stressor (Allwood et al., 2011; Gordis et al., 2008; Ponzi et al., 2015; Takai et al., 2004). This was potentially confirmed with the mean SAA levels for all participants increasing upon introduction to the stressor. The SAA levels of the entire sample (n=48) rose from the introductory reading at the second meeting/time two (99.70 $\mu\text{g/dL}$) to introduction of the stressor/time three (105.26 $\mu\text{g/dL}$)—as evidenced in Table 7 of the results sections.

Figure 27 shows that within the three experimental groups, the levels of SAA for the group that prayed was lowest at time four, after the experimental condition was utilized. It was interesting to see that the three experimental group's SAA levels at time four rose after the utilization of the experimental conditions: prayer (103.33 $\mu\text{g/dL}$), meditation (116.28 $\mu\text{g/dL}$), and study guide (154.78 $\mu\text{g/dL}$). The pattern of prayer being the lowest SAA level and study guide being the highest SAA level was consistent

over each of the four times, although the impact on the research question is limited since the experimental condition was only presented at time three. It was also notable to mention that the SAA of the meditation group showed the least increase (2.57 $\mu\text{g/dL}$) after the experimental conditions were utilized; supporting the notion that meditation may have an impact on SAA levels.

Did the Test Anxiety Stressor Biologically Produce Test Anxiety?

The stress of test anxiety has been consistently shown to affect student's biological stress levels, which impacts student cognitive functioning (Lupien et al., 2007; Martinek et al., 2003; Spangler et al., 2002). The biomarkers used to evaluate student test anxiety were heart rate (HR), salivary alpha-amylase (SAA) and salivary cortisol (SC). Studies have shown that biomarkers may be increased by a variety of stressors (Allwood et al., 2011; Gordis et al., 2008; Martinek et al., 2003; McGraw et al., 2013; Takai et al., 2004) and it has been shown that psychological stressors can up to double the levels of some biomarkers, like salivary alpha amylase (Bosch et al., 1996).

The results of the quantitative portion of the study did not clearly confirm that test anxiety stressor with a reward and potential peer evaluation created biologically measurable stress. Students were presented with a test anxiety stressor during the experimental meeting right before the collection at time three. Aligned with research by Smyth et al. (2013), the stressor presented could potentially raise biomarkers since it was tied to performance, the threat of social evaluation and uncontrollability. The test anxiety stressor presented was informing students they were going to take a new IQ test where they had the potential to win a great prize (\$100 gift card). It was hypothesized

that telling students their results on the IQ test would be displayed publicly on campus for all students to see compounded the stress. Researchers have shown (Decaro et al., 2011; Hagtvet, 1983; Kurosawa & Harackiewicz, 1995; Morris & Liebert, 1970; Putwain et al., 2010; Smyth et al., 2013; Wine, 1971) that test anxiety increases with fear of failing, worry about other's perceptions, and feelings of inadequacy.

Amongst all experimental groups, the heart rates increased from the baseline reading/time one (74.31 bpm) to the presentation of the stressor/time three (78.02 bpm), as evidenced in Table 5 in the results section. The increase was, however, not statically significant when examined using an ANOVA in SPSS.

Salivary Alpha Amylase (SAA) showed a small, non-significant increase when the stressor was presented at the third collection time. It was interesting to see those with higher levels of test anxiety according to the WTAS (MH and EH) had SAA levels rise at time three, but not significantly. Salivary Cortisol (SC) levels remained fairly unchanged for across the experimental measurements.

There may be a few reasons that the stressor did not produce significant results. First, as stated previously, maybe more data points were necessary after the stressor to see how biomarkers continued to change more than twenty minutes post stressor presentation. Second, it is possible that the stressor implemented by the researcher was potentially "not stressful" enough. The particular group of students may not have been affected by the reward presented or the display of results. The data from each of the group's biomarkers may have also had such large variations that clear differences between the groups were hard to detect. This is apparent in Tables 6, 13, and 15. The

standard deviations reported were quite variable in relationship to the means. These are addressed further in the limitations section of this chapter.

Self-Reported Prayer Importance Related to Student Test Anxiety

Dehghani et al. (2012) defined prayer as human communication with divine and spiritual entities. Christian prayer is a type of prayer that believers of Jesus Christ use to stay in communication with God, who shows Himself and speaks to humans through Jesus and the books in the Holy Bible (Constable, 2003). Christians believe prayer is a form of concentrated communication with God that is often preferred in times of stress and anxiety by followers of Jesus Christ (Weld & Eriksen, 2007). Christians, through this prayer, experience a personal relationship with God and are able to seek help and reassurance directly, feeling as if God is an advocate or trusted friend (Pargament, 1997; Poloma & Gallup, 1991).

Aside from the experimental groupings; two other groupings were used to collectively look at the quantitative data in an attempt to better understand the impact of test anxiety on students. The first were student groups based on their scores on the Westside Test Anxiety Scale (WTAS). The number of the students in each group can be found in Figure 11. To summarize the table, there were four categories of the WTAS, comfortably low (CL, 3 students), normal (N, 23 students), moderately high (MH, 19 students), and extremely high (EH, 3 students). The second were student groups who defined prayer values as very important (VI, 31), Somewhat Important (SI, 15), or Not Important At All (NI, 3). Due to the small sample in the WTAS groups of (CL, 3) and (EH, 3) and the Prayer Value (NI, 3) group, it is essential to note that any comparison to said groups should be reviewed cautiously.

Students who ranked prayer as very important (VI) had the lowest average HRs across each of the four times when compared to students who valued prayer as somewhat important or not important at all. This data is shown in Table 5 of the results section. As stated above, there were only three students in the (NI) group, but the fact that students who highly valued prayer as (VI, 31) had lower mean heart rates on average than those in the somewhat important (SI, 15) group, although not significant, is quite interesting.

When looking at the value of prayer in student lives in relation to the salivary biomarkers of SC and SAA, the importance of prayer was shown to have significant relationships to biological test anxiety levels. Across the board, those who found prayer to be very important (VI) had lower SC levels than those who valued prayer as somewhat important (SI) or not important at all (NI).

Specifically, a significant difference with a large effect size was discovered at the introductory reading at the second meeting/time two between the VI group and the SI group ($p=.004$, $d=.86$)—which indicates that the value a student places on prayer may play a role in their stress level upon entrance into an examination situation. It may be interpreted that the students who valued prayer were shown to have less stress as measured by SC prior to having a test anxiety stressor presented. The students who valued prayer as very important also had significantly lower SC level changes than the SI group between times 1 and 2 ($p=.015$, $d=.79$) and times 2 and 4 ($p=.009$, $d=.86$). This data lends to the idea that the value a student places on prayer could be a potential buffer of test anxiety stressors for students who suffer from testing anxiety.

Significant disparities also existed in SAA amongst the students who valued prayer differently. Some of the significant differences are not included here since they involved the (NI) group, which only had three students—making it hard for generalizability. In each of the four times however, SAA levels showed a pattern--those who valued prayer the most (VI) having the lowest SAA levels and those who valued prayer the least (NI) having the highest SAA levels.

At time two, significant differences were shown between VI and SI groups ($p=.001$, $d=.08$). As with the SC at time two, this may indicate that the value a student places on prayer may play a role in their stress level upon entrance into an examination situation. This data was echoed at time three, with significant differences being found between SI and NI groups ($p=.045$, $d=1.72$). Time three clearly showed that when presented with a test anxiety stressor, those who valued prayer had statistically significant lower SAA levels. It is necessary to point out that there was data showing significant differences between the (NI) group and other groups at these times as well, but they were left out due to the small sample of only three students in the (NI) group.

From the significant findings in this section, the data may indicate that in this study, the subjective value that a student places on prayer may have been a clearer indication of biomarker changes of test anxiety than the groups of prayer, mediation, or a study guide.

An Unintended Finding: Support of the WTAS

As an unintended research finding, the results of the study had poignant deductions related to the effectiveness of the WTAS to measure student test anxiety. For the current research, the WTAS was put into four categories of test anxiety:

comfortably low (CL), normal (N), moderately high (MH), and extremely high (EH). It is important to identify that application of the findings could be limited since of the four groups, the high and low ends of the spectrum (EH and CL) had only three students.

Students with normal test anxiety (N) seemed to be biologically calmer than students with moderately high (MH) test anxiety at each measurement point. As Table 5 in the results section show, the HR's of the (N) group are consistently lower than those in the (MH) group. Also, the HR's of those who scored a CL test anxiety level were the lowest for each the four times over the study—and consistently lower than the students who ranked as EH test anxiety. A significant difference was also found to support this point. The mean HRs at time one had a significant difference ($p=.032$) with a medium effect size ($d=.6$) between the N group and the MH group. There were other significant differences, but the difference between the MH and N group should be more applicable since those two groups had larger sizes (N=23, MH=19).

Non-significant findings presented patterns to support the WTAS as a way to measure test anxiety. The heart rates of the students with CL test anxiety were the lowest when the stressor was presented at time three, and the lowest after the experimental condition was utilized. It strengthens the support of the WTAS to see that when a test anxiety stressor was presented (time three) the HR's incrementally increased amongst the WTAS categories. The stacked heart rates can be viewed in Table 5 of the results section. The salivary biomarker of SAA also helped to support the usage of the WTAS for evaluating test anxiety. Table 7 in the results section indicates that the lowest SAA readings when a stressor was introduced were that of the CL group. Students with CL and N test anxiety, when the stressor was presented, were both shown

to have drops in SAA—whereas students with MH and EH showed an increase in SAA. This makes sense; seeing that those with increased levels of testing anxiety would be assumed to have a larger biological reaction.

Although one would hypothesize changes based on SC levels would have helped to affirm the WTAS as an effective test anxiety measurement tool at this time, there were not obviously noticeable patterns of increase from CL to EH. This is shown in Figure 18 of the results section. However, with the HR and SAA data, there seems to be enough biomarker findings to help suggest that the WTAS is an effective measurement for the varying levels of testing anxiety in college students.

Other Findings

Some findings did not directly apply to the research questions, but were stimulating to see. For instance, it was assumed and found that the HR would drop from after the experimental conditions were utilized, but it was remarkable to see that the mean heart rate of each experimental group (prayer, meditation, study guide) increased from the first meeting with the students to the beginning of the second meeting with the students a week later. When the HR's were evaluated from the groupings of the WTAS, the same finding was shown for each group from baseline reading/one to the introductory reading at the second meeting/time two, as evidenced again in Table 5 in the results section. The first time was a baseline reading, with students not being sure what was going to specifically happen. It could be assumed that student heart rates potentially increased during the second meeting since they knew they were attending the experimental portion of the study, and unsure of exactly what would be taking place.

It was also exciting to see the average SAA levels for all participants were higher during the first saliva collection than at the entrance of the second meeting (time two) and the presentation of the stressor (time three) (162.27 $\mu\text{g/dL}$, 105.26 $\mu\text{g/dL}$). This could indicate that HR and SAA don't rise symmetrically at all times and may show that students could have been somewhat more comfortable during the second meeting after seeing the lab setting, going through one saliva collection procedure, and getting to know the lead researcher. The researcher is not alone in this finding, with Keller et al. (2012) showing nonlinear findings of biomarkers and cognitive abilities. It was also interesting to see that HR of the WTAS category of extremely high (EH) test anxiety dropped largely (10.67 bpm) after the experimental conditions. This finding was not significant, but could indicate that anxiety reduction techniques can help those who report as the most stressed. This data furthers the need to keep researching methods to lower test anxiety of students in college.

Research Question Two

The second research question intended to explore how college students believe focused Christian prayer impacts their experienced test anxiety. This was done with two focus groups. The two focus groups were determined based on the student's ratings of prayer's value in their lives. As stated earlier, there was a desire for three focus groups to be interviewed as a way to grasp the viewpoints of students who valued prayer differently, but only two were formed. The students who ranked prayer as not important (NI) declined to participate in a focus group. The first focus group consisted of seven students that ranked prayer as very important (VI). The second focus group consisted of four students that ranked prayer as somewhat important (SI).

As stated in the previous chapter, nine themes emerged from two focus groups.

The themes are again reported here:

1. Test Anxiety Amongst College Students Presents Itself in Distracting Physical Symptoms
2. Test Anxiety Amongst College Students Presents Itself in Distracting Mental Thought Processes
3. Students Cope with Test Anxiety Differently
4. Factors Outside of Physical Symptoms and Mental Thought Processes Affect Student Test Anxiety
5. Test Anxiety Can be a Positive Trait
6. College Students Define Prayer Differently
7. College Students Have a Desire to Pray More
8. College Students Find Prayer to be Both Helpful and Harmful for Test Anxiety
9. Prayer Can Increase Focus

The themes that emerged helped to understand the diverse nature and interrelation of test anxiety and prayer. The findings of the qualitative data confirmed research showing that test anxiety is a multidimensional construct that has both physical and mental components (Lowe et al., 2008; Morris & Liebert, 1970; Pekrun et al., 2004; Sarason, Sarason, & Pierce, 1990) that students have learned to cope with in different ways. The qualitative portion noted that environmental factors outside of mental and physical experiences can affect student test anxiety, which Putwain et al. (2010) found similar results to when looking at situational variables.

In direct relation to the research question, prayer was found to be unique to each student. This is elaborated in the next subsection. 86% of students who valued prayer as very important had a desire to increase their prayer, whereas students who viewed prayer as somewhat important did not report that desire. The students consistently reported that there was a desire to increase their prayer life since it brought them a sense of peace. This would make sense in a time of test anxiety, where peace can be fleeting.

According to Table 10 in the results section, the theme with the most responses (28) related to the idea that prayer can be both helpful and/or harmful for testing anxiety. All of the students that valued prayer as very important (VI) commented on that theme, while 75% of students who valued prayer as somewhat important commented on the theme. Students expressed that being close to God continually gave them peace and a sense of calm that things were going to work out in the end. Multiple students asked God directly to help them to be calm, whereas other students just asked for God's will to be done. Students consistently reported that just spending time with God was a way to relax and get their minds off the test. Some even stated that having professors pray for them helped since it brought their attention off of the test and onto God. Two students from the group that valued prayer as somewhat important reported that prayer could actually increase their stress. One expressed that being prayed for by a professor led to internal dialogues related to not being trusted to do well on the test, and another said that prayer took away from focus on the test itself.

The second research question, as well as the first, is more fully explored through the interpretation of both the quantitative and qualitative portions, which follows.

Conclusions Through the Interpretation of Mixed Methods Findings

According to Spratt et al. (2004), mixed methods are conceptually complex and offer a way to triangulate data sources. Quantitative and qualitative portions of the study gathered pieces of the test anxiety and prayer relationship puzzle. Since the mixed methods study was an explanatory sequential design (Creswell, 2012), the quantitative portion of the study was followed by the qualitative portion as a way to harness insight into the interrelationship of the two phenomena. The qualitative portion helped to humanize the findings of the quantitative findings. As a lens to see the entire interrelationship, the Cognitive Attentional Theory (CAT) was used. This section attempts to blend the narratives, numbers, and theory to help make a story of the phenomena.

