CLOSER TO GOD: AN ERP INVESTIGATION INTO THE ROLE OF GOD AS AN ATTACHMENT FIGURE

by

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Attachment theory is often used to explain differences in responses to emotional events and perceived threats from the environment related to interpersonal relationships. While this has been thoroughly studied regarding interpersonal attachment, potential attachment to God has only begun to be explored. The present study aimed to assess neurophysiological measures of attachment, in particular electroencephalograms (EEGs) to attachment cues, as these could provide insight into the early, automatic processes of attention allocation when the threat of separation from God (the attachment figure) is made salient through negative cues. For the present study, moderate to highly religious individuals heard attachment-related sentence stems in which God was centered as the attachment figure. These stems ended with the visual presentation of a positive, negative, or nonword target. Brain responses to these target words were analyzed across three epochs (N400, early LPP, and late LPP). Results regarding attachment style predicting N400 amplitudes for negative cues trended toward significance with attachment anxiety predicting smaller (less negative) N400s, contrary to hypotheses. However, exploratory analyses revealed an interaction of word type by time epoch such that negative words garnered greater sustained attention in the late LPP. Furthermore, attachment anxiety was a significant predictor of this later attention allocation to negative cues when participants reported being in a relationship. Interpretations of these findings are explored in the framework of the correspondence and compensation models of religious attachment. Limitations and future directions are discussed.

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INTRODUCTION

In times of need, we turn to those that are close to us for support, be it emotional, financial, or physical in nature. As social beings, we require the close contact of others and to be part of a community. From an evolutionary perspective, these social tendencies afforded humans with the protection of the group, thus, fostering social bonds and increased survival odds. While humans desire proximity to others, our reaction to one another is not necessarily consistent. The unpredictability of human behavior can lead to overwhelming anxiety and frustration when those we depend on let us down. Most individuals are capable of coping with the occasional fickleness of others, though a more concrete and stable behavior pattern would nearly always be preferable. In contrast to the capricious human nature, the foundations of most world religions are grounded in a central figure(s) that have an established position in the believer's life. Accomplishments or transgressions have expected rewards or punishments based on the religion's doctrine and/or the believer's interpretation of their faith. Since we are unable to control the reaction of others to our behavior, religion may offer a stability that is not as certain in human relationships. Put more simply, believers that are dissatisfied with interpersonal relationships may substitute God as a stable compensation for an attachment figure.

Originally formulated to explain differing patterns of mother-infant bonds, Bowlby et al. (1969) developed attachment theory while observing the proximity seeking behavior of children under stress. In his research, Bowlby observed the different ways in which infants and young children would achieve closeness with their primary caregiver or attachment figure. In general, infants attempt to prevent separation from their attachment figure and, if separation does occur, the child will become distressed and search for the missing caregiver. Bowlby hypothesized that the attachment process develops a cognitive/emotional system in infants that drives them to seek close proximity to their attachment figure when frightened or injured, which in turn, improves survival chances.

Ainsworth and Wittig (1969) built on Bowlby's theory by studying the attachment system through the Strange Situation paradigm. In this paradigm, mothers and children are placed in a room with toys. The mothers are given cues to stop interacting with the child and leave the room, then strangers come in and try to engage with the child. The researchers observed the reaction of the children to the separation, the presence of the stranger and finally the reuniting of the mother with the child. From these studies, Ainsworth and Wittig were able to distinguish three separate attachment styles based on how children responded in the Strange Situation paradigm. These three categories were later labeled secure, anxious-ambivalent and avoidant. The development of the different attachment styles is based on how the caregiver responds to the infant's attempt at gaining proximity. Responsive, attentive caregivers engender a secure attachment in the infant, whereby the infant can rely on the caregiver in times of stress but not be fearful of exploring away from their secure base. Inconsistent caregivers that are overly cautious at

times and dismissive at other times lead the infant to become more anxious when the caregiver is out of sight. Unreliable and dismissive caregivers who often ignore the infant's needs lead the infant to become distrustful of the caregiver and avoid attempts by the caregiver to obtain proximity. The emerging differentiation of attachment characteristics opened the door for myriad applications in research concerning interpersonal relationships.

Adult Attachment

While the original application of attachment theory to parenting styles has seen a great deal of research, the past three decades have seen a vast expansion of Bowlby's theory to other domains beyond the mother-infant bond. In particular, researchers have looked into the role attachment styles play in adult romantic relationships (Ainsworth & Wittig, 1969; Fraley & Shaver, 1997; Mikulincer & Shaver, 2010). While an individual's attachment style is formulated in infancy, many of the characteristics of this initial attachment to the caregiver appear to continue on into adult relationships as well.

Within the context of adult romantic relationships, similarities in the secure, anxious, and avoidant tendencies of infants can be seen in the interpersonal interactions of adults (Mikulincer & Shaver, 2010). In general, insecure individuals (anxious or avoidants) do not tend to cope well with stressful events, especially those related to relationship troubles, in comparison to their securely attached counterparts. Securely attached individuals feel they can count on their partner to support them in difficult times and are not overly fearful of abandonment by their partner. These individuals feel deserving of positive attention and love. Further, secure individuals seem capable of dealing with stressful events, including those related to relationships. On the other hand,

anxiously attached individuals are constantly fearful that their partner is not supportive of them or available emotionally. This leads to overcompensation to gain proximity to their partner and a hyper-vigilance for signs of abandonment from their partner (Mikulincer, Gillath, & Shaver, 2002). For avoidant individuals, close relationships present a different set of issues. Avoidants typically feel uncomfortable getting close emotionally with their partner and will attempt to distance themselves from their partner when they feel the relationship is impeding on their independence. These overarching behavior patterns observed in close relationships have implications not only for how individuals respond in stressful relationship situations, but, more broadly, how people perceive the actions of others and attend to emotional stimuli (Collins, 1996).