The first research question was: is there a difference in the physiological responses to test anxiety of students who use focused Christian prayer compared to students who meditate or use a study guide? The second research question was: how do college students believe focused Christian prayer impacts test anxiety? The two research questions are directly related to one another, just as the two methods of research are.

The results of the quantitative and qualitative portions of this study suggest that test anxiety stressors create mental and physical distractions that impact student ability to concentrate on testing. Test anxiety has been shown to affect overall grades in college courses (Naveh-Benjamin et al., 1981), and according to the CAT, students are impacted by both physical and mental test anxiety symptoms that reduce concentration on testing, that can impact performance. This was confirmed in student heart rates and SAA levels increasing for all participants when a test anxiety stressor was presented.

Students in the two focus groups were unified in the confirmation of findings by Sarason (1987) and Salend (2011) that there are many aspects of each student's situational test anxiety. Physical symptoms of test anxiety were mentioned six times in each focus group. Kira stated that test anxiety increased her heart rate and blurred her vision. Alice, Annie, and Marvin expressed that test anxiety noticeably increased their heart rates as well. Kyle even stated that he felt the test anxiety affect his digestion. Mental symptoms were reported 21 times over the two focus groups. Students explained that they often catastrophized their testing situations, letting their concentration move to potential future failures. An example is Sara, who explained that her thinking snowballed into thoughts about her "GPA, and then scholarships, and then letting my family down and disappointing them". Along with internal factors, students also reported that factors such as class size, preparation, time limits, and professor attitude impacted their test anxiety symptoms.

The results of the quantitative and qualitative findings of the study lend to beliefs that prayer is unique to all students and can be an effective way to lower physical and mental testing anxiety. It was initially of note that within the first focus group (VI), none of the students fit into the extremely high (EH) WTAS category. It was also fascinating to see that within the second focus group (SI), there were no students who were ranked to have comfortably low (CL) test anxiety on the WTAS. This echoed the quantitative portion of the study, where students who viewed prayer as more important were likely to have less biomarkers for test anxiety.

Twenty statements during the two focus groups were related to student definitions of prayer in their lives. They ranged from the opinion of Mary, that prayer "is quite time with God that is personal and out loud" to Kyle, stating that prayer is "a state of mind or way of living...that is not a routine or a ritual". The majority of students (86%) who valued prayer as

very important expressed a statement of desiring to pray more, since, as Hal stated, “when I actually take the time to pray, it is helpful.”

Prayer was shown to be able to impact different measurements of biological test anxiety in the quantitative portions of the study. Of the three experimental conditions, the students who used focused Christian prayer were shown to have the largest decrease in heart rates after a test anxiety stressor was presented (5.89 bpm), although not a significant finding at $p=.05$. It was also found that students who ranked prayer as very important (VI) had the lowest HR, SAA levels and SC levels across each of the four times when compared to students who valued prayer as somewhat important and/or not important at all. This aligns with research by Harris et al. (2002) that shows student who are active in their relationship with God (i.e. pray more) had lower levels of anxiety. The qualitative focus group expands on these findings, with students describing prayer to be helpful. Many of the students expressed that prayer brought them a sense of peace since, like Emma saying, “God is in control of everything”. Mary confirmed that prayer was helpful since it helped her know God is present, which led her to “calm down and know life is good”.

It was also found during the quantitative portion of the study that students who found prayer to be very important (VI) had lower SC levels than those who valued prayer as somewhat important and/or not important at all. There was a significant difference and large effect size ($p=.004$, $d=.86$) between the VI group and the SI group at time two. The same two groups also had two significant differences between time one/time two ($p=.015$, $d=.78$) and between time two/time four ($p=.009$, $d=.86$).

Of the three experimental groups, the levels of SAA for the group that prayed was lowest at time four, after the experimental condition was utilized to assumedly cope with the test anxiety

stressor. These findings may suggest that students who were asked to pray and students who value prayer had a lower measurable biomarker (SAA) of test anxiety. Although not significantly significant, the data does confirm that SAA scores of the students who prayed were lower than those who meditated or used a study guide. It was also interesting to see that during each of the four times, SAA levels showed a consistent pattern--those who valued prayer the most (VI) had the lowest SAA levels and those who valued prayer the least (NI) had the highest SAA levels. Time three was especially important since the data clearly showed that when presented with a test anxiety stressor, those who valued prayer had statistically significant lower SAA levels. Amongst time three of the SAA readings, significant differences and large effect sizes were found between the VI and NI groups ($p=.022$, $d=1.54$) and the SI and NI groups ($p=.045$, $d=1.72$), indicating that the value students place on prayer has an impact on their biological stress readings when presented with a stressor. Again, due to fact there were only three members of (NI) group, the data has limitations as it is unknown if the pattern would remain the same with a larger sample size.

These findings may indicate evidence of what students like Mel reported in the focus group, asking God to “keep me calm in this moment, so I can perform the way I need to”. This is echoed by findings (Meichenbaum, 1972) showing that being aware of negative self-talk and addressing them lowered test anxiety. It also relates to research by Blankstein and Flett (1992), which found that students with elevated test anxiety avoided coping since they viewed the problem as out of their control. This may indicate that there is a more calm confident approach with students who value prayer, since students like Annie admitted, “God has me and I can relax”.

According to the Cognitive Attentional Theory (CAT), negatively focused thoughts about the self and supposed poor performance have an impact on test anxiety. The Control-Process of Anxiety (Carver & Sheier, 1988) also supports that a lack of belief a person has to cope with anxiety increases that anxiety. Annie expressed that focusing on God helped her to know what was important. In fact, 17 statements were mentioned by all but one student about prayer as a way to increase student focus. Kira stated that prayer helped to “increase focus before a test” and Mel said he asked to God to “keep my mind focused on the test and not get distracted”. Kyle explained it perfectly, saying:

As far as saying a verbal prayer to God, one of the main things that it does, no matter what you say, it brings you into a state of reverence. If you truly believe you’re talking to the Almighty, it brings you into the Presence. In that moment, there is something so valuable in your midst that you necessarily stop thinking about the future or past and it brings you into a presence. That could possibly stop your mind from wandering into useless patterns of thought.

Students repeatedly acknowledged that a focus on God and prayer increased prayer and focus for them. This makes sense in the lens of the CAT, seeing as students are focused on a positive force that offers hope and peace.

When looking at the two questions, the mixing of methods provided a story of data and narratives to help understand the interaction of prayer and test anxiety phenomena. There were distinguished significant and non-significant quantitative findings that could indicate prayer may have the ability to impact biomarkers of test anxiety in students.

These findings were evident in student stories of the interrelation of prayer and testing anxiety in their lives. The CAT helped to blend the two phenomena together, helping to grasp

that test anxiety has cognitive factors that are potentially remediated by focused Christian prayer. Independent students biological test anxiety readings of HR, SC, and SAA indicated that students who valued prayer and were asked to pray when put into a test anxiety situation may have a buffer to the effects of said stress. Student reports in the focus groups confirmed these findings, with students over and over again reported prayer to be helpful with cognitive hope and attentional focus.

Overall, the data furthers the need to keep researching methods to lower test anxiety of students in college. The WTAS category of extremely high test anxiety dropped largely by 10.67 bpm, which was not significant, but indicates that anxiety reduction techniques can help those who are most stressed.

The Neurobiology of the Test Anxiety Results

The notion of stress is based on the idea that both psychological and physical demands can create biological changes, also referred to in research as a general adaption syndrome (GAS) (Selye, 1936; Ursin & Olf, 1993). To go further, stress is a experience that can be caused by a real or perceived threat and in humans follows a common biological track: a perceived stressor, a hypothalamus response, a pituitary response, and an adrenal response (Chrousos, Kino & Charmandari, 2009; Lupien et al., 2007).

Two main systems shown in research are involved in producing biomarkers related to psychological stress: the hypothalamus-pituitary-adrenocortical (HPA) axis and the Sympathomedullary (SAM) system (Takai et al., 2004; Chen et al., 2014).

The most distinctive response to stress is the release of the ACTH and the adrenal cortex releasing glucocorticoids into the blood stream as a result of the activation of the HPA axis (Graeff & Junior, 2010). Research by Kirschbaum and Hellhammer (1994) and Smyth et al.

(2013) indicates that salivary cortisol signifies Hypothalamic Pituitary Adrenal (HPA) activity and implies that psychological stress increases the body's salivary cortisol levels above baseline. Smyth et al. (2013) explained the biological cortisol response, also known as the Hypothalamic Pituitary Adrenal (HPA) axis, as follows: The nervous system secretes cortisol based on an internal/external stressor, the hypothalamus is activated, the pituitary gland sends to the adrenal cortex, which then leads to secretion of cortisol into the bloodstream.

Along with this reaction, the Sympathomedullary (SAM) pathway is active, with adrenaline being released, which arouses the sympathetic portion of the autonomous nervous system (Currie & Symington, 1955). Psychological stressors can elevate adrenaline levels in the blood, which leads to an enzyme known as salivary alpha-amylase (SAA) being produced (Gallacher & Petersen, 1983). The enzyme alpha amylase (SAA) is a useful biomarker for measuring the response of these systems (Chen et al., 2014; Walsch et al., 1999; Skosnik et al., 2000). The Sympathetic Adrenal Medullary (SAM) system is different from the HPA system noted above, with noradrenaline in the blood coming from an overage in the nervous system, which indicates increased sympathetic system activity (Lake et al., 1984; Kennedy et al., 2001). According to research by Chatteron et al. (1996), there is a relationship between blood levels of salivary alpha-amylase (SAA) and blood adrenaline/noradrenaline (stress). SAA can be more accurate in measuring the effects of stress on the body on the human body (Ali & Pruessner, 2012) and can be as much as doubled by a psychological stressor (Bosch et al., 1996).

The research from the current study can be looked at from the light of the two neurobiological systems explained above. The test anxiety experienced by the students was psychological. Research has shown however that the anxiety, though starting out as a psychological stressor, is concurrently both psychological and physiological leading up to the

test. Research has shown that testing for many students is initially a perceived threat that leads to physiological reactions, which tend to then create more anxiety for students as it is put into focus. In this, both the HPA axis and SAM system are activated. A study by Graeff and Junior (2010) was conducted to determine if general anxiety differed from panic attacks. The researchers used the two categories of anxiety generally as psychological (general anxiety) and physiological domains (panic) of emotions. Other researchers have shown that cortisol responses are different in patients with panic symptoms compared to those without (Petrowski, Herold, Joraschky, Wittchen, & Kirschbaum, 2010). Graeff and Junior (2010) found similar results, with participants having panic disorder not showing HPA axis responses indicated by peaks in cortisol. This may suggest that there are different biological responses to different types of stress.

The current study showed that the HPA axis, as measured by the cortisol level differences for students, was not significantly responsive to the test anxiety stressor that was presented. Cortisol levels were generally unchanged over the four measurements. As stated in this chapter, this could have potentially been due to the fact that the HPA axis was not activated by a “stressful enough” stressor.

The current study showed that the SAM system, as measured by differences of SAA levels, was also not able to show significant measurement differences when looking at the experimental groups of prayer, meditation, and test anxiety. It was interesting to see though that the experimental group that prayed had the lowest SAA at each of the four times, potentially indicating that less of an adrenaline response to the test anxiety stressor was felt amongst the group that prayed—since it was not significant however, this could also be due to chance.

SAM system changes indicated by SAA levels did differ quite a bit based on the subjective prayer values of students. The significant differences found between the groups who valued prayer as very important and somewhat important possibly indicate that the value a student places on prayer may have a therapeutic affect on the activation of the SAM system and the release of adrenaline.

Looking at the research by Graeff and Junior (2010), it may be that the test anxiety stressor was enough to elicit an SAM response but not a HPA axis response. According to Nater et al. (2005) though, “While it seems clear that alpha-amylase levels rise following physical stress, the response to a psychological stressor appears to be more inconsistent” (p.2). The researcher continues, saying, “This might be due to the psychological nature of the stressors employed” (Nater et al., 2005, p.2). This neurobiological view may help to understand the lack of definitive data in this study.

Limitations to the Study

Each study has potential limitations. This study, since it is dealing with two phenomena (prayer and test anxiety) that are quite subjective and hard to define, offers no fewer limitations than other studies related to the topics. According to Zeidner (1998), test anxiety research is concerning since results may not be able to be generalized to populations at large. Those words, which potentially could have been a disclaimer to this field, are echoed in the results.

It is important go back to where this whole journey began in chapter 2, discussing the multidimensional construct of test anxiety. As Zeidner (1998) stated, test anxiety is a unique phenomenon that has no exact descriptive model to explain all the convoluted factors involved. Test anxiety is incredibly distinctive to each student

who experiences it—with both physiological and cognitive components. The reason for addressing this again is to identify the potential limitations that may be related to the uniqueness of test anxiety.

Prayer, meditation, and a study guide could possibly have had a more significant effect on the test anxiety cognitions of students rather than the biological systems involved. Perhaps the students involved had cognitions related to test anxiety, but the physiology did not correlate. This idea was found in research by (Martinek et al., 2003) that showed students who thought they were experiencing test anxiety did not show symptoms of that anxiety.

Much of the test anxiety research, especially in terms of peer evaluations (Decaro et al., 2011; Kurosawa & Harackiewicz, 1995; Putwain et al., 2010) shows that test anxiety increases with the stress over how students feel others will judge how they perform. The campus on which the testing took place is not large, with a student body lower than two thousand. The smaller tight knit community could potentially mute the physiological response to stress, since fear of negative evaluation in a supposed supportive environment may be less likely. There is also the idea that prayer is more cognitive in nature, and thus may be easier to detect in surveys or qualitative data, rather than biological measures.

In relation, and as stated in the methods section, the fact that the students were tested in a controlled setting makes the true test anxiety situation artificial. This situation could either induce or decrease test anxiety for the student test takers. The study having taken place on a Christian campus also provided some limitation. It is not surprising to note that the subgroups were not equally sized when looking at prayer values. This can be assumed since the research was conducted on a Christian campus. Possibly on a non-Christian campus there would be more

students who did not value prayer as highly. Students may have felt a pressure to pray, from both the researcher and/or other students, since they were being analyzed. Students with different belief systems may have also actively not prayed as a way to object to the cultural themes at the college they attend—but not said anything vocally. On the same note, students who were not asked to pray while in the meditation and/or study guide groups, may have done so.

The study did have more females than males (31/17) and the females showed higher levels test anxiety on the WTAS, which is found in research (Cassady & Johnson, 2002). The researcher attempted to address this by randomizing the groups based on WTAS scores, but some groups had more females than males, which could have impacted the results. It is suggested that future research attempt to gather participant groups that are balanced among gender, due to the said differences of gender test anxiety in literature (Cassady & Johnson, 2002).

Saliva flow rate could have impacted results. Even though research (Bosch et al., 1996) has shown that saliva flow rate is not related to SAA levels, the relationship between the flow rates and SAA levels are not examined conclusively. The idea that anxiety levels may differ for students in different fields could also a potential limitation. In a dissertation by Johnson (2013), it was affirmed that nursing students have higher testing anxiety than general population students. This may be true of other fields as well.

Funding was also a limitation of the study. Salivary biomarker kits are quite expensive. SC level changes could have potentially been better understood if more times were added to the collection protocol. According to Smyth et al. (2013) and Kirschbaum and Hellhammer (2000), five to six measurements seem to be more ideal for evaluating SC. A study by Nater et al. (2005) posited that multiple measurement

points helped to make their evaluation of SC, SAA, and HR changes effective. SAA level changes can also sometimes be hard to pinpoint if enough measurements are not taken and a consistent stressor is not repeatedly used (Nater et al., 2005).

The generalizability of the data is also a limitation. The sample size, due to its small amount of students, led to limited application of some findings. The fact that there were only three students who had comfortably low test anxiety and three that had extremely high test anxiety, makes findings from those two groups of the WTAS limited. The same can be said with the group that rated prayer as Not Important At All (NI). Since that group only had three participants, differences among the SI and VI groups must be tapered before application. A larger sample size, with at least 100 students, would be ideal for a study of this type.

Lastly, the researcher admits that his presence in the experimental meetings may have had an alleviating effect. The researcher is a social worker and a professor who admits to attempting to alleviate stress in the classroom when working with students. It is possible that during the experimental research that the researcher may have used calming talk as participants were arriving that was not on the script. As the researcher also commonly uses humor in the classroom with students, this may have been present during the research as well which may have had a calming effect on participants. It is suggested in future research that the researcher use a research assistant to gather saliva samples, as well as a recorded script, to keep from unintentionally lowering the stress/test anxiety in the testing setting.

Recommendations for Further Research

Test anxiety is currently a problem that affects students (Ackerman & Heggstad, 1997; Bonaccio & Reeve, 2010; Casbarro, 2004; Hembree, 1988; Onyeizugbo, 2010; Putwain, Seipp, 1991; Woods, & Symes, 2010). It is quite different for each student, and due to that, many different methods for limiting test anxiety have been studied (Ahern & Norris, 2011; Damer & Melendres, 2011; Hembree, 1988; Johnson, 2013; Kondo, 1996; Plante, Marcotte, Manuel, & Willemssen, 1996; Prato & Yucha, 2013; Topp, 1989). Kondo (1996) expressed that to fully grasp test individual coping mechanisms for test anxiety, different methods of coping should be studied in relation to their influence on the situation as well as the influence of the situation itself. Haas (2007) affirmed that attempting to gather evidence of prayer actually being heard by God is done so by testing if prayers are trailed by what was requested in them. The research conducted attempted to determine if prayers about lowering test anxiety for students were effective.

This interrelationship between prayer (especially Christian prayer) and test anxiety in the U.S.A. is a new topic of research. The findings from this explanatory mixed-methods dissertation research lead to recommendations for future research that has the potential to add to the body of literature on the topics of Christian prayer and test anxiety. Research shows that studies have examined prayer and anxiety (Dehghani et al., 2012; Harris et al., 2002), but there is still limited data on the relationship between prayer and test anxiety. Since prayer has been shown to help in diverse areas of human life (Boelens et al., 2009, 2012; Stanley, 2009; Tloczynski & Fritsch, 2002; Vannemreddy et al., 2009; Whittington & Scher, 2010), it is worthy of continuous study. The limited amount of research on Christian prayer is also indicative of an area that could use a more breadth of knowledge. This study builds on findings that praying involving Jesus has the potential to be highly relaxing (Meany et al., 1984).

As Nater et al. (2005) suggests, further studies are necessary for the investigation of parasympathetic and sympathetic activity on SAA levels in relation to psychosocial and psychological stressors. This research may help to support the claim by Allen (2016, p.72) that “Salivary alpha-amylase through further research may prove to be a useful biomarker in stress research due to the ease of collection, the minimally invasive nature of collection, and the ease of analysis”. The study suggests that there may be reason to research the impact that perceived value of prayer has on reported testing stress as well as biomarkers (such as SAA) of stress more fully. More research on Christian prayer as an attempt to explore the benefits of its practice is also indicated.

The findings lead the researcher to also recommend more studies using biomarkers of test anxiety to evaluate the validity of written test anxiety tools. Since the WTAS findings were possibly supported by the biomarker measurements in this dissertation, more test anxiety evaluative tools could be examined with test anxiety biomarkers supported in research.

Conclusion and Implications for Professional Practice

Students in schools are suffering from testing anxiety. Talib and Sansgiry (2012) have affirmed that the higher a student’s test anxiety, the more potential for a reduction in GPA. Skill training has been shown to be effective when teaching subjects not focus on negative aspects of test anxiety (Wine, 1970). Prayer has been found to be a key coping source for persons facing elevated levels of emotional suffering, and this is particularly the case when other possible coping responses are unreachable or unsuccessful (Das & Anand, 2012; Ellison, Burdette, & Hill, 2009). Studies have also shown those seeking mental health care desire prayer in their services (Weld & Eriksen, 2007).

According to Robotham (2008), the “key role for higher education institutions in relation to stress is the provision of appropriate resources to enable individuals to deal with stress” (p. 7). Although Christian prayer is not part of the culture at every school, it is part of the culture of some agencies and educational environments. This study promotes that professionals working with students inside and outside of Christian school settings could encourage students to use prayer, as one of many potential tools, as a means to attempt and lower their cognitive and physiological test anxiety symptoms.

Teaching students to use skills to lower test anxiety has the ability to improve their self-confidence in testing situations, which has been shown to lend itself to higher success in academics (Onyeizugbo, 2010). Teaching students relaxation and attentional skills has also been shown to lower test anxiety (Little & Jackson, 1974). Although prayer is unique to each individual that partakes in the practice (Ladd and Spilka, 2006) it can be used as a way to improve confidence, increase relaxation, and focus on God.

Focused Christian prayer and test anxiety were worthy of study in relation to one another. Testing anxiety plagues too many students and it is a problem that has not disappeared, nor appears to be moving towards extinction. Christian prayer was shown to lower some biomarkers of test anxiety more than meditation or a study guide in students who valued prayer, as well as in students who utilized prayer in the face of a test anxiety stressor. Anxiety is a natural protective function that is sensitive to the probability of negative events happening and an individual’s ability to deal with those events if they do happen (Bateson et al., 2011). If students in certain environments could be taught that focusing their attention on God is more helpful than focusing on potential predicted negative events related to poor testing, then less stress may be encountered as they walk through the web of tests school systems create.

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Appendix A

Permission to Conduct Research on Campus

To Drey Campbell

Assuming you get HRRC approval, it's fine.

On Monday, November 3, 2014, Drey Campbell wrote:

B.W.

10/15/14

Dear Dr. W:

On behalf of myself, I am writing to request permission to conduct research titled, "A mixed methods study investigating prayer and test anxiety among college students". My plan is to recruit up to 80 students from four different disciplines and conduct physiological and survey testing on the campus over the next year. The estimated time frame for the study is July 1, 2015 – May 1, 2016. Thank you for your consideration in this matter.

Sincerely,
Prof. Drey Campbell, LCSW

Dissertation Chair:
Dr. Eric Werth
EWerth@nnu.edu

Appendix B

Permission to Use Figure 2

Dear Drey Campbell,

Thank you for your request. You can consider this email as permission to reprint the material as detailed below in your upcoming dissertation. Please note that this permission does not cover any 3rd party material that may be found within the work. We do ask that you properly credit the original source, Teaching Exceptional Children. Please contact us for any further usage of the material.

Best regards,

Michelle Binur

Rights Assistant

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Appendix C

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Author: Patricia A. Lowe, Steven W. Lee, Kristin M. Witteborg, Keri W. Prichard, Megan E. Luhr, Christopher M. Cullinan, Bethany A. Mildren, Jennifer M. Raad, Rebecca A. Cornelius, Melissa Janik

Publication: Journal of Psychoeducational Assessment

Publisher: SAGE Publications

Date: 09/01/2008

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Appendix D

Permission to Use Figures 8 & 9

December 9, 2014
Springer reference

Perspectives on Individual Differences
1998

Test Anxiety

The State of the Art

Authors: Moshe Zeidner

DOI: 10.1007/b109548

ISBN: 978-0-306-45729-6 (Print)

ISBN: 978-0-306-47145-2 (Online)

Materials requested: Figures 3.1 & 3.2

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Please note I am in the office on Tuesdays, Thursdays & Fridays

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Email: dreycampbell@yahoo.com

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Book Author: Fink

Book Year: 2000

Book Pages: 379 to 383

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Appendix G

HRRC Approval

Dear Drey,

The HRRC has reviewed your protocol: Protocol #1432015 - A MIXED METHODS STUDY INVESTIGATING PRAYER AND TEST ANXIEITY AMONG COLLEGE STUDENTS. You received "Full Approval".

Congratulations, you may begin your research. If you have any questions, let me know. If you intend to make any changes to the protocol, Please notify the HRRC.

Staff

Appendix H

Permission to Use Figure 7



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Title: Salivary alpha amylase–cortisol asymmetry in maltreated youth
Author: Elana B. Gordis, Douglas A. Granger, Elizabeth J. Susman, Penelope K. Trickett
Publication: Hormones and Behavior
Publisher: Elsevier
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Appendix I

September 15, 2015

To: Drey Campbell

From:

Re: IBC Protocol Review

Research Project Title: A mixed methods study on the effects of prayer on test anxiety

A statement of work comparison has been performed for subaward number CWK400-SB-005. All procedures meet the terms of this institution's federal assurances as identified and approved by the following committees.

Biosafety Committee

Researcher Name: Drey Campbell

Protocol: A mixed methods study on the effects of prayer on test anxiety

Approval Date: September 15, 2015

Expiration Date: September 15, 2018

Relevant minutes of Committee meetings will be made available upon request.

Appendix J

Script for Recruitment

Hello Students. I am Professor Drey Campbell. I teach in the social work department [REDACTED] and am currently working on my PhD as well.

Your kind professor has allowed me to take a few minutes and invite you participate in an exciting opportunity to help assist me with my research.

I am currently conducting a study on college student testing skills and need the help of some undergraduate students (you all) from [REDACTED] campus. The goal of the study is to look at a couple of biological responses during student testing situations. There will be simple pre test and a posttest and there is extremely minimal risk in participating. An example part of the experiment is simply completing a survey.

Your professor has agreed to offer you (#) points of extra credit for your assistance with the research study. As an additional incentive, there will be **two 100\$ visa cards** randomly given out.

The research study will require approximately two hours of your time. One hour will be needed in the evening hours (4-7 pm) on October 2nd and one hour in the same time frame on October 9th.

I am now passing out a sign up sheet.

If you are interested and would like to help, please sign your name, email address, and phone number on the form that I am now passing out. I will let your professor know who has completed the study for the extra credit points.

Thank you for your time.

Appendix L

Student Packet for Baseline Readings

**First off, Thank You for agreement to
assist in this research today and next
Friday.**

Appendix L Cont.

Informed Consent

Participant's name (Please Print): _____

Date: _____

I authorize and give my full permission to Professor Drey Campbell, of [REDACTED] and/or any designated research assistants to gather information from me on the topic of prayer and test anxiety.

I understand that the general purpose of the research is to determine biological process in the student test taking, which will require me to contribute a very small amount of saliva and measure my heart rate with a fingertip heart rate monitor. The approximate total time of my involvement will be roughly 1-2 hours.

I am aware that I may choose not to answer any questions that I find embarrassing or offensive. I understand that my participation is voluntary and that I may refuse to participate or discontinue my participation at any time without penalty or loss of benefits to which I am otherwise entitled.

I understand that there is a chance my stress/anxiety will increase during this experimentation and that after my participation, if I experience any undue anxiety or stress or have questions about the research or my rights as a participant, that may have been provoked by the experience, Professor Drey Campbell will be available for consultation, and will also be available to provide direction regarding medical assistance in the unlikely event of injury incurred during participation in the research.

The researcher will maintain confidentiality of research results. My individual results will not be released without my written consent.

The primary risks/benefits of the research study are the risk stress/anxiety could potentially increase during testing and the benefit to possibly win 100 dollars.

Signature of Participant

Please sign and return it to the researcher. The other copy you may keep for your records.

Questions and comments may be addressed to Drey Campbell.

Appendix L Cont.

Name: _____ Vial #: _____

Baseline Instructions for HR Monitor Use And Passive Drool Collection

HR Monitor:

Take the HR monitor out of the Velcro case in front of you.

Press the small power button once and the screen will have red lights turn on.

Place your index finger in the HR monitor with the nail side facing up. Set your hand down flat on the desk in front of you.

Let the device detect your pulse and your oxygen level.



The screen will look like this:

When you look at the monitor, your oxygen level will be the top number. Please write down your oxygen level here:

_____ (Oxygen percentage)

Your pulse rate is the larger number on the bottom. Please write down your pulse rate here:

_____ (Pulse rate)

**If your HR is jumping around, please take your finger out, turn the HR monitor off, and then start the process over again. Sit quietly for a moment and take the number that is shown. When you are done, please set the heart monitor back in the Velcro holster and place it to the side.

Passive Drool Collection:

For this portion of the data collection, you will need to do the following:

Take the small green and clear tube that is in front of you. The number on your vial is your unique testing ID number, which will follow you through this study. Unscrew the green cap of your vial and set them aside. Open the white foil saliva collection aid pouch in front of you. Place the ribbed end of the saliva collection aid into the small vial. Allow your saliva to pool in your mouth and then tilt your head forward and GENTLY push saliva into the vial. Stop when there is **1 ml** of saliva in the vial. Put your green cap back on your vial and set that down next to you.

Take the Saliva Collection aid and put it in the waste container on the desk. Please wipe down the outside of your vial and put that in the waste as well.

Appendix L Cont.

Age: _____ Gender: _____ ID# on your vial: _____

Thank you for your participation in this study

Please take some time and rate how true each of the following is of you, from extremely or always true, to not at all or never true. Use the following 5-point scale.

5= extremely or always true

4= highly or usually true

3= moderately or sometimes true

2= slightly or seldom true

1= not at all or never true

- ___ 1) The closer I am to a major exam, the harder it is for me to concentrate on the material.
- ___ 2) When I study, I worry that I will not remember the material on the exam.
- ___ 3) During important exams, I think that I am doing awful or that I may fail.
- ___ 4) I lose focus on important exams, and I cannot remember material that I knew before the exam.
- ___ 5) I finally remember the answer to exam questions after the exam is already over.
- ___ 6) I worry so much before a major exam that I am too worn out to do my best on the exam.
- ___ 7) I feel out of sorts or not really myself when I take important exams.
- ___ 8) I find that my mind sometimes wanders when I am taking important exams.
- ___ 9) After an exam, I worry about whether I did well enough.
- ___ 10) I struggle with writing assignments, or avoid them as long as I can. I feel that whatever I do will not be good enough.

Also, please answer the following question:

How important is prayer to you?

Very Important

Somewhat Important

Not Important

Appendix M

Script for Student Baseline Collection

Hello Students, My Name is Professor Drey Campbell.

Thank you for agreeing to take part in this study, which will happen today and next Friday. If you cannot make the same time next Friday, please exit at this time.

Sitting on your desks, you will see a packet, a heart rate monitor, a saliva collection vial with a number on it, and a bottle of water.

Please do not move forward in the packet without being told to do so.

Please take this time and swish some WATER around in you mouth and swallow it.