Evolution of Religion

While close romantic relationships provide real-world examples of how people interact with and relate to their attachment figures, recent research has begun exploring less tangible entities that may serve as attachment figures for certain individuals, such as religious deities. Every culture, regardless of geographical location, population size or ethnic makeup, has a variation of how it relates to the divine. From the Hindu belief in that reality only exists as the dream of Brahma, to the Judeo-Christian conception of God walking the earth as Jesus Christ, in varying degrees, religion provides human beings with a spiritual if not physical contact with the heavenly or godly. In many ways, this relationship resembles the function more worldly attachment figures serve, with God or a deity providing a stable and secure base individuals can turn to in stressful times. Particularly, in Judeo-Christian traditions, the image of God as a wise and strong father figure or personal savior is nearly ubiquitous. The importance and pervasiveness of

religion throughout the world has led some scholars to hypothesize the possible evolutionary basis of religion (Crespi & Summers, 2014; Grinde, 1998).

Three primary evolutionary necessities have been put forth as reasons for the evolutionary nature of religion: 1) right action through rules, 2) social cohesion through ritual, and 3) mitigation of existential fear through symbolic and literal immortality (Crespi & Summers, 2014). Heculano-Houzel (2012) posits that around 1.2 million years ago humans began trading physical strength and robustness for a powerful cortex, indeed the largest relative cortex-to-body ratio of any animal. Though physically lesser than other competitors, humans gained strength in numbers as strong social bonds formed in familial clans. The first hypothesis as to why religion may have evolved is that religion provides an often clearly delineated set of rules for right and wrong action as well as a select set of rewards and punishments for transgressions and achievements. In setting forth these rules, conflicts between group members could be reduced and the overall odds of survival for the group and its members would be increased. One example of religious dogma maintaining social order is offered by Crespi and Summers (2014). Many religions set forth rules regarding procreation such that sex outside of wedlock or adultery are punishable acts. By prohibiting such acts, competition between group members for the ability to reproduce would be limited (Grinde, 1998). Dogmatic rules like restricting procreation to marriage led to development of rituals that celebrate group membership within the religion and fostering social cohesion, the second hypothesis as to why religion evolved. Rituals such as marriage ceremonies, birth rites, funerals, or any religious service where written or oral traditions are transmitted all serve as a time and place for community gatherings that engender closeness between group members

(Kirkpatrick, 2012). Rituals add religious credence to special times during the year or in an individual's life where the group can celebrate or mourn together. Finally, researchers have posited the evolution of religion came about because, with our growing frontal cortex, we became aware of the inevitable demise of our corporeal body. While attachment to a romantic partner provides the promise of symbolic immortality through one's children, religion provides humans with a means of living beyond the physical world with the promise of literal immortality in an idyllic afterlife (Grinde, 1998; Rose, B., & O'Sullivan, M., 2002; Wink, P., & Scott, J., 2005). Although not advanced in previous theories of the evolution of religion, an attachment to God could bring one that much closer to this stable, permanent spiritual world.

A broader extension of how religion developed could be this notion of gaining proximity to the divine, which is perceived as immutable and permanent. One example of this proximity-seeking is the way in which we speak about religion (Kirkpatrick, 2012). Kinship language narrows the divide between the heavenly or spiritual world and the corporeal world humans reside in. For instance, Christian traditions often reference the "Holy Father", "the Son of God" and fellow church-goers are "brothers and sisters" of the faith. Not only does this kin language draw God to the physical world, but it draws God right into the family circle (Kirkpatrick, 2012). Some theorists posit that God represents an extension of the family circle (Grinde, 1998; Crespi & Summers, 2014). Just as religious leaders in various faiths represent sanctity and power in an earthly being, so too does God, but in a stable and everlasting realm.

Attachment to God

Recent studies by a handful of researchers have looked into religiosity and the potential role God may serve as an attachment figure for individuals. (Bradshaw, Ellison, & Marcum, 2010; Cassibba, Papagna, Calabrese, Constantino, Paterno, & Grandqvist, 2013; Kirkpatrick, 1998; Ross, 2007). Much of the current research focuses on adult attachment style as it relates to religious satisfaction and coping with grief, illness or other stressors. Kirkpatrick (1998) is one of the only researchers to posit that God serves as a substitute attachment figure. Self-report and behavioral research into the notion of God as an attachment figure has revealed differences in attachment styles and images of god as either loving/forgiving or cold/punitive (Kirkpatrick, 1998). In this longitudinal study, Kirkpatrick investigated the tendency of women to undergo religious conversion over a two-year period as well as how they perceived God and their attachment style. His findings indicate that securely-attached people (individuals with positive models of themselves and others according to the attachment scale developed by Bartholomew and Horowitz, 1991) tended to be the most religious and have the most positive images of God. Further, individuals higher in attachment anxiety (a negative model of self and positive model of others) tended to have more religious conversions over the two-year period.

Kirkpatrick (1998) placed these findings in the broader context of a correspondence model and a compensation model of religious attachment. The correspondence model of religious attachment posits that mental models and attachment processes for interpersonal relationships mimic how people interpret their relationship with God. That is, if one views their close relationships as based in trust and stability,

then they are likely to perceive their relationship with God in the same way. Those that are anxiously attached and crave close proximity to their attachment figure report religious experiences being more powerful emotionally. Avoidant individuals typically turn away from religious beliefs as they do interpersonal relationships (Kirkpatrick, 1992).