On the **first page**, you will see a thank you (again, thank them ☺)

On the **second page**, you will find an informed consent.

(Go over the informed consent with the participants)

On the **third page**, you will find basic instructions on how to use the heart rate monitors and saliva tubes that are sitting in front of you.

(Go over the instructions)

Thank you for that section of the data collection.

Now, please turn to the **fourth page** of your packet.

Take a moment and write down your age, gender, and ID # that was provided to you on your green vial (the one you put on the last page).

Take a moment and answer the ten questions as honestly as possible, on a 1-5 scale with 5 being always true and 1 being not true at all.

Also, please answer the question at the bottom related to prayer.

Please turn your packets over when you are finished.

You are scheduled to return next Friday (the 9th) at the same time you came today.

Again, Please refrain from eating 1 hour before your appointment and please do not consume alcohol within 12 hours of your appointment.

Also, it is imperative that you maintain confidentiality in this study.

Please do not talk about what happened today until the study is over (2 weeks).

Not maintaining confidentiality could jeopardize the results of the study.

Thank you again for your time and I appreciate your participation!

Appendix N**Student Packet for Experimentation Meeting**

PAGE 1

Name: _____

Experimental Number given in first session: _____ (1-60)

If you forgot your number, that's ok, Jennifer has a master list she will pull it from.

Appendix N Cont.

PAGE 2

Experimental Instructions for HR Monitor Use And Passive Drool Collection

HR Monitor:

Take the HR monitor out of the Velcro case in front of you.

Press the small power button once and the screen will have red lights turn on.

Place your index finger in the HR monitor with the nail side facing up. Set your hand down flat on the desk in front of you.

Let the device detect your pulse and your oxygen level.



The screen will look like this:

When you look at the monitor, your oxygen level will be the top number. Please write down your oxygen level here:

_____ 98 _____ (Oxygen percentage)

Your pulse rate is the larger number on the bottom. Please write down your pulse rate here:

_____ 100 _____ (Pulse rate)

**If your HR is jumping around, please take your finger out, turn the HR monitor off, and then start the process over again. Sit quietly for a moment and take the number that is shown.

When you are done, please set the heart monitor back in the Velcro holster and place it to the side.

Passive Drool Collection:

For this portion of the data collection, you will need to do the following:

Take the small green and clear tube that is in front of you.

The number on your vial is your unique testing ID number, which will follow you through this study.

Unscrew the green cap of your vial and set them aside. Open the white foil saliva collection aid pouch in front of you. Place the ribbed end of the saliva collection aid into the small vial.

Allow your saliva to pool in your mouth and then tilt your head forward and GENTLY push saliva into the vial. Stop when there is **1 ml** of saliva in the vial. Put your green cap back on your vial and set that down next to you.

Take the Saliva Collection aid and put it in the waste container on the desk. Please wipe down the outside of your vial and put that in the waste as well.

Appendix N Cont.**PAGE 3**

(Oxygen percentage)

(Pulse rate)

**If your HR is jumping around, please take your finger out, turn the HR monitor off, and then start the process over again. Sit quietly for a moment and take the number that is shown.

Now, Please Take your saliva the 2nd time

Appendix N Cont.**PAGE 4**

_____ (Oxygen percentage)

_____ (Pulse rate)

**If your HR is jumping around, please take your finger out, turn the HR monitor off, and then start the process over again. Sit quietly for a moment and take the number that is shown.

Now, Please Take your saliva the 3rd time

Appendix O

Script for Experimentation Meeting

Have students enter and sit into Room 204

Remind them that If they ate within one hour of this session, they need to please drink some water provided and swish it around a bit before swallowing.

Experimental SCRIPT

Hello Students, My Name is Professor Drey Campbell.

Thank you again for showing up a second time to participate in this study.

Please take a seat where your experimental number is located. Your number is on the board with your initials. If you cannot figure this out, please ask me.

This second meeting, you will again see a packet sitting on your desks. Please do not move forward in the packet without being told to do so.

4:10 pm

To begin today, please take the **first tube**, which is the one that has your ID number and a green one on it. Open the white foil package and deposit your drool as you did in the first session, but this time, you only have to go to the .5 ml mark. When you are done, set it aside.

I wanted to remind you that this study is confidential. Please do not talk about what happens in this room today---especially after you leave today! There will be other student outside of this classroom and it is imperative that you do not share your experience with them.

Now, please look at the first page of your packet, you will have a sheet with an option to put your name and your experimental number given to you last meeting (1-60).

Please turn to the second page. On the second page, again, you will find basic instructions on how to use the heart rate monitors and saliva tubes that are sitting in front of you.

(Go over the instructions again)

4:30 pm

I wanted to take this time to remind you that you have the chance to win 100\$ by participating in this study. Today you will be taking a new very short professional IQ test. After tonight, the test results will be posted next to your name on a poster in the lobby, so that all participants can see where they placed and how you did. The top two finishers on the short IQ test will win the 100\$.

Now, please **take your heart rate** and write it down on the third page of your packet.

Now, please **fill the second tube**, which has your number and a purple two on it, with your 5 ml of passive drool.

Appendix O Cont.

Now I would like to ask each of you to participate in a short activity before your IQ test. For the next twenty minutes I would like you to please (pray/meditate/study). Hand out Each packet as fit.

4:50 pm

Now that you have done your activity, please measure your **heart rate again** and place it on page four. Also, please **take your saliva a third time** (the vial with your number and a brown 3 on it).

Please write the HR measurements down on the 4th page.

After Done:

I wanted to tell you that you are the control group in the study. You do not have to take the IQ test at this time. Also, it is imperative that you maintain confidentiality in this study and please do not talk about what happened today until the study is over (2 weeks).

Not maintaining confidentiality could severely jeopardize the results of the study.

Thank you again for your time and I appreciate your participation!

I will be in touch with the winners of the gift cards via e-mail.

Appendix P

Prayer Handouts for Students

Prayer #1: The lords Prayer

Please take 5 minutes to recite this prayer repetitively. You can read it out loud or to yourself.

‘Our Father in heaven:
May your holy name be honored;
¹⁰ **may your Kingdom come;**
may your will be done on earth as it is in heaven.
¹¹ **Give us today the food we need.^[a]**
¹² **Forgive us the wrongs we have done,**
as we forgive the wrongs that others have done to us.
¹³ **Do not bring us to hard testing,**
but keep us safe from the Evil One.’^[b]

Prayer #2: Improvised Personal Prayer

Please take the next 5 minutes to improvise your own prayer. There are no limitations here. Pray how you see fit as long as it is safe and respectful to others around you.

Prayer #3: Group Prayer

Please recite the following prayer out loud with Professor Campbell for 5 minutes.

Dear Lord Jesus, Please direct my life today.
Lord God, I place my actions in your hands and ask that my actions are a reflection of your
Love and Glory.
God I pray that any difficulty I face will lead me closer to you.
God I pray that you help me to search for understanding in the world.
Help me to be a light to those whom are around me.
Lord help this study be one that would bring me closer to you than I was before.
Lord, help me to seek you when I am faced with life’s challenges.
God, Help me to seek you before I speak, act, and are tested by situations in this world.
Lord, help me to see your Glory in all things, from the beauty of the Sky to the wonderful
ability to use my mind efficiently.
God, I trust you in all areas of my life.
You are my comforter.
You are my redeemer.

Appendix P cont.

**You make things new.
I know that I can call on you and you will not forsake me.
Lord, I know that you are here when I am faced with challenges, tests, and obstacles.
I know that you are the destroyer of fear, worry, and stress.
Please give me will power to make it through the trials I face.
I love you Lord Jesus and I know you walk aside me.
I know I can trust in you and call on you in times of need.
I call on you today God.
Your word tells me that when two or more are gathered in your name, you are here. We
gather today and know you are here with us.
No obstacle shall stand against us. You provide loving warmth and comfort beyond
description.
You are a loving and just God who gave his Son for us.
We do not walk alone and through our testing, please draw us closer to you.**

Prayer #4: Improvised Personal Prayer

Please take the last 5 minutes to improvise your own prayer. There are no limitations here. Pray how you see fit as long as it is safe and respectful to others around you.

Appendix Q

Meditation Handout for Students

Meditation Instructions

For this portion of the study, please follow the instructions that are played over the speakers in the room.

This will be a twenty minute guided meditation

Please refrain from laughing or using any electronic devices.

Please take this as seriously as you can.

Appendix R**Study Guide Handout for Students****IQ Test Study Guide**

Please take some time to review the following practice IQ test questions

Q 1

Which of the words below is closest in meaning to the word 'Reassuring'?

- a compassionate
- b comforting
- c explanatory
- d meddlesome

Q 2

Number series

Which number logically follows this series: 4 - 6 - 9 - 6 - 14 - 6 - ...

Q 3

What number is one quarter of one tenth of one fifth of 200?

Q 4

A palindrome is a word or phrase that is spelled the same written forward or backward, often used for I.Q. test questions. "Stets" is a palindrome.

- a. True
- b. False

Q 5

Quick mathematical computations are common on IQ tests. Speed of response is important and used to determine the final IQ score. Three of the following numbers add up to twenty-seven. 6, 22, 13, 17, 14, 5

- a. True
- b. False

Q 6

Sequential reasoning is often tested in IQ exams. 3, 7, 13, 21, 31. What number comes next in the sequence?

Q 7

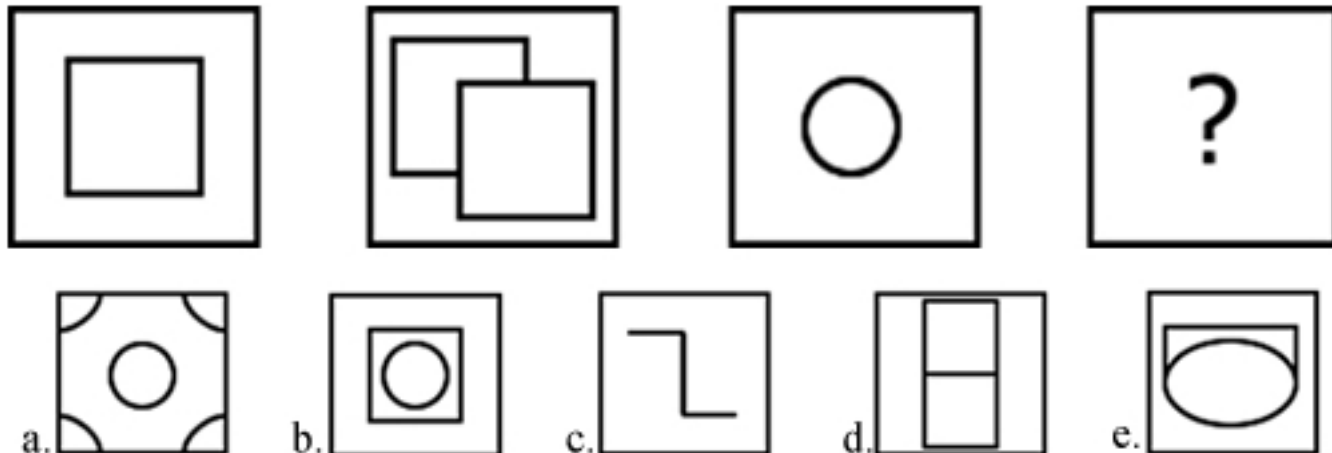
Compare and contrast or classification problems are commonly used to measure intelligence. Which of the five is least like the other four?

- a. Eel
- b. Shark
- c. Dolphin
- d. Swordfish
- e. Turtle

Q 8

Appendix R Cont.

Pattern recognition is another essential skill measured by many IQ exams. Which image best completes the pattern?



- a.
- b.
- c.
- d.
- e.

Q 9

Sales of an intelligence test, authored by Joe Doe, an awarding-winning psychologist and educator with more than 35 years of experience, are skyrocketing above competitors. More than 30,000 intelligence tests were sold in the first six months, but sales are now falling. A competitor is selling 12,000 cognitive intelligence tests every three months. In another six months, how many more tests will Joe Doe have sold than his closest competitor?

- a. 30,000
- b. 10,500
- c. 12,000
- d. Growth will be the same
- e. Not enough information to determine

Q 10

Any word or phrase produced from an original word or phrase by rearranging all the original letters to produce a new word or phrase is an anagram, another common IQ question type. Which of the following is an anagram for "Intelligence Tests"?

- a. Clientele Setting
- b. Genetic Littleness
- c. Electing Entitles
- d. All of the above
- e. None of the above

Appendix R Cont.

Q 11

If you rearrange the letters of "ahret," you would have the name of a:

- a. Ventricle
- b. Fish
- c. River
- d. Planet
- e. Country

Q 12

A, B, D, G, K. Which letter comes next in the sequence?

Q 13

Which item best completes the IQ test analogy question, train is to truck as airplane is to?

Q 14

The mystery number is between 60 and 150, a multiple of 7, and the sum of its digits is 10. What is the mystery number?

Q 15

"Senile Felines" is a palindrome.

- a. True
- b. False

Q 16

Two rabbits, butt to butt, start hopping in opposite directions for 2 meters, hop left 3 meters, and then left another 2 meters. What is the distance between them?

Q 17

Which word is not a synonym of the others?

- a. IQ
- b. Coruscation
- c. Luminosity
- d. Lassitude
- e. Trenchancy

Q 18

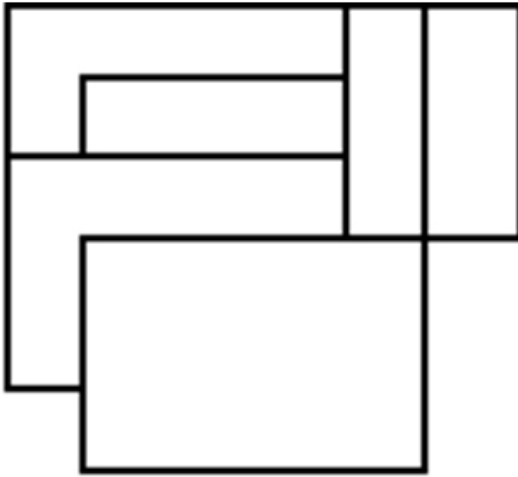
144, 233, 377, 610, ____, 1597, 2584. What is the missing number?

- a. 1110
- b. 1287
- c. 987
- d. 961
- e. None of the above

Q 19

How many four sided figures are in this diagram?

Appendix R Cont.



- a. 3
- b. 4
- c. 5
- d. 6
- e. 7

Q 20

Select a number in your head. Double it. Subtract 2. Multiply by 3. Divide by 6. Add 2. The number is the same one you first selected in your head.

- a. True
- b. False

Each underlined section corresponds to an answer choice. The first underlined section corresponds to choice A, the second to choice B, and so on. Please select the answer choice that either contains an error or select choice E which is "No error."

1. Her novel is an American classic about a young girl who she called Billie Joe. No error.

- A. A
- B. B
- C. C
- D. D
- E. E

2. Hours of driving laid ahead of us before we could complete the trip. No error.

- A. A
- B. B
- C. B
- D. D
- E. E

3. Both Thoreau and Emerson were abolitionists; they had spoken out against the evils of slavery. No error.

- A. A
- B. B

Appendix R Cont.