While not in direct contrast to the correspondence model, the compensation model of religious attachment views this form of attachment in a different light. For those that are insecurely attached, God may serve directly as a substitute or compensatory attachment figure when human relationships are too inconsistent (Kirkpatrick & Shaver, 1990; Kirkpatrick, 1997). Kirkpatrick and Shaver asked participants to classify their childhood relationships with their mothers into secure, anxious or avoidant categories. These classifications were then correlated with numerous measures of religiosity and perceptions of God. Findings from this study indicated that avoidant individuals were more likely in adulthood to report religious conversion and having a personal relationship with God. A later study revealed a similar pattern for anxious individuals (Kirkpatrick, 1997). From attachment theory, it follows that, if God serves as an attachment figure for individuals, these people might turn to their deity during times of stress. Because separation from attachment figures is particularly distressing for anxious individuals, the present research is designed to investigate the perceived separation from a religious figure, as this should similarly activate the attachment system if God does indeed serve as an attachment figure. Furthermore, results of this research may shed light on whether religious attachment follows the correspondence model or the compensation model.

Attachment and ERPs

While recent investigations into attachment theory have predominately focused on differential responses between attachment styles in a variety of contexts (such as responses to caregivers or romantic partners) these studies have done so through behavioral and self-report measures. Only a handful of studies have looked into physiological responses to attachment threats. The addition of physiological responses adds to the existing literature elucidating the earliest perception of these threats, at least in the realm of romantic relationships. Zayas , Shoda, Mischel, and Tanahashi (2009) were some of the first researchers to use automatic brain responses in a romantic relationship context as a physiological measure. In their study, the researchers uncovered differential brain responses to partner rejection cues in a group of anxiously attached women. In order to understand the efficacy of employing physiological measures in psychological paradigms, a background on the particular measures (*e.g.*, electroencephalograms) proposed for this study will be useful.

Electroencephalograms (EEGs) are measures of the electrical activity produced by the firing of neurons in the brain. EEGs are recorded non-invasively from the scalp of participants using sensors. Predominantly, EEG activity is linked to the presentation of various stimuli to assess neurological activity due to the presence of a stimulus. When linking stimuli to EEG activity, the resulting waveform is called an *event-related potential* (ERP). ERPs record voltage changes in neural activity typically in response to the presentation of emotionally-charged stimuli and are indicative of underlying cognitive activities related to the processing of the emotional stimuli and attention allocation. Often times, and for the purposes of the present study, EEG recordings are used to study

differential brain responses to emotionally charged words (Schupp, Junghöfer, Weike, & Hamm, 2003; Hofmann, Kuchinke, Tamm, Võ, & Jacobs, 2009). The particular waveform of interest in such studies is the *event-related potential* (ERPs). This waveform is time-locked to the presentation of a stimulus and records the voltage change in neural activity that is linked to cognitive events related to perception of the stimuli. ERPs are categorized according to the length of time between stimulus presentation and the peak amplitude achieved in the voltage change and whether the voltage change was negative or positive at the scalp (Schupp et al., 2003). If an ERP waveform is negative, it is labeled with an "N" or, if it is positive, labeled with a "P". These waveforms are further labeled with the approximate millisecond after stimulus presentation. Thus, the N400 is a negative voltage change that occurs approximately 400 milliseconds after a word or picture is presented.

The various components of ERPs that occur at different time periods with different voltage changes are typically associated with specific cognitive functions. For instance, early negativities (between 100 and 400 ms) are associated with selective attention and early feature or semantic analysis of a stimulus (Fabiani, Gratton, & Coles, 2000). The amplitude of ERPs is associated with the amount of attention being given to a particular stimulus. Therefore, higher amplitudes indicate greater neural activity, thus, greater attention being given to a stimulus (Donchin & Coles, 1988).

Research in individual differences using ERP measures revealed differential brain responses to emotional stimuli based on a number of traits. Of particular interest in the present research is evidence that adult attachment styles are predictive of differential brain responses to emotional stimuli (Hazan & Shaver, 1987; Mikulincer and Shaver,

2007). In these studies, the overall finding was that anxiously-attached individuals are hyper-vigilant to threatening stimuli, particularly regarding relationship threats, as indicated by higher amplitudes in the ERP waveforms (Zilber, Goldstein, and Mikulincer, 2007; but see Chavis & Kisley, 2012). Such evidence suggests anxiously attached individuals are dedicating more attention and cognitive resources to stimuli that may represent a threat to their relationship with their attachment figure. On the other hand, Fraley and Shaver (1997) found evidence that avoidantly attached individuals turn their attention *away* from threatening stimuli. These early neural responses, particularly to threatening cues such as negative images are linked to mood disorders and anxiety (Compton, 2003; Derryberry & Reed, 2002)

N400 and Attachment

The waveform of interest in the present study is the N400. This waveform is typically considered to begin around 250ms and peaks around 400ms (Figure 1). It is an early negative deflection in the ERP that is linked to semantic processing and the detection of incongruence of stimuli within a given context (Hagoort, Hald, Bastiaansen, & Petersson, 2004). Hagoort et al. (2004) found the presentation of non-words and semantically incorrect words within a sentence elicited more negative-going deflections early in attention processing. Further, stimuli that are not attended to do not elicit as negative of a deflection in this waveform, nor do these deflections last for as long (Bentin, Kutas, & Hillyard, 1995; Kiefer & Brendel, 2006). Therefore, the more negative the deflection and the longer-lasting the deflection implies greater processing of stimuli.