C. C

D. D

E. E

4. Yesterday our classroom computer was acting rather strangely. No error.

A. A

B. B

C. C

D. D

E. E

5. We decided against medical careers because science had always given Sue and I trouble. No error.

A. A

B. B

C. C

D. D

E. E

6. After a whole afternoon of playing basketball, I sleep very sound at night. No error.

A. A

B. B

C. C

D. D

E. E

7. In the winter I usually like skiing and to skate. No error.

A. A

B. B

C. C

D. D

E. E

8. The judge showed early signs of genius; for example, she began law school when she was only 19 years old. No error.

A. A

B. B

C. C

D. D

E. E

9. The general greeted his former mess sergeant, whom he had not seen in many years. No error.

A. A

B. B

C. C

Appendix R Cont.

D. D

E. E

10. Lately, many of the committee's suggestions has been rejected. No error.

A. A

B. B

C. C

D. D

E. E

11. The Supreme Court decision, along with discussions of the Justices' opinions are printed in today's newspaper. No error.

A. A

B. B

C. C

D. D

E. E

12. Neither Sue nor Carol thinks they is ready to write the final draft. No error.

A. A

B. B

C. C

D. D

E. E

13. These notebooks have laid on the desk all week; please put them away. No error.

A. A

B. B

C. C

D. D

E. E

14. You had better leave for home quick if you want to avoid the storm. No error.

A. A

B. B

C. C

D. D

E. E

15. Monet used short brush strokes to create the allusion of moving water. No error.

A. A

B. B

C. C

D. D

E. E

Appendix R Cont.

16. Did Mr. Smith infer that our research paper had to be about an American author? No error.

- A. A
- B. B
- C. C
- D. D
- E. E

17. A spoonerism is a slip of a tongue in which the beginning sounds of two words are switched. No error.

- A. A
- B. B
- C. C
- D. D
- E. E

18. Being that I was sick, I missed a whole week of classes; luckily I copied all the lecture notes from Linda. No error.

- A. A
- B. B
- C. C
- D. D
- E. E

19. In 1912 Congress set a limit on the total amount of representatives in the House of Representatives. No error.

- A. A
- B. B
- C. C
- D. D
- E. E

20. In science class we learned about digestion, respiration, circulation, and etc. No error.

- A. A
- B. B
- C. C
- D. D
- E. E

21. Clean air, as well as clean lakes and rivers, concern all of the citizens of the United States. No error.

- A. A
- B. B
- C. C
- D. D
- E. E

22. A school handbook is given to everyone who enrolls in our school. No error.

Appendix R Cont.

- A. A
- B. B
- C. C
- D. D
- E. E

23. Yes, records and compact discs have the same sound in my opinion. No error.

- A. A
- B. B
- C. C
- D. D
- E. E

24. Today the talent committee will audition Joe, Steve, and myself. No error.

- A. A
- B. B
- C. C
- D. D
- E. E

****<http://allabout2011.blogspot.ca/2013/03/how-to-shine-in-gre-entrance-exam-and.html>**

****<http://saveandmakemoremoney.blogspot.com/2013/04/check-your-iq-with-free-and-printable.html>**

Appendix S

OPERATOR'S MANUAL

Ver. 3.2C
Fingertip Pulse Oximeter

CE 0123

General Description

Haemoglobin Saturation is percentage of HbO₂ (Oxyhemoglobin), compounded with oxygen, in haemoglobin (Hb). In other words, it indicates the saturation of HbO₂ in blood. It is a crucial physiological parameter for Respiration System. Many respiratory diseases can lead to decrease of SPO₂ saturation. Moreover, such factors as organic automatic adjustment malfunction derived from anesthesia, side effect of major operation and injuries aroused from physical check can also cause problems about SPO₂ saturation variation, which contributed to such adverse symptoms such as faint, vomit and feel weakness and so on. What's more, if can not get the right remedy, it can lead to dangers to human's life. Hence, it is very feasible for doctors to analyze patients' SPO₂ saturation as reference to detect the root of the causes, which is more effective to relieve patients' pain and conduct suitable therapy plan as soon as possible.

The fingertip pulse oximeter r with features of small dimension, low power consumption, easy-to-use and convenience for carry. As long as you put your figure in the device which read data though a light-sensitive probe, then the associated reading will be displayed on the indicator. It is proved by clinical trial Pulse Oximeter have outstanding precise and could repeat to measure the SPO₂ more accurately and stably.

Measurement Principle

The fingertip pulse oximeter contains a dual light source and photodetector. Bone, tissue, pigmentation, and venous vessels normally absorb a constant amount of light over time. The arteriolar bed normally pulsates and absorbs variable amounts of light during systole and diastole, as blood volume increases and decreases. The ratio of light absorbed at systole and diastole is translated into an oxygen saturation measurement. This measurement is referred to as SpO₂.

The principle of the oximeter rely on the property of spectrum which collect data from

automatically.

Precautions for use

- Do not use the pulse oximeter in an MRI or CT environment
- Do not use the pulse oximeter in situations where alarms are required. The device has no alarms.
- Explosion hazard: Do not use the pulse oximeter in an explosive atmosphere.
- The pulse oximeter is intended only as an adjunct in patient assessment. It must be used in conjunction with other methods of assessing clinical signs and symptoms.
- Check the pulse oximeter sensor application site frequently to determine the positioning of the sensor and circulation and skin sensitivity of the patient.
- Do not stretch the adhesive tape while applying the pulse oximeter sensor. This may cause inaccurate readings or skin blisters.
- Before use, carefully read the manual.
- The pulse oximeter has no SpO₂ alarms; it is not for continuous monitoring, as indicated by the symbol.
- Prolonged use or the patient's condition may require changing the sensor site periodically. Change sensor site and check skin integrity, circulatory status, and correct alignment at least every 4 hours.
- Inaccurate measurements may be caused by autoclaving, ethylene oxide sterilizing, or immersing the sensors in liquid may cause inaccurate readings.
- Significant levels of dysfunctional hemoglobins (such as carboxy-hemoglobin or methemoglobin)
- Intravascular dyes such as indocyanine green or methylene blue
- SpO₂ measurements may be adversely affected in the presence of high ambient light. Shield the sensor area (with a surgical towel, or direct sunlight, for example) if necessary.
- Excessive patient movement
- Venous pulsations
- Placement of a sensor on an extremity with a blood pressure cuff, arterial catheter, or intravascular line
- The patient has hypotension, severe vasoconstriction, severe anemia, or hypothermia
- The patient is in cardiac arrest or is in shock
- Fingernail polish or false fingernails may cause inaccurate SpO₂ readings.

Follow local ordinances and recycling instructions regarding disposal or recycling of the device and device components, including batteries.

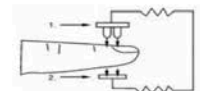
hemoglobin and oxyhemoglobin in glow area and area of approximate infrared source and apply the formular "Lammert Beer" to establish the evaluating equation. In fact, the basic calculating technique is to combine electro-photo SPO₂ detecting technology with recording mock pulse rate technology to get the result, the process demonstrate as below:

Firstly, use glow with wavelength of 660nm and approximate infrared with wavelength of 940nm to put light on the finger tip ready to read analogue data.

Secondly, to process the data by electric circuit and microprocessor, then convey the data to LED display for reading.


Diagram of Operation Principle

- Red and Infrared-ray Emission Tube
- Red and Infrared-ray Receipt Tube



Technical Specifications

- Display mode: LED.
Measuring range for SPO₂: 35-99%
Measuring range for PR: 30-235 BPM
PR display mode: bargraph

Low power indication: 
- Battery standard: Two AAA 1.5V Alkaline Battery
- Power consumption: Less than 40mA
- Resolution: ±1% for SPO₂ and ±1BPM for Pulse Rate
- Measurement accuracy:
SpO₂: 80%–99%, ±2%; 70%–80%, ±3%; ≤70%, no definition.
PR: 30–235 BPM, ±2% or 2 BPM
- Sensitive degree test: Under the condition of poor perfusion, when the amplitude of pulse waveform is 6% detected by BIO-TEK INDEX tester. Then it can be proved the sensitive degree is Ok.
- Resistance capacity against ambient light: Device work normally when mixed noise produced by BIO-TEK INDEX Pulse Oximeter tester
- Automatic power off: When no finger in the device for 8 seconds, it will power off

Product Properties

- Easy to use.
- Small dimension, light in weight (total weight is about 50g including batteries) and convenient for portable.
- Lower power consumption; originally-equipped two AAA batteries can last to 30 hours.
- Low voltage warning will be indicated in visual window when battery voltage is too low and normal application of the Oximeter might be influenced.
- No signal can be tested, device will power off automatically in 8 seconds.

Product Operation Scope

The fingertip oximeter can be used to measure human Haemoglobin Saturation and heart rate through finger. The product is suitable for use in family, hospital (including clinical use in internist/surgery, Anaesthesia, paediatrics, intensive care and etc.) Oxygen Club, social medical organizations, physical care in sports (It can be used before or after sports. Operation in sport procedure is not recommended) and etc.

The product is not suitable to monitor patient continuously.

The pulse oximeter requires no routine calibration or maintenance other than replacement of batteries.

Operation Instructions

- Installing two AAA batteries into battery cassette before closing its cover.
- Open the clamp shown as in the picture below.
- Put one of your fingers into rubber hole of the Oximeter (it is better to let your finger touch the bottom.) before releasing the clamp
- Press the switch button for one time on front panel.
- Do not rock your finger when starting test. Recommend you do not move your body at the same time.
- Read correspondent data from display screen.

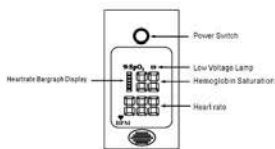
Declaration: Please use the medical alcohol to clean the rubber touching the finger inside of Oximeter, and clean the test sensor using alcohol before and after operation. (The rubber inside of the Oximeter is medical rubber, which has no toxin, and no harmful to the skin of human being).

When you put finger into the Oximeter, your nail surface must be upward.



Appendix S cont.

Brief Description of Front Panel



The length of the bargraph indicates the intensity of the pulse

Product Accessories

1. One hang lace
2. Two batteries
3. One user manual

Battery Installation

1. Put the two AAA batteries into battery cassette in correct polarities.
2. Push the battery cover horizontally along the arrow shown as below:



Notes: Battery polarities must be correctly installed. Otherwise, damage might be caused to device.

Please put or remove batteries in right order, or likely to damage the device bracket.
Please remove the battery if the Oximeter will not be used for long time

Hang Lace Installation

1. Thread thinner end of the hang lace through the hanging hole
2. Thread thicker end of the lace through the threaded end before pulling it tightly

Maintenance and Storage

1. Replace the batteries timely when low voltage indicator is on.
2. Clean surface of the fingertip oximeter before it is used in diagnosis for patients
3. Remove the batteries inside the battery cassette if the Oximeter will not be operated for a long time
4. It is better to preserve the product in a place where ambient temperatures range from -10 to -40°C (14-104°F) and humidity range from 10% to 80%.
5. It is recommended that the product be kept in a dry place. A damp ambient might affect its lifetime and even might damage the product.
6. Please follow the articles of the local government to deal with run-out-of battery

Calibrating the Oximeter

1. The functional tester cannot be used to assess the accuracy of the oximeter.
2. Index 2 that made by Bioteck company is a function tester. Set Tech to 1, R curve to 2, then user can use this particular calibration curve to measure the oximeter. The test methods used to establish the SpO2 accuracy is clinical testing. The oximeter used to measure the arterial haemoglobin oxygen saturation levels and these levels are to be compared to the levels determined from arterial blood sampling with a CO-oximeter.

Declaration

EMC of this product comply with IEC60601-1-2 standard
The materials which user can come into contact are no toxicity and no action on tissues; comply with ISO10993-1,-5,-10.

Guidance and manufacture's declaration – electromagnetic emissions- for all EQUIPMENT and SYSTEMS

Guidance and manufacture's declaration – electromagnetic emission

The *Pulse Oximeter* is intended for use in the electromagnetic environment specified below. The customer of the user of the *Pulse Oximeter* should assure that it is used in such an environment.

Emission test	Compliance	Electromagnetic environment – guidance
RF emissions CISPR 11	Group 1	The Pulse Oximeter uses RF energy only for its internal function. Therefore, its RF emissions are

RF emission CISPR 11	Class B	very low and are not likely to cause any interference in nearby electronic equipment. The <i>Pulse Oximeter</i> is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
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Possible Problems and resolutions

Problems	Possible reason	Solution
SpO2 or PR can not be shown normally	1.Finger is not plugged correctly 2.Patient's Oxyhemoglobin value is too low to be measured	1. Retry by plugging the finger 2. Try some more times, If you can make sure about no problem existing in the product. Please go to a hospital for exact diagnosis
SpO2 or PR is shown unstably	1.Finger might not be plugged deep enough 2.Finger is trembling or patient's body is in movement status	1. Retry by plugging the finger 2.Try not to move
The Oximeter can not be powered on	1.Powerof batteries might be inadequate or not be there at all 2.Batteries might be installed incorrectly 3.The Oximeter might be damaged	1.Please replace batteries 2.Please reinstall the batteries 3.Please contact with local customer service centre
Indication lamps are suddenly off	1.The product is automatically powered off when no signal is detected longer than 8 seconds 2. Lower power	1.Normal 2.Replace the batteries
"Error3"or"Error4" Displayed on screen	1 Low power 2 Receiving tube being shielded or damaged together with broken connector. 3 mechanical Misplace for receive-emission tube 4 amp circuit malfunction.	1 change new battery 2 Please contact with local customer service center 3 Please contact with local customer service center 4 Please contact with local customer service center

Symbol Definitions

Symbol	Definition
	The equipment type is BF
	Refer to user manual before application
% SpO2	Hemoglobin saturation
BPM	Heart rate (BPM)
	Low power indication
	No SpO2 Alarm
	Power switch
SN	Serial No

Appendix T

Qualitative Interview Questions/Guide

Qualitative Interview Questions

How would you verbalize your experience of test anxiety?

What contexts or situations have typically influenced or affected your experiences of test anxiety?

What is prayer to you?

Do you pray before you take a test? If so, what and why do you pray before a test?

Do you think prayer helps with your test anxiety?

Do you feel that prayer is a common strategy used before tests among college students?

Appendix U

Informed Consent for those helping with research

CONFIDENTIALITY AGREEMENT

Title of Research Project: A MIXED METHODS STUDY INVESTIGATING PRAYER AND TEST ANXIETY AMONG COLLEGE STUDENTS

Local Principal Investigator: Drey Campbell, LCSW

As an assistant to the research team I understand that I may have access to confidential information about study sites and participants. By signing this statement, I am indicating my understanding of my responsibilities to maintain confidentiality and agree to the following:

- I understand that names and any other identifying information about study sites and participants are completely confidential.
- I agree not to divulge, publish, or otherwise make known to unauthorized persons or to the public any information obtained in the course of this research project that could identify the persons who participated in the study.
- I understand that all information about study sites or participants obtained or accessed by me in the course of my work is confidential. I agree not to divulge or otherwise make known to unauthorized persons any of this information, unless specifically authorized to do so by approved protocol or by the local principal investigator acting in response to applicable law or court order, or public health or clinical need.
- I understand that I am not to read information about study sites or participants, or any other confidential documents, nor ask questions of study participants for my own personal information but only to the extent and for the purpose of performing my assigned duties on this research project.
- I agree to notify the local principal investigator immediately should I become aware of an actual breach of confidentiality or a situation which could potentially result in a breach, whether this be on my part or on the part of another person.