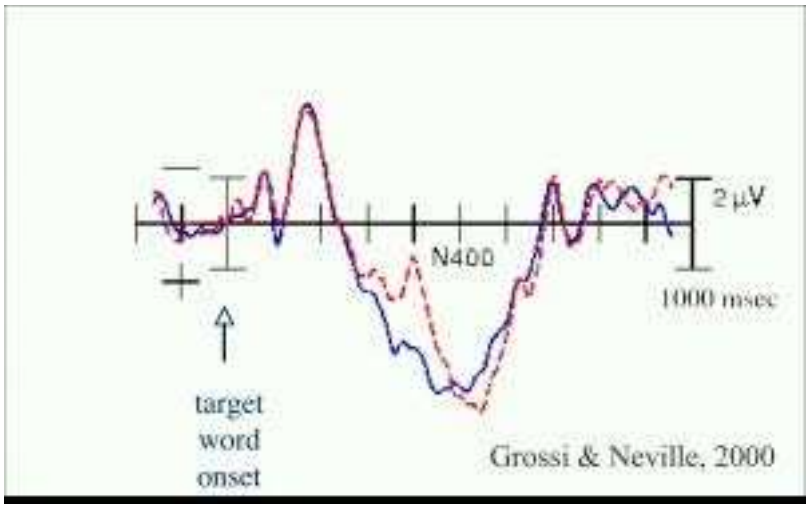

Figure 1. The blue line indicates the waveform associated with a context-consistent word paring (e.g., dog-cat). The red line indicates the waveform associated with context-inconsistent word paring (e.g., dog-sun). Note the larger deflection for context-inconsistent parings. (From Grossi & Neville, 2000)

Zayas et al. (2009) used the N400 to investigate attachment styles as they pertain to romantic partners and the potential for romantic rejection. In their study, Zayas et al. had participants listen to sentences that were either attachment primes (*e.g.,* "When I am having a hard time my partner is…") or a neutral prime (*e.g.,* "When I am balancing my checkbook my partner is…"). The target words were either non-words (to test the presence of the N400 for semantic processing), acceptance words (*e.g.,* " supportive") or rejection words (*e.g.,* "absent"). N400 waveforms were averaged for each target word and attachment styles were measured. The findings indicate that the N400 amplitude was greatest for non-words and rejection words, particularly in the context of the attachment prime with anxiously-attached participants. The authors argue that these findings suggest individuals with anxious tendencies are hyper-vigilant for threats to their relationships early in attention allocation processes and that this is especially relevant when it is in the context of an attachment prime. In this way, differential responses in the N400 based on one's attachment style indicate whether they perceive a rejection word as sufficiently

upsetting or attention-grabbing to require further processing. The potential for separation from their romantic partner (attachment figure) activates their attachment system when they first perceive this threat and the attention-grabbing nature of the rejection cue indicates a *turning toward* the threatening stimulus among anxious individuals. The opposite pattern was seen among avoidant individuals as they showed reduced N400 amplitudes for rejection words, indicating a *turning away* from a threatening stimulus. Typically, EEG studies of attention focus on a different waveform known as the *late positive potential* (LPP), which occurs later in processing (between 450ms and 700ms) and is associated more with overall attention allocation (Luck and Kappenman, 2012). Because these authors were interested in the initial orienting towards or away from threatening stimuli, they opted for using the earlier N400 to assess immediate reactions. In the context of the current study, a similar paradigm can be used to investigate whether one's deity is serving a comparable role as an attachment figure, especially for highly religious people. Additionally, this physiological measure would add to the literature on religious attachment as the N400 can tap into early, automatic perceptions of a potential attachment figure.

Present Study

The aim of the present study was to use electrophysiological measures of early neural processing to better understand moderate to highly religious individual's perception of God. Presently, research into the potential role God may fill as an attachment figure has only been investigated through self-report measures of religious beliefs, religious conversions and correlations between attachment styles and perceptions of group membership in religious institutions (Kirkpatrick, 2003). Therefore, this study

broadens the literature in this area to include neurophysiological measures to elucidate the early processing of threats to religious attachment figures. *Hypothesis 1:* N400 amplitudes will be higher (more negative) overall from rejection cues over acceptance cues. This would be indicative of the relative surprise individuals might perceive when hearing cues indicating rejection by a powerful religious figure (God). *Hypothesis 2a:* For highly anxious individuals, the N400 waveform for rejection cues will show the greatest amplitude over those that are securely or avoidantly attached. Such a finding would reflect the activation of the attachment system to the perceived threat of separation from God and demonstrating that, in this context, God is perhaps serving as a corresponding attachment figure. As the correspondence model suggests, just as insecurely attached individuals perceive their attachment figure (caregiver or significant other) to be unreliable, so too do they perceive their god to be unreliable. Thus, target words implying rejection are particularly attention-grabbing for anxious individuals as they are hyper-vigilant for threats to their attachment relations, thereby greater N400s in this group would lend support for the correspondence model of religious attachment.

On the other hand, should the N400 amplitudes for rejection cues be *less* negative for anxious individuals, this could lend support for the compensation model (*Hypothesis 2b*). Since the compensation model posits that God serves as a *secure* base for insecure individuals when worldly attachment figures fail them, the hyper-vigilance of anxious individuals may not be cued by a presupposed secure attachment figure, thus rejection cues are less attention-grabbing. No specific predictions are made regarding more avoidant individuals as research indicates these individuals tend to use deactivating strategies when they encounter emotionally-charged situations and suppress their

reactions to that type of material (Mikulincer & Shaver, 2007). Finally, if the N400 is indicative of initial orientation towards surprising, out-of-context stimuli that may require further processing, then LPP waveforms that are typically used to assess overall attention allocation to and processing of a stimulus should differ between target word type (Chavis & Kisley, 2012; Thomas, Johnstone, & Gonsalvez, 2007; Zilber, Goldstein, & Mikulincer, 2007). No specific predictions were made for these LPP waveforms, but these data were collected during the recording process and exploratory analyses were conducted.