Signature

Date

Printed name

Signature of local principal investigator

Date

Drey Campbell
Printed name

Appendix V**Salimetrics Instruction Pamphlets for testing SAA****SALIVARY α -AMYLASE**
KINETIC ENZYME ASSAY KIT

For Research Use Only
Not for use in Diagnostic Procedures

Item No. 1-1902, (Single) 96-Well Kit; 1-1902-
5, (5-Pack) 480 Wells

Appendix V Cont

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Intended Use

The Salimetrics® α -Amylase Kinetic Enzyme Assay Kit is specifically designed and validated for the kinetic measurement of salivary α -amylase activity. It is not intended for diagnostic use. It is intended only for research use in humans and some animals. Salimetrics has not validated this kit for serum or plasma samples.

Please read the complete kit insert before performing this assay. Failure to follow kit procedure and recommendations for saliva collection and sample handling may result in unreliable values.

For further information about this kit, its application, or the procedures in this insert, please contact the technical service team at Salimetrics or your local sales representative.

Introduction

Technical advances that make the assessment of biomarkers in saliva possible have enabled researchers to non-invasively study biosocial processes related to stress in naturalistic contexts. Much of the attention has focused on the activity of the limbic hypothalamic- pituitary-adrenal (LHPA) axis as indexed by individual differences and intra-individual change in salivary cortisol. Recently, it was suggested that the nearly exclusive focus of this endeavor on salivary cortisol may not enable researchers to adequately operationalize the psychobiology of the stress response. (1) Physiologists have known for decades that the stress response has at least two principal components. One involves corticotropin-releasing hormone, activation of the LHPA axis, and the secretion of glucocorticoids (e.g., cortisol) into circulation. The second involves activation of the locus coeruleus /autonomic (sympathetic) nervous system and the release of catecholamines (e.g., norepinephrine) into the blood stream. (2) Theorists argue that, to advance our understanding of how biological, social, and behavior processes interact to determine risk versus resilience, the next generation of studies will need to employ analytical models that operationalize both the behavioral and biological sides of the equations using multi-method and trait measurement approaches. (1) Unfortunately, our ability to do so has been restricted because, in contrast to the highly sensitive, accurate, and valid measurement of LHPA products in saliva (i.e., cortisol, dehydroepiandrosterone), the non- invasive measurement of autonomic (sympathetic) nervous system activity in saliva (i.e., catecholamines) has been problematic. (3)

In an attempt to overcome this problem, we conducted an extensive computerized literature search for potential surrogate markers of autonomic (sympathetic) nervous system activation that could be measured accurately in saliva. α -Amylase, the most abundant salivary enzyme in humans, has been identified as a biomarker that appears to fill this role. Best known for its function as a digestive enzyme that breaks down dietary starch, α -amylase has also been studied for its ability to bind to oral bacteria and to tooth enamel. It is believed to play a key role in the establishment and maintenance of the oral microflora to form dental plaques. (4,5) Secretion of α -amylase from the salivary glands is controlled by autonomic nervous signals,

Appendix V Cont

and substantial literature reveals that salivary α -amylase is a correlate of sympathetic activity under conditions of stress. Studies show that levels of salivary α -amylase increase under a variety of physically (i.e., exercise, heat and cold) and psychologically (i.e., written examinations) stressful conditions (6) in human subjects. Interestingly, studies show that cortisol levels often do not correlate with α -amylase during stress, (1,6,7) suggesting that individual differences in α -amylase represent a response to a stress signal independent of the LHPA axis.

Early studies on salivary α -amylase showed that its concentrations are predictive of plasma catecholamine levels, particularly norepinephrine (NE), and are highly correlated with NE changes in response to stress. (6) However, more recent studies call this relationship into question. (7) The literature does show that stress-related increases in salivary α -amylase can be inhibited by the adrenergic blocker propranolol (8,9) and also that beta-adrenergic agonists are capable of stimulating α -amylase release without increasing salivary flow. (10,11) This link suggests that the same stimuli that increase autonomic (sympathetic) arousal may activate sympathetic input to the salivary glands. The salivary alpha-amylase response to stress is complex, however, and it appears also to involve the parasympathetic system to a lesser degree. (7) A recent article has emphasized the contribution of the parasympathetic system to salivary alpha-amylase secretion, pointing out in particular that autonomic reflex activity from the oral cavity, which can increase the parasympathetic signaling to the salivary glands, may have the potential to obscure the effects of central SNS activity. (12) However, a subsequent study has found that SAA responses significantly predict responses to the TSST for norepinephrine (NE) but not for epinephrine (E). The relationship between SAA and NE was stronger than the relationship between NE and E responses, indicating the predictive power of SAA is well within the expected range for different SNS markers. (13)

Although further work is necessary to understand better the underlying physiological factors that influence salivary alpha-amylase secretion, studies have already shown that salivary α -amylase measurements may be employed as a non-invasive measure of autonomic nervous system activation and are related to a variety of behavioral, social, health, and cognitive phenomena in human subjects. (14-16)

Test Principle

This method utilizes a chromagenic substrate, 2-chloro-p-nitrophenol linked with maltotriose.

(17) The enzymatic action of α -amylase on this substrate yields 2-chloro-p-nitrophenol, which can be spectrophotometrically measured at 405 nm. The amount of α -amylase activity present in the sample is directly proportional to the increase in absorbance at 405 nm. For ease of use, the reaction is read in a 96-well microtiter plate with controls provided.

Appendix V Cont

Safety Precautions

Read Safety Data Sheets before handling reagents.

Hazardous Ingredients

The substrate reagent contains potassium thiocyanate. Poisonous. Do not ingest. May produce irritating fumes if exposed to bleach.

The substrate reagent contains 0.01% sodium azide as a preservative. Do not ingest. Upon contact with acid, sodium azide forms toxic hydrazoic acid. Explosive metal azides may form in copper or lead plumbing. Disposal requires large volumes of water to prevent the buildup of azide.

We recommend the procedures listed below for all kit reagents.

Handling

Follow good laboratory practices when handling kit reagents. Laboratory coats, gloves, and safety goggles are recommended. Wipe up spills using appropriate absorbent materials while wearing protective clothing. Follow local regulations for disposal.

Emergency Exposure Measures

In case of contact, immediately wash skin or flush eyes with water for 15 minutes. Remove contaminated clothing. If inhaled, remove individual to fresh air. If individual experiences difficulty breathing call a physician.

The above information is believed to be accurate but is not all-inclusive. This information should be used only as a guide. Salimetrics will not be liable for accidents or damage resulting from misuse of product.

Safety Data Sheets are available by contacting Salimetrics at support@salimetrics.com (See www.salimetrics.com for alternative contact options).

Appendix V Cont

General Kit Use Advice

- This is a kinetic assay that involves taking readings at two different time points. Accurate timing of reagent addition and plate reading is critical for correct assay results. Until experience is gained, we recommend that samples be processed one strip at a time. See Technical Bulletin on the Salimetrics website for Running Multiple Amylase Strips: www.salimetrics.com/documents/amylase-tb.pdf
- Avoid microbial contamination of opened reagents. Salimetrics recommends using opened reagents within one month. Store all reagents at 2-8°C.
- Controls should be assayed at least once on each day of testing. Volume supplied in the kit is sufficient for testing multiple times on multiple days.
- Do not mix components from different lots of kits.
- Protect the α -amylase substrate reagent from exposure to direct sunlight.
- When using a multichannel pipette, α -amylase substrate solution should be added to wells at the same time, using the dispensing mode to avoid introducing bubbles into the wells.
- Routine calibration of pipettes and other equipment is critical for the best possible assay performance.

Storage

All unopened components of this kit are stable at 2-8°C until the kit's expiration date.

Specimen Collection

Avoid sample collection within 60 minutes after eating a major meal or within 12 hours after consuming alcohol. Acidic or high sugar foods can compromise assay performance by lowering sample pH and influencing bacterial growth. To minimize these factors, rinse mouth thoroughly with water 10 minutes before sample is collected.

Collect whole saliva by unstimulated passive drool. Donors may tilt the head forward, allowing the saliva to pool on the floor of the mouth, and then passing the saliva through the SalivaBio Collection Aid (SCA) into a polypropylene vial. Collection protocols/methods are available online at www.salimetrics.com or upon request.

Samples visibly contaminated with blood should be recollected. Record the time and date of specimen collection.

Appendix V Cont

Note: The technique used to collect saliva (various swabs, passive drool), the collection point duration, and the oral fluid type (whole saliva vs. specific glandular saliva) all have an effect on estimates of salivary α -amylase activity. Recent studies have stressed that consistency in collection methods is important in order to avoid introducing unsystematic error into study data. (24,25) Typically, α -amylase concentrations in saliva from the parotid glands in the cheeks are higher than those found in pooled whole saliva from the floor of the mouth. We find that saliva collected by placing a swab underneath the tongue on the floor of the mouth yields results similar to those from whole saliva collected by passive drool. We recommend this location for studies measuring α -amylase along with other analytes.

Alternatively, if measuring α -amylase alone, a swab may be used to collect samples of parotid saliva by placing it next to the cheek opposite the 2nd upper molar, where the duct from the parotid gland opens into the mouth. Unstimulated flow from the parotid glands is lower than from the submandibular glands in the floor of the mouth; if collecting parotid saliva, we recommend extending the collection time period in order to ensure the collection of sufficient amounts of saliva.

Although one study has reported that response patterns of SAA during the Trier Social Stress Task were consistent regardless of whether the amylase concentration (U/mL) or the amylase output (U/min) was examined, (11) there is still a concern that the effects of saliva flow rate on levels of salivary alpha-amylase may lead to problems in the interpretation of data. (24,12). Salimetrics currently advises that researchers should note the time period needed to collect the desired amount of saliva, in order to estimate the flow rate (mL/min). Assay results (U/mL) may then be multiplied by the flow rate in order to express the results as output per unit of time (U/min), which may be used for comparison in the data analysis.

If an absorbent device from the SalivaBio Oral Swab family (SOS, SCS, SIS) is used to collect saliva for determination of SAA levels, the volume of saliva collected by the swab can be determined by weighing the device along with the storage tube before and after collection. (An approximate value of 1.0 g/mL may be assumed for the density of the saliva.) If the length of time the swab is in the mouth is also recorded, the flow rate can then be estimated. The device must be removed from the mouth before it reaches its capacity, however, since after that point the estimate of flow rate will not be accurate. (24) This ceiling effect is especially a concern for smaller devices, such as the SIS swab, which can reach saturation fairly quickly. A preliminary study may be necessary to determine the optimum collection period, and it may be difficult to find a collection period that will work for all participants.

Appendix V Cont

Sample Handling and Preparation

After collection it is important to keep samples cold, in order to avoid bacterial growth in the specimen. Refrigerate sample within 30 minutes, and freeze at or below -20°C within 4 hours of collection. (Samples may be stored at -20°C for up to 6 months.) For long term storage, refer to the Salimetrics Collection and Handling Advice Booklet.

Do not add sodium azide to saliva samples as a preservative, as it may cause interference when testing samples for multiple analytes. (Sodium azide may be used only if testing for α -amylase alone.)

On day of assay, thaw the saliva samples completely, vortex, and centrifuge at 1500 x g (@3000 rpm) for 15 minutes. Freezing saliva samples will precipitate mucins. Centrifuging removes mucins and other particulate matter which may interfere with antibody binding and affect results. Samples should be at room temperature before making dilutions. Pipette clear sample into appropriate dilution tubes. Re-freeze saliva samples as soon as possible after running assay. Re-centrifuge saliva samples each time that they are thawed. Avoid multiple freeze-thaw cycles.

Saliva samples must be diluted for this assay. See Procedure for details.

Materials Supplied with Single Kit

	Item	Quantity/Size
1	α-Amylase Substrate Liquid preparation of 2-chloro-p-nitrophenol linked with maltotriose. Ready-to-use. Contains: substrate, buffer, 0.01% sodium azide preservative.	1 bottle/45 mL
2	α-Amylase Controls High, Low. α -Amylase in a saliva-like matrix. Ready to use. Do not dilute. Contain: α -amylase, buffer, preservative.	2 vials/100 μ L each
3	α-Amylase Diluent Contains: phosphate buffer, preservative.	1 bottle/30 mL
4	Microtiter Plate Break apart. Use number of strips desired.	1/96-well
5	Reagent Warming Trough Trough may be reused for several partial plate runs.	1

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Materials Needed But Not Supplied

- Precision pipette to deliver* 8 μL
- Precision multichannel pipette to deliver* 320 μL
- Vortex
- Plate reader with 405 nm filter
- Computer software for data reduction
- Small disposable polypropylene tubes for dilution of samples
- Pipette tips
- Timer
- 37°C incubator (A Microtiter plate 37°C incubator/rotator is recommended for heating of substrate).
- Plate rotator with 0.08-0.17 inch orbit capable of operating at 500 rpm & 37°C (only if NOT using a Microtiter plate 37°C incubator/rotator)
- Centrifuge capable of 1500 x g (@3000 rpm)

* without employing “blow-out” mechanism

Reagent Preparation

- Bring all reagents to room temperature and mix before use. Minimum warm-up times of 1.5 hours is recommended.
- See Step 4 of procedure for other α -amylase substrate considerations before beginning assay.

Appendix V Cont

Procedure

Step 1: Read and prepare reagents according to the Reagent Preparation section before beginning assay. Determine your plate layout. Here is a suggested layout. (Controls and saliva samples should be assayed in duplicate.)

	1	2	3	4	5	6	7	8	9	10	11	12
A	Ctrl-H	Ctrl-H										
B	Ctrl-L	Ctrl-L										
C	SMP-1	SMP-1										
D	SMP-2	SMP-2										
E	SMP-3	SMP-3										
F	SMP-4	SMP-4										
G	SMP-5	SMP-5										
H	SMP-6	SMP-6										

Step 2: Keep the desired number of strips in the strip holder and place the remaining strips back in the bag.

Step 3: Set your plate reader to incubate at 37°C, and to read in center measurement kinetic mode initially at one minute, then again two minutes later. Choose the 405 nm filter with no reference filter. For plate readers without these options, incubation can take place in a plate incubator/rotator with manual movement of the plate into and out of the plate reader for the 1 minute and 3 minute readings. Kit validation was performed under these conditions.

Step 4: Heat the α -amylase substrate solution to 37°C in the trough provided. (For ease of use we recommend using a *preheated* 37°C microtiter plate incubator.) Be sure substrate solution has reached 37°C before use. A minimum warm up time of twenty minutes, from room temperature, in a preheated microtiter plate incubator is recommended. (If using any other incubator it can take an hour or more to reach 37°C. Keep trough covered to prevent evaporation of substrate solution.)

Step 5: Saliva samples are to be diluted with the α -amylase diluent provided. Prepare a 1:10 dilution of the saliva by pipetting 10 μ L of saliva into 90 μ L α -amylase diluent. Mix well.

Further dilute by pipetting 10 μ L of the 1:10 dilution into 190 μ L α -amylase diluent (1:20). Final dilution is 1:200. The remainder of the 1:10 dilution may be set aside in case a different final dilution is necessary.

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Step 6: Add 8 μL of controls and/or diluted saliva samples to individual wells. *We strongly recommend reverse pipetting to avoid introducing any bubbles into the well.*

Step 7: Add 320 μL of preheated (37°C) α -amylase substrate solution to each well simultaneously using a multichannel pipette. Discard pipette tips to avoid reagent contamination. *Do not return any of the α -amylase substrate solution left in the tips to the bulk tray once you have dispensed it into the wells. This could contaminate the bulk tray contents and affect any subsequent testing.* Any well containing bubbles at the time of reading must be repeated.

Step 8: If reading kinetically in a programmable 37°C plate reader, immediately place plate in reader and start reader. *Wells are very full. Program plate reader to mix slowly or substrate could spill into the plate reader.*

Otherwise, follow these steps:

- Start timer *immediately* and mix (500-600 RPM) at 37°C .
- Transfer plate to reader in time to read the Optical Density (OD) at *exactly* 1 minute, and then return to mixing at 37°C . *Save* 1 minute OD readings.
- Transfer plate again and read the OD at *exactly* 3 minutes. *Save* 3 minute OD readings.

Calibration

This procedure is standardized using the millimolar absorptivity of 2-chloro-p-nitrophenol under the test conditions described.

Quality Control

The Salimetrics' high and low α -amylase controls should be run at least once on each day of testing. The control ranges established at Salimetrics are to be used as a guide. Each laboratory should establish its own range. Variations between laboratories may be caused by differences in techniques and instrumentation.

Appendix V Cont

Calculations

Subtract the one minute reading from the three minute reading and multiply by the conversion factor (see below). The conversion factor takes the 1:200 sample dilution into account for the controls and pre-diluted samples.

It is convenient to set up a spreadsheet to subtract the ODs and multiply by the conversion factor. Results are expressed in U/mL.

$$\frac{\Delta\text{Abs./min} \times \text{TV} \times \text{DF}}{\text{MMA} \times \text{SV} \times \text{LP}} = \text{U/mL of } \alpha\text{-amylase activity in sample}$$

Where: $\Delta\text{Abs./min}$ = Absorbance difference per minute
 TV = Total assay volume (0.328 mL)

DF = Dilution factor

MMA = Millimolar absorptivity of 2-chloro-p-nitrophenol (12.9)

SV = Sample volume (0.008 mL)

LP = Light path = 0.97 (specific to plate received with kit)

$$\frac{\Delta\text{Abs./2} \times 0.328 \times 200}{0.008 \times 0.97} = \Delta\text{Abs.} \times 328^* = \text{U/mL } \alpha\text{-amylase activity} \times 12.9$$

Example: If change in absorbance (OD change over 2 minutes) was 0.3, then $0.3 \times 328 = 98.4 \text{ U/mL}$

*If using a Tecan plate reader and data capture by AssayZap software, multiply by 0.0328.

NOTE: Multiply value by 0.01667 to convert to SI Units (nKat/L)

See Limitations below.

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Limitations

- Samples that exceed 400 U/mL (linearity limit at 1:200 dilution) or have an OD value > 3.0, should be rerun at a dilution of 1:800. Multiply the results by 4.
- Samples that yield values less than 2.0 U/mL (at a 1:200 dilution) may not result in a reliable value. These samples should be repeated at a 1:10 dilution, dividing the results by 20.
- See "Specimen Collection" recommendations to ensure proper collection of saliva specimens and to avoid interfering substances.
- Do not add sodium azide to saliva samples as a preservative, as it may cause interference when testing samples for multiple analytes. (Sodium azide may be used only if testing for α -amylase alone.)
- Any quantitative results indicating abnormal α -amylase levels should be followed by additional testing and evaluation.
- Cigarette use can be associated with lower alpha-amylase scores returned by this assay because acid aldehydes in cigarette smoke are capable of changing the function and/or structure of the alpha-amylase enzyme. (18)
- Caffeine and other exogenous substances with sympathomimetic properties may be associated with higher alpha-amylase levels. (19)
- Other potential confounding factors include increased production of saliva and salivary components from activities such as eating and drinking. (20,21) Additionally, naturally occurring alpha-amylase inhibitors have been identified in a number of foods. (22,23)

Salivary α -Amylase Example Ranges*

Group	N	Mean (U/mL)	Absolute Range (U/mL)
Adult	75	92.4	3.1 - 423.1

*To be used as a guide only. Each laboratory should establish its own range.

Appendix V Cont

Salivary α -Amylase Kinetic Enzyme Assay Kit Performance Characteristics

Precision

The intra-assay precision was determined from the mean of 10 replicates each.

Saliva Sample	N	Mean (U/mL)	Standard Deviation (U/mL)	Coefficient of Variation (%)
H	10	474.6	11.8	2.5
M	10	108.8	7.2	6.7
L	10	17.7	1.3	7.2

The inter-assay precision was determined from high and low α -amylase samples run in 8 individual runs.

Saliva Sample	N	Mean (U/mL)	Standard Deviation (U/mL)	Coefficient of Variation (%)
H	8	166.0	6.0	3.6
L	8	10.6	0.6	5.8

Recovery

Five saliva samples containing different levels of an endogenous α -amylase were spiked with known quantities of α -amylase and assayed.

Saliva Sample	Endogenous (U/mL)	Added (U/mL)	Expected (U/mL)	Observed (U/mL)	Recovery (%)
1	72.18	65.19	137.37	134.73	98.1
2	123.97	77.09	201.06	224.43	111.6
3	103.28	10.01	113.29	109.37	96.5
4	29.99	6.72	36.71	40.96	111.6
5	42.01	3.14	45.15	39.44	87.4

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Sensitivity

The lower limit of sensitivity is governed by the change in absorbance. Samples that yield values less than 2.0 U/mL (at a 1:200 dilution) may not result in a reliable value. These samples should be repeated at a 1:10 dilution, dividing the results by 20.

Sample Dilution Recovery

Two samples were serially diluted with α -amylase diluent and assayed.

Saliva Sample	Dilution Factor	Expected (U/mL)	Observed (U/mL)	Recovery (%)
1			40.96	
	1:2	20.48	19.35	94.5
	1:4	10.24	9.76	95.3
	1:8	5.12	4.57	89.3
	1:16	2.56	2.13	83.2
2			1943.16	
	1:3	647.72	649.21	100.2
	1:9	215.91	224.64	104.0
	1:27	71.97	78.08	108.5

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Seller's Limited Warranty

“Seller warrants that all goods sold hereunder will be free from defects in material and workmanship. Upon prompt notice by Buyer of any claimed defect, which notice must be sent within thirty (30) days from date such defect is first discovered and within three months from the date of shipment, Seller shall, at its option, either repair or replace the product that is proved to Seller’s satisfaction to be defective. All claims should be submitted in written form. This warranty does not cover any damage due to accident, misuse, negligence, or abnormal use. Liability, in all cases, will be limited to the purchased cost of the kit.

It is expressly agreed that this limited warranty shall be in lieu of all warranties of fitness and in lieu of the warranty of merchantability. Seller shall not be liable for any incidental or consequential damages that arise out of the installation, use or operation of Seller’s product or out of the breach of any express or implied warranties.”

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Updated:
 February 4, 2015

Appendix W

Salimetrics Instruction Pamphlets for testing Cortisol



**Expanded Range High
Sensitivity**

SALIVARY CORTISOL

ENZYME IMMUNOASSAY KIT

For Research Use Only
Not for use in Diagnostic Procedures

Item No. 1-3002, (Single) 96-Well Kit; 1-3002-
5, (5-Pack) 480 Wells

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Intended Use

The Salimetrics® Cortisol Enzyme Immunoassay Kit is a competitive immunoassay specifically designed and validated for the quantitative measurement of salivary cortisol. It is not intended for diagnostic use. It is intended only for research use in humans and some animals.

Salimetrics has not validated this kit for serum or plasma samples.

Please read the complete kit insert before performing this assay. Failure to follow kit procedure and recommendations for saliva collection and sample handling may result in unreliable values.

For further information about this kit, its application, or the procedures in this insert, please contact the technical service team at Salimetrics or your local sales representative.

Introduction

Cortisol (hydrocortisone, Compound F) is the major glucocorticoid produced in the adrenal cortex. (1) Cortisol production has a circadian rhythm, (2,3) with levels peaking in the early morning and dropping to lowest values at night. (4,5) Levels rise independently of circadian rhythm in response to stress. (6)

In blood, only about 5-10% of cortisol is in its unbound or biologically active form. The remaining cortisol is bound to serum proteins. (7) Unbound serum cortisol enters saliva via intracellular mechanisms; in saliva, the majority of cortisol remains unbound to protein.

Salivary cortisol levels are unaffected by salivary flow rate and are relatively resistant to degradation from enzymes or freeze-thaw cycles. (8,9) Studies consistently report high correlations between serum and salivary cortisol, indicating that salivary cortisol levels reliably estimate serum cortisol levels. (10-12)

(Internal Salimetrics Data, n=26. Time of cortisol peak will vary in individuals relative to their normal wake-up time.)

Appendix W cont.

Test Principle

This is a competitive immunoassay kit. Cortisol in standards and samples compete with cortisol conjugated to horseradish peroxidase for the antibody binding sites on a microtitre plate. After incubation, unbound components are washed away. Bound cortisol enzyme conjugate is measured by the reaction of the horseradish peroxidase enzyme to the substrate tetramethylbenzidine (TMB). This reaction produces a blue color. A yellow color is formed after stopping the reaction with an acidic solution. The optical density is read on a standard plate reader at 450 nm. The amount of cortisol enzyme conjugate detected is inversely proportional to the amount of cortisol present, in the sample. (13)

Safety Precautions

Read Safety Data Sheets before handling reagents.

Hazardous Ingredients

Liquid stop solution is caustic; use with care. We recommend the procedures listed below for all kit reagents.

Handling

Follow good laboratory practices when handling kit reagents. Laboratory coats, gloves, and safety goggles are recommended. Wipe up spills using appropriate absorbent materials while wearing protective clothing. Follow local regulations for disposal.

Emergency Exposure Measures

In case of contact, immediately wash skin or flush eyes with water for 15 minutes. Remove contaminated clothing. If inhaled, remove individual to fresh air. If individual experiences difficulty breathing call a physician.

The above information is believed to be accurate but is not all-inclusive. This information should be used only as a guide. Salimetrics will not be liable for accidents or damage resulting from misuse of product.

Safety Data Sheets are available by contacting Salimetrics at support@salimetrics.com (See www.salimetrics.com for alternative contact options).

Appendix W cont.

General Kit Use Advice

- This kit uses break-apart microtitre strips. You may run less than a full plate. Unused wells must be stored at 2-8°C in the foil pouch with desiccant and used in the frame provided.
- Avoid microbial contamination of opened reagents. Salimetrics recommends using opened reagents within one month. Store all reagents at 2-8°C.
- The quantity of reagent provided with a single kit is sufficient for three partial runs. The volumes of wash buffer and enzyme conjugate prepared for assays using less than a full plate should be scaled down accordingly, keeping the same dilution ratio.
- Do not mix components from different lots of kits.
- To ensure highest quality assay results, pipetting of samples and reagents must be done as quickly as possible (without interruption) across the plate. Ideally, the process should be completed within twenty minutes or less.
- When using a multichannel pipette to add reagents, always follow the same sequence when adding all reagents so that the incubation time is the same for all wells.
- When running multiple plates, or multiple sets of strips, a standard curve must be run with each individual plate and/or set of strips.
- The temperature of the laboratory may affect assays. Salimetrics' kits have been validated at 68-74°F (20-23.3°C). Higher or lower temperatures may affect OD values.
- Routine calibration of pipettes and other equipment is critical for the best possible assay performance.
- When mixing plates during assay procedures, avoid speeds that spill the contents of the wells.

Storage

All unopened components of this kit are stable at 2-8°C until the kit's expiration date.

pH Indicator

Cortisol values from samples with a pH ≤ 3.5 or ≥ 9.0 may be inaccurate. A pH indicator in the assay diluent alerts the user to samples with high or low pH values. Upon addition of the assay diluent, acidic samples will turn yellow and alkaline samples will turn purple. Dark yellow or purple wells indicate that a pH value for that sample should be obtained using pH strips.

Appendix W cont.

Samples with a pH ≤ 3.5 or ≥ 9.0 should be recollected. (14)

Specimen Collection

Avoid sample collection within 60 minutes after eating a major meal or within 12 hours after consuming alcohol. Acidic or high sugar foods can compromise assay performance by lowering sample pH and influencing bacterial growth. To minimize these factors, rinse mouth thoroughly with water 10 minutes before sample is collected.

Collect whole saliva by unstimulated passive drool. Donors may tilt the head forward, allowing the saliva to pool on the floor of the mouth, then pass the saliva through the SalivaBio Collection Aid (SCA) into a polypropylene vial. Collection protocols/methods are available online at www.salimetrics.com or upon request.

Samples visibly contaminated with blood should be recollected. Samples may be screened for possible blood contamination (15,16) using our Blood Contamination EIA Kit (Item Nos. 1- 1302/1-1302-5). Do not use dipsticks, which result in false positive values due to salivary enzymes.

It is important to record the time and date of specimen collection when samples are obtained due to the diurnal variation in cortisol levels.

Sample Handling and Preparation

After collection it is important to keep samples cold, in order to avoid bacterial growth in the specimen. Refrigerate sample within 30 minutes, and freeze at or below -20°C within 4 hours of collection. (Samples may be stored at -20°C for up to 6 months.) For long term storage, refer to the Salimetrics Collection and Handling Advice Booklet.

Do not add sodium azide to saliva samples as a preservative, as it may cause interference in the immunoassay.

On day of assay, thaw the saliva samples completely, vortex, and centrifuge at $1500 \times g$ (@3000 rpm) for 15 minutes. Freezing saliva samples will precipitate mucins. Centrifuging removes mucins and other particulate matter which may interfere with antibody binding and affect results. Samples should be at room temperature before adding to assay plate. Pipette clear sample into appropriate wells. Re-freeze saliva samples as soon as possible after adding to the assay plate. Re-centrifuge saliva samples each time that they are thawed. Avoid multiple freeze-thaw cycles.

Appendix W cont.