CHAPTER 2

METHOD

Participants

Four hundred and sixty University of Colorado, Colorado Springs psychology students took part in the online data collection through the SONA System Website from March 2015 through March of 2016. Compensation for the completion of these surveys was granted as one point of extra credit which the participant could apply to any psychology course in which they were currently enrolled. Data from the Centrality of Religiosity survey was analyzed from these participants and those scoring 3.0 and higher on the survey (indicating moderate to high religiosity) were individually contacted via email by the principal investigator asking for their participation in the second part of the study. Forty-three participants took part in the second part of the study which involved the recording of electrophysiological measures (*i.e.* EEG) that took place on the UCCS campus. Compensation for their participation in the second part of the study was made in the form of two points of extra credit or $20 cash payment. Of the 43 participant that completed both the online survey and lab recordings, three of them had to be removed from the final analysis. Two of these participants had braids and/or hair extensions that made cleanly recording brain response impossible and the last person had a corrupted data file that was unable to be analyzed. The final analyzed sample consisted of 40 participants with suitable recordings: 32 were female and 8 were male (80% female, 20%

male) and their age ranged from 18 - 40 years (M = 21.62, SD = 5.36). The ethnic makeup of the sample was predominantly white (60%), followed by latinos (15%) and other/mixed (15%), and asian (7.5%), with the remaining 2.5% being undefined. The religious affiliation of the sample was predominantly Christian (50%), followed by 27.5% Catholic, 10% Other, 7.5% agnostic, 2.5% Muslim, and 2.5% Buddhist. Of the participants, just slightly over half reported being single or divorced at the time of the initial online surveys (52.5%) while the remaining reported being in a relationship. Prior to the EEG recording, the Snellen visual acuity chart was used to determine participants' ability to see the words that were presented on the computer monitor in front of them during the EEG recording. All participants tested 20/40 or better with natural or corrected vision.

Materials and Procedure

Participants completed a series of surveys online prior to coming to the on-campus laboratory for the EEG recording session. Participants signed up for the study using the SONA System that is accessed through the University of Colorado website. The SONA System allows participants to create an account to which extra credit is granted when they participate in a study. This extra credit can be applied to psychology courses they are completing through the University. Once the participant signed up, they were redirected to the Qualtrics website, an online survey platform, where they completed the surveys. Following completion of the surveys, extra credit was granted to the participant's SONA account. These surveys consisted of a demographics questionnaire, the Centrality of Religiosity Scale (Huber and Huber, 2012) the Emotions in Close Relationships questionnaire, and the Image of God scale (Benson & Spilka, 1973).

Centrality of Religiosity Scale

The Centrality of Religiosity Scale (CRS; Huber and Huber, 2012) is a reliable and validated measure of the importance or salience of one's religious practice in their life. It is based on five core features of religiosity including public practice, private practice, religious experiences, ideology, and intellectual dimensions. The scale is measured on a five-point Likert scale ranging from 1 (Not at all important) to 5 (Very important). The combination of these five dimensions can be viewed as a valid measure of an individual's religiosity. The scale authors set forth recommended cutoff values to differentiate highly religious from moderate and low religiosity (1.0 to 2.0: not religious, 2.1 to 3.9: religious, 4.0 to 5.0: highly religious). The CRS has been used in 25 different countries and the 15-item scale shows good reliability ($\alpha = .96$).

For the purposes of the present study, the cutoffs on the CRS were used to select only the moderately to highly religious participants. Because we were interested in the neurological responses to god-related acceptance and rejection cues, we did not necessarily expect an effect for individuals that are low in religiosity. Participants were pre-screened using their scores on the CRS. Initially participants scoring 4.0 and higher on the CRS were chosen for the EEG recording portion of the study. However, due to a low number of participants scoring in this high range, we chose to expand the selection criteria to those scoring 3.0 and above on the CRS. Those scoring below 3.0 on the scale were not asked to participate in the second portion of the study where EEGs were recorded. The participants that were excluded were still granted 1 point of extra credit for their time completing the online surveys.

Emotions in Close Relationships Scale

The Emotions in Close Relationships Scale (ECR; Brennan, Clark, & Shaver, 1998) is a reliable (α = .92) and validated measure of adult romantic attachment styles. The ECR is comprised of two 18-item subscales that measure levels of relationship anxiety (e.g., “I am worried my partner will leave me.”) and relationship avoidance (e.g., “I don’t feel comfortable getting close romantically.”) on an 8-point Likert scale. The averages of anxiety and avoidance subscales are computed and individuals are classified into one of four attachment style categories based on these scores. Individuals scoring low in both anxiety and avoidance are considered securely attached while if either anxiety or avoidance is high, the participant will be classified as one of those two dimensions (see Figure 2). Those scoring high on both dimensions are rare but are considered to be anxious/avoidants.

Image of God Scale

The image of God scale (Benson and Spilka, 1973) is a measure of an individual’s perception of god as loving and forgiving or vengeful and punishing. Following Kirkpatrick and Shaver’s (1992) adaptation of the scale, there are twelve items that ask participants to rate how closely an adjective describes their perception of god on a Likert scale ranging from 1 (not at all) to 9 (very much). The image of god scale can be subdivided into three subscales that include a Loving God scale (five items), a Controlling God scale (three items), and a Distant God scale (four items). Alpha coefficients for the three subscales are good for the Loving God subscale (α = .96), good for the Distant God subscale (α = .84), and fair to low for the Controlling God subscale (α = .64).

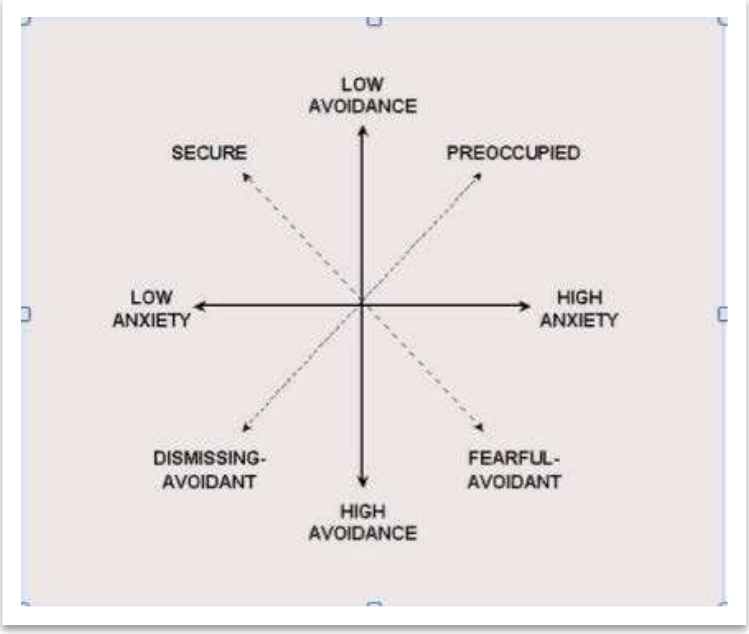

Figure 2. Low avoidance and low anxiety scores will place an individual in the upper-left quadrant (secure). High anxiety and low avoidance scores will place an individual in the upper-right quadrant (anxious [preoccupied]). High avoidance and low anxiety will place an individual in the lower-left quadrant ([dismissing-] avoidant). Finally high anxiety and high avoidant scores will place an individual in the lower-right quadrant (anxious-avoidant [fearful-avoidant]). (From Mikulincer & Shaver, 2010)

Lexical Decision Task and EEG

The electrophysiological recording took place in the Human neurophysiology Lab on the UCCS campus. Participants were fitted with a 74-channel sintered Ag/AgCl electrode cap from Electrode Arrays (Electrode Arrays, EL Paso, TX) connected to a multi-channel amplifier. The amplifier and cap were controlled with data collection software (Sensorium, Inc., Charlotte, VT) that recorded EEG responses that were time-locked to the presentation of the target words. The cap resembles a swim cap that has an array of electrodes arranged over various areas of the scalp (Figure 3). It is applied to the scalp using an electrically conductive gel (EGel) that is inserted into each of the 74 electrodes with a syringe and blunt-tip metal applicator tube as per the manufacturer's instructions. The conductive EGel serves to reduce electrical resistance on the scalp so

that neuronal activity can be more easily recorded. The standard accepted resistance levels is approximately 10 kohms or below to reduce the influence of artifacts in the recording. Electrical activity of neurons located below each electrode is amplified and recorded at a rate of 2,000 Hz. In addition, lateral and superior electrode sites around the eyes collected eye movements and blinks which can contaminate EEG recordings, thus, these movements are removed from the final analysis.

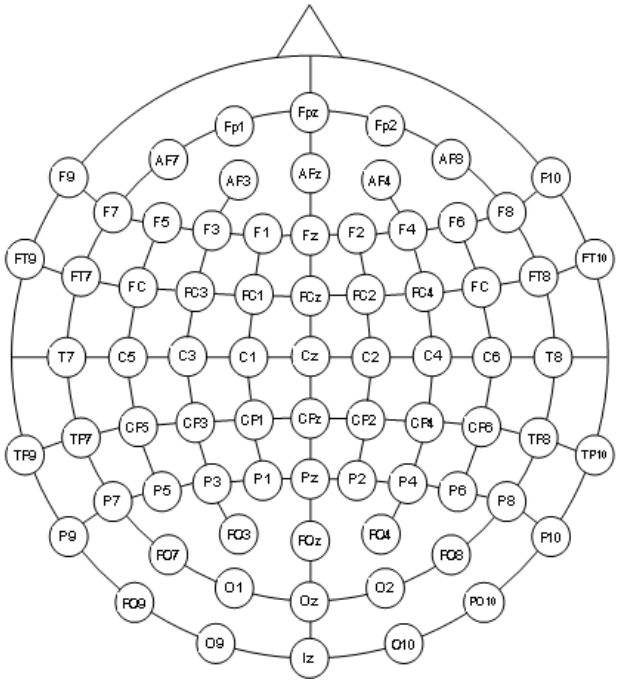

Figure 3. The distribution of 74 electrodes across the scalp.