Materials Supplied with Single Kit

	Item	Quantity/Size
1	Microtitre Plate Coated with monoclonal anti-cortisol antibodies.	1/96 well
2	Cortisol Standard In a saliva-like matrix. Ready to use, traceable to NIST standard: 3.0, 1.0, 0.333, 0.111, 0.037, 0.012 µg/dL (82.77, 27.59, 9.19, 3.06, 1.02, 0.33 nmol/L). Contains: Cortisol, buffer, preservative.	6 vials / 500 µL each
3	Cortisol Controls High, Low, in a saliva-like matrix. Ready to use. Contain: Cortisol, buffer, preservative.	2 vials / 500 µL each
4	Cortisol Enzyme Conjugate Concentrate. Dilute before use with assay diluent. (See step 5 of Procedure.) Contains: Cortisol conjugated to HRP, preservative.	1 vial / 50 µL
5	Assay Diluent Contains: phosphate buffer, pH indicator, preservative.	1 bottle / 60 mL
6	Wash Buffer Concentrate (10X) Dilute before use according to Reagent Preparation. Contains: phosphate buffer, detergent, preservative.	1 bottle / 100 mL
7	TMB Substrate Solution Non-toxic, ready to use.	1 bottle / 25 mL
8	Stop Solution	1 bottle / 12.5 mL
9	Non-Specific Binding (NSB) Wells Do not contain anti-cortisol antibody. Break off and insert as blanks (optional) where needed.	1 strip

Appendix W cont.

Materials Needed But Not Supplied

- Precision pipette to deliver 15 and 25 μL
- Precision multichannel pipette to deliver 50 μL and 200 μL
- Vortex
- Plate rotator with 0.08-0.17 inch orbit capable of 500 rpm
- Plate reader with 450 nm and 490 to 492 reference filters
- Computer software for data reduction
- Deionized water
- Reagent reservoirs
- One disposable polypropylene tube to hold at least 24 mL
- Pipette tips
- Serological pipette to deliver up to 24 mL
- Centrifuge capable of 1500 x g (@3000 rpm)

Reagent Preparation

- Bring all reagents to room temperature and mix before use. A minimum of 1.5 hours is recommended for the 24 mL of assay diluent used in Step 5 (conjugate dilution) to come to room temperature.
- Bring microtitre plate to room temperature before use. ***It is important to keep the foil pouch with the plate strips closed until warmed to room temperature, as humidity may have an effect on the coated wells.***
- Prepare 1X wash buffer by diluting Wash Buffer Concentrate (10X) 10-fold with room- temperature deionized water (100 mL of Wash Buffer Concentrate (10X) to 900 mL of deionized H₂O). ***Dilute only enough for current day's use and discard any leftover reagent.*** (If precipitate has formed in the concentrated wash buffer, it may be heated to 40°C for 15 minutes. Cool to room temperature before use in assay.)

Appendix W cont.

Procedure

Step 1: Read and prepare reagents according to the Reagent Preparation section before beginning assay. Determine your plate layout. Here is a suggested layout. (Standards, controls, and saliva samples should be assayed in duplicate.)

	1	2	3	4	5	6	7	8	9	10	11	12
A	3.000 Std	3.000 Std	Ctrl-H	Ctrl-H								
B	1.000 Std	1.000 Std	Ctrl-L	Ctrl-L								
C	0.333 Std	0.333 Std	SMP-1	SMP-1								
D	0.111 Std	0.111 Std	SMP-2	SMP-2								
E	0.037 Std	0.037 Std	SMP-3	SMP-3								
F	0.012 Std	0.012 Std	SMP-4	SMP-4								
G	Zero	Zero	SMP-5	SMP-5								
H	NSB*	NSB*	SMP-6	SMP-6								

*NSB = Non-specific binding wells. These may serve as blanks. Use is optional.

Step 2: Keep the desired number of strips in the strip holder and place the remaining strips back in the foil pouch. If you choose to place non-specific binding wells in H-1, 2, remove strips 1 and 2 from the strip holder and break off the bottom wells. Place the strips back into the strip holder leaving H-1, 2 blank. Break off 2 NSB wells from the strip of NSB wells included in the foil pouch. Place in H-1, 2. Alternatively, NSBs may be placed wherever you choose on the plate. Reseal the foil pouch with unused wells and desiccant. Store at 2-8°C.

Cautions: 1. Extra NSB wells should not be used for determination of standards, controls, or unknowns.

2. Do not insert wells from one plate into a different plate

Step 3: Pipette 24 mL of assay diluent into the disposable tube. (Scale down proportionally if using less than the entire plate.) Set aside for Step 5.

Step 4:

- Pipette 25 µL of standards, controls, and saliva samples into appropriate wells.
- Pipette 25 µL of assay diluent into 2 wells to serve as the zero.

- Pipette 25 μL of assay diluent into each NSB well.

Appendix W cont.

Step 5: Dilute the enzyme conjugate 1:1600 by adding 15 μL of the conjugate to the 24 mL tube of assay diluent. (Scale down proportionally if not using the entire plate.) Conjugate tube may be centrifuged for a few minutes to bring the liquid down to the tube bottom.

Immediately mix the diluted conjugate solution and add 200 μL to each well using a multichannel pipette.

Step 6: Mix plate on a plate rotator for 5 minutes at 500 rpm and incubate at room temperature for a total of 1 hour.

Step 7: Wash the plate 4 times with 1X wash buffer. A plate washer is recommended. However, washing may be done by gently squirting wash buffer into each well with a squirt bottle, or by pipetting 300 μL of wash buffer into each well and then discarding the liquid over a sink. After each wash, the plate should be thoroughly blotted on paper towels before turning upright. If using a plate washer, blotting is still recommended after the last wash.

Step 8: Add 200 μL of TMB Substrate Solution to each well with a multichannel pipette.

Step 9: Mix on a plate rotator for 5 minutes at 500 rpm and incubate the plate in the dark (covered) at room temperature for an additional 25 minutes.

Step 10: Add 50 μL of Stop Solution with a multichannel pipette.

Step 11:

- Mix on a plate rotator for 3 minutes at 500 rpm. If green color remains, continue mixing until green color turns to yellow. Be sure all wells have turned yellow.

Caution: Spillage may occur if mixing speed exceeds 600 rpm.

- Wipe off bottom of plate with a water-moistened, lint-free cloth and wipe dry.
- Read in a plate reader at 450 nm. Read plate within 10 minutes of adding stop solution. (For best results, a secondary filter correction at 490 to 492 nm is recommended.)

Quality Control

The Salimetrics' high and low cortisol controls should be run with each assay. The control ranges established at Salimetrics are to be used as a guide. Each laboratory should establish its own range. Variations between laboratories may be caused by differences in techniques and instrumentation.

Appendix W cont.

Calculations

1. Compute the average optical density (OD) for all duplicate wells.
2. Subtract the average OD for the NSB wells (if used) from the OD of the zero, standards, controls, and saliva samples.
3. Calculate the percent bound (B/Bo) for each standard, control, and saliva sample by dividing the OD of each well (B) by the average OD for the zero (Bo). (The zero is not a point on the standard curve.)
4. Determine the concentrations of the controls and saliva samples by interpolation using data reduction software. We recommend using a 4-parameter non-linear regression curve fit.
5. Samples with cortisol values greater than 3.0 µg/dL (82.77 nmol/L) should be diluted with assay diluent and rerun for accurate results. If a dilution of the sample is used, multiply the assay results by the dilution factor.

A new Standard Curve must be run with each full or partial plate.

Typical Results

The results shown below are for illustration only and should not be used to calculate results from another assay.

Well	Standard	Average OD	B	B/Bo	Cortisol (µg/dL)
A1,A2	S1	0.094	0.071	0.048	3.000
B1,B2	S2	0.236	0.213	0.145	1.000
C1,C2	S3	0.524	0.501	0.340	0.333
D1,D2	S4	0.897	0.874	0.593	0.111
E1,E2	S5	1.219	1.196	0.812	0.037
F1,F2	S6	1.379	1.356	0.921	0.012
G1,G2	Bo	1.496	1.473	NA	NA
H1,H2	NSB	0.023	NA	NA	NA

Appendix W cont.

Limitations

- Samples with cortisol values greater than 3.0 µg/dL (82.77 nmol/L) should be diluted with assay diluent and rerun for accurate results. To obtain the final cortisol concentration, multiply the concentration of the diluted sample by the dilution factor.
- A pH value should be obtained on samples that appear yellow or purple after the diluted conjugate solution is added and the plate is mixed (Step 6). Samples with pH values ≤ 3.5 or ≥ 9.0 should be recollected.
- See "Specimen Collection" recommendations to insure proper collection of saliva specimens and to avoid interfering substances.
- Samples collected with sodium azide are unsuitable for this assay.
- Any quantitative results indicating abnormal cortisol levels should be followed by additional testing and evaluation.

Salivary Cortisol Example Ranges*

Group	Number	Overall Range (µg/dL)
Children, neonatal	275	ND - 3.417
Children, age 6 months	165	ND - 2.734

Group	Number	23:00 hrs (µg/dL)
Normal subjects	19	0.007 – 0.115
Cushing's subjects	21	0.130 – 2.972

Appendix W cont.

Group	Number	AM Range ($\mu\text{g}/\text{dL}$)	PM Range ($\mu\text{g}/\text{dL}$)
Children, ages 2.5-5.5	112	0.034 - 0.645	0.053 - 0.607
Children, ages 8-11	285	0.084 - 0.839	ND - 0.215
Adolescents, ages 12-18	403	0.021 - 0.883	ND - 0.259
Adult males, ages 21-30	26	0.112 - 0.743	ND - 0.308
Adult females, ages 21-30	20	0.272 - 1.348	ND - 0.359
Adult males, ages 31-50	67	0.122 - 1.551	ND - 0.359
Adult females, ages 31-50	31	0.094 - 1.515	ND - 0.181
Adult males, ages 51-70	28	0.112 - 0.812	ND - 0.228
Adult females, ages 51-70	23	0.149 - 0.739	0.022 - 0.254
All adults	192	0.094 - 1.551	ND - 0.359

Appendix W cont.

*To be used as a guide only. Each laboratory should establish its own range.

ND = None detected

Expected ranges for neonates to 5.5 years were derived using the Salimetrics Salivary Cortisol Immunoassay Kit.

Expected ranges for 8 to 18 years were reported from an unpublished manuscript, Pennsylvania State University's Behavioral Endocrinology Laboratory. Adult ranges were obtained from published literature. (7)

HS Salivary Cortisol EIA Kit Performance Characteristics

Precision

The intra-assay precision was determined from the mean of 20 replicates each.

Saliva Sample	N	Mean (µg/dL)	Standard Deviation (µg/dL)	Coefficient of Variation (%)
PS1	20	2.07	0.08	4
PS2	20	1.14	0.05	4
PS3	20	0.42	0.01	3
PS4	20	0.16	0.01	5
PS5	20	0.06	0.00	7

Appendix W cont.

The inter-assay precision was determined from the mean of average duplicates for 20 separate runs.

Saliva Sample	N	Mean (µg/dL)	Standard Deviation (µg/dL)	Coefficient of Variation (%)
PS1	20	1.99	0.05	3
PS2	20	1.16	0.05	4
PS3	20	0.43	0.01	3
PS4	20	0.18	0.01	9
PS5	20	0.06	0.01	11

Recovery

Five saliva samples containing different levels of an endogenous cortisol were spiked with known quantities of cortisol and assayed.

Saliva Sample	Endogenous (µg/dL)	Added (µg/dL)	Expected (µg/dL)	Observed (µg/dL)	Recovery (%)
1	0.071	2.00	2.07	2.20	106
2	0.071	0.20	0.27	0.28	104
3	0.071	0.04	0.11	0.11	98
4	0.078	2.33	2.41	2.33	97
5	0.078	0.20	0.28	0.31	113
6	0.080	0.04	0.12	0.12	103
7	0.86	0.20	1.06	1.16	109
8	0.89	0.04	0.93	1.02	109

Appendix W cont.

Analytical Sensitivity

The lower limit of sensitivity was determined by interpolating the mean optical density minus 2 SDs of 10 sets of duplicates at the 0 µg/dL level. The minimal concentration of cortisol that can be distinguished from 0 is 0.007 µg/dL.

Correlation with Serum

The correlation between serum and saliva cortisol was determined by assaying 49 matched samples using the Diagnostic Systems Laboratories serum Cortisol EIA and the Salimetrics HS Salivary Cortisol EIA.

The correlation between saliva and serum was highly significant, $r(47) = 0.91$, $p < 0.0001$.

Sample Dilution Recovery

Four saliva samples were diluted with assay diluent and assayed.

Saliva Sample	Dilution Factor	Expected (µg/dL)	Observed (µg/dL)	Recovery (%)
S1	undiluted	N/A	0.73	N/A
	1:2	0.37	0.39	107
	1:4	0.18	0.20	111
	1:8	0.09	0.10	111
	1:16	0.05	0.05	105
S2	undiluted	N/A	0.80	N/A
	1:2	0.40	0.40	101
	1:4	0.20	0.19	97
	1:8	0.10	0.09	94
	1:16	0.05	0.05	110
S3	undiluted	N/A	0.61	N/A
	1:2	0.31	0.30	98
	1:4	0.15	0.15	101

	1:8	0.08	0.08	108
	1:16	0.04	0.04	108
S4	undiluted	N/A	2.89	N/A
	1:2	1.45	1.53	105
	1:4	0.72	0.77	106
	1:8	0.36	0.42	115
	1:16	0.18	0.20	108

Linearity of Assay

Saliva Sample	Samples		Avg Observed ($\mu\text{g/dL}$)	Expected ($\mu\text{g/dL}$)	Recovery (%)
	Low	High			
a (Low)	100%	0%	0.07	0.07	N/A
b	90%	10%	0.36	0.34	108
c	80%	20%	0.63	0.61	104
d	70%	30%	0.93	0.88	106
e	60%	40%	1.13	1.15	98
f	50%	50%	1.45	1.42	102
g	40%	60%	1.64	1.69	97
h	30%	70%	1.88	1.96	96
i	20%	80%	2.27	2.23	102
j	10%	90%	2.49	2.50	99
k (High)	0%	100%	2.77	2.77	N/A

Appendix W cont.

Antibody Specificity

Compound	Spiked Concentration (ng/mL)	% Cross-reactivity in HS Salivary Cortisol EIA
Prednisolone	100	0.568
Prednisone	1000	ND
Cortisone	1000	0.130
11-Deoxycortisol	500	0.156
21-Deoxycortisol	1000	0.041
17 α -Hydroxyprogesterone	1000	ND
Dexamethasone	1000	19.2
Triamcinolone	1000	0.086
Corticosterone	10,000	0.214
Progesterone	1000	0.015
17 β -Estradiol	10	ND
DHEA	10,000	ND
Testosterone	10,000	0.006
Transferrin	66,000	ND
Aldosterone	10,000	ND

ND = None detected (<0.004)

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Seller's Warranty

“Seller warrants that all goods sold hereunder will be free from defects in material and workmanship. Upon prompt notice by Buyer of any claimed defect, which notice must be sent within thirty (30) days from date such defect is first discovered and within three months from the date of shipment, Seller shall, at its option, either repair or replace the product that is proved to Seller's satisfaction to be defective. All claims should be submitted in written

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form. This warranty does not cover any damage due to accident, misuse, negligence, or abnormal use. Liability, in all cases, will be limited to the purchased cost of the kit.

It is expressly agreed that this limited warranty shall be in lieu of all warranties of fitness and in lieu of the warranty of merchantability. Seller shall not be liable for any incidental or consequential damages that arise out of the installation, use or operation of Seller's product or out of the breach of any express or implied warranties."

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Updated: December 9, 2014