The paradigm participants took part in during the EEG recording was modeled after Zayas et al. (2009) with the exception that the context of the sentences replaced partner cues with God cues. The *lexical decision task* (LDT) is a common decision task that requires participants to classify words from nonwords. Once the cap was applied and the electrical resistance reached acceptable levels, participants had headphones placed on their heads over the electrode cap. An audio paradigm consisted of a recorded female voice reading sentence stems of similar structure and length. As per Zayas et al., these

sentence stems were in an attachment-related context such that a mildly stressful situation is brought to mind, as this serves to activate the attachment system. The attachment figure in the sentence was “God” and the target word was either accepting or rejecting in nature, though not spoken in the recording. Instead, the target word was displayed on a computer monitor in front of the participant when the recorded sentence stem had completed. For example, the sentence “When I am having a difficult time at work, God is supportive” places God as the attachment figure in an attachment-related context and the target word (e.g., “supportive”) is the acceptance cue. Similarly, in the sentence “When I am having a difficult time at work, God is dismissive” the same sentence structure is maintained and God remains the attachment figure, but the target word is change to a rejection cue. The target words were displayed on a 17-inch LCD computer monitor placed approximately 50 centimeters from the participant’s face. E-Prime software (Psychological Software Tools, Inc. Pittsburg, PA) was used to play the pre-recorded sentence stems and to display the target words for the participants. Brain responses to these target words were time-locked to the presentation of the word for a one second duration (0 - 1,000ms) using a photosensitive diode attached to the monitor displaying the target words. To test for the presence of N400 waveforms, one-third of the target words were orthographically correct nonwords (e.g., “kating”). The difficulty of placing nonwords in context generates large N400 amplitudes and this served as a manipulation check (Luck & Kappenman, 2012). Participants were then asked to classify the target as either a word or nonword using mouse button-presses and both their response time and response accuracy was recorded through Sensorium. Sentence stems and target word presentation were grouped in pseudo-random order into blocks of five sentences each. There were a total of 40

positive, 40 negative, and 40 nonword targets used resulting in 120 sentence stems presented to participants in 24 blocks. Prior to beginning the task, participants were read the following instructions:

"You will hear several sentences of similar semantic structure, however, the final word of each sentence you hear will not be heard, but will be projected on the screen in front of you. This word may be a real word or a nonword that looks grammatically correct. This word will be projected on the screen in front of you for one second and you will be asked to indicate whether you think this word is a real word by pressing the right mouse button or a nonword by pressing the left mouse button. After indicating your response, the next sentence will be read and the target word will again appear on the screen. After every fifth word you will be given a break. Press any mouse button at this time when you are ready to continue."

Following completion of the LDT, the electrode cap was removed and participants were debriefed on the purpose of the study and questions or concerns they had were addressed. The recorded data files for each participant were then analyzed for the ERP data.

Analysis

Behavioral data and EEG data were analyzed separately. Button-press accuracy and response-time measures were recorded during the task to ensure proper task performance. Waveforms for each target word type (positive, negative, and nonword) were measured using EMSE Data Editor and unique waveforms for these target cues for each participant were generated by averaging brain responses to each word type across a one-second time window. Within these unique one-second-duration waveforms, the

primary epoch in interest was the N400 that ranged from 350ms to 450ms following the onset of word presentation. In addition, and for the purposes of exploratory analyses, amplitudes for later epochs were also measured, these being early (400ms-600ms) and late (600ms-800ms) LPPs (*late positive potentials*). Within each epoch, mean amplitudes for each word type within that time window served as the measure of brain activity to that given cue. By averaging all participant brain responses together for each word type, grand average waveforms showing the overall brain activity across a one-second time window was produced and is shown in Figure 4. Based on procedures used by Zayas et al. N400 amplitude means at midline site PZ were used as the dependent variable to assess the effect of rejection and acceptance cues in the subsequent analyses. For the N400 mean amplitudes, it is important to remember that smaller positive values indicate more negative peak deflections (*i.e.* more attention-grabbing).

CHAPTER 3

RESULTS

All data were analyzed using SPSS Statistical Package by IBM. As a manipulation check to ensure participants were completing the assigned lexical decision task, response time to target word classification and accuracy of button presses were assessed. Results from each are presented in Table 1. The high accuracy of button presses to classify word type indicates participants engaged in the task correctly.

Table 1

Behavioral and ERP Responses
*Means and standard deviations reported M (SD); ERP amplitudes reported in microvolts (*µV)

	Word Type		
	Positive	Negative	Nonword
Behavioral Responses			
Response Time (ms)	571.13 (194.38)	674.59 (209.69)	727.95 (326.58)
Response Accuracy (%)	99.2% (.22)	98.8% (.27)	98.4% (.30)
ERP Responses			
N400 (µV)	6.76 (5.18)	6.62 (6.03)	4.55 (5.05)
LPP Early (µV)	7.02 (4.61)	6.87 (5.40)	3.53 (4.80)
LPP Late (µV)	3.83 (4.18)	5.72 (4.64)	3.71 (4.46)

ERP Data

The first analyses preformed on the ERP data were intended to provide support for the validity of procedures used in this study (*i.e.* presence of N400). A repeated-measures ANOVA was conducted to compare mean amplitudes for the N400 during presentation of positive, negative, and nonword targets to ensure N400 amplitudes for nonword targets were greater (more negative/less positive) than for real word targets (Kuntas & Hillyard, 1984) and results are reported in Table 1. A main effect of word type was revealed, $F(1, 39) = 15.50$, $p < .001$. Bonferroni-correct post-hoc comparisons revealed mean N400 amplitudes for nonword targets were indeed more negative than for negative word targets ($p < .001$). Further, the N400 amplitudes for nonword targets were also more negative than those N400 amplitudes for positive words ($p < .001$). *Hypothesis 1*, which predicted N400 amplitudes would be more negative for negative target words compared to positive targets was not supported ($p = .774$).

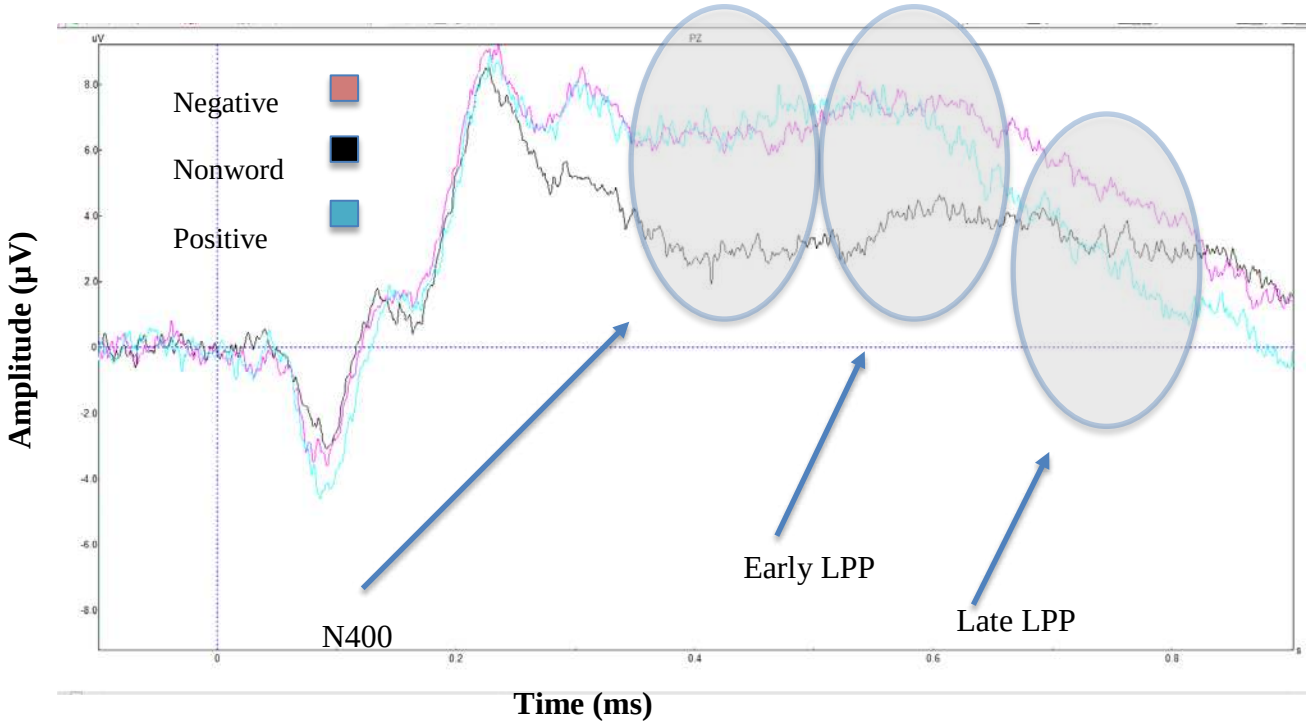

Figure 4. Grand-average waveforms for each for type across 1s time window

To test the hypothesis that N400 amplitudes would vary based on attachment style, a multiple regression was performed with attachment anxiety and avoidance scores as predictors of N400 amplitude. *Hypothesis 2a* predicted that N400 amplitudes would be greatest (most negative) for more anxious individuals. The model did not significantly predict N400 amplitudes for negative words with an R^2 of .079. However, attachment anxiety was trending toward significance with an unstandardized beta of 1.48 (p = .087). This indicates that for an increase of 1 in anxiety scores, there was an increase in N400 amplitudes of 1.48 microvolts. In terms of what this means for the influence of attachment style on initial responses to negative words relating to God, and trending towards support of *Hypothesis 2b,* is that negative cues in the context of God are actually less attention-grabbing for anxious individuals. Additionally, no significant regression model was found for N400 amplitudes for positive words (R^2 = .062). Finally, no significant regression model was found for N400 amplitudes for nonwords as well (R^2 = .012).

LPP Analyses

While no significant predictive ability of attachment style was found concerning the N400 waveforms, exploratory analyses were performed on later epochs of the ERP data looking at overall attention allocation to negative and positive targets. These later waveforms ranging from 400ms to 800ms are late positive potentials and are positive-going patterns of activation that are indicative of attention allocation to emotional stimuli. For the purpose of the exploratory analyses, we divided the LPP into an early and late epoch. The early LPP was the time window between 400ms and 600ms after target word presentation and the late LPP was the time window between 600ms and 800ms. This was

done primarily based upon a visual inspection of the grand average waveforms that appears to show a difference in activation based on word type over time.

An analysis of variance (ANOVA) was performed in a 2 X 2 design with Time (early and late LPPs) and Word Type (positive and negative) as the factors. There was a significant main effect for Time, $F(1, 39) = 23.98$, $p < .001$, and a near significant main effect for Word Type, $F(1, 39) = 3.30$, $p = .077$. Interestingly, there was a significant interaction between Time and Word Type, $F(1, 39) = 15.92$, $p < .001$. This interaction indicates that while early processing of negative and positive words (400 - 600ms) was approximately the same, brain activation for negative words remained higher for a longer duration (600 - 800ms) indicating greater need for processing for these words (Figure 5). Post-hoc tests confirmed there was a no significant difference in processing (*i.e.* ERP amplitudes) for positive and negative words during the early LPP waveform ($p = .779$). However, during the late LPP, there was significant difference in processing (i.e. ERP amplitudes) between word type during this time window ($p = .002$).

Based upon the observation of this interaction in the LPP waveforms, we decided to examine the potential effect of whether the participant was in a relationship or not during the recording and if this affected their attention to attachment-related cues. Based upon recent findings (Lathrop, Davis, & Kisley, 2015), the LPP waveforms produced in response to attachment-related contexts differs based upon whether the individual is in a relationship or not. In effect, being in a relationship appears to amplify attachment anxiety such that LPP responses to negative cues draw more sustained attention from those individuals that are high in attachment anxiety and also in a relationship.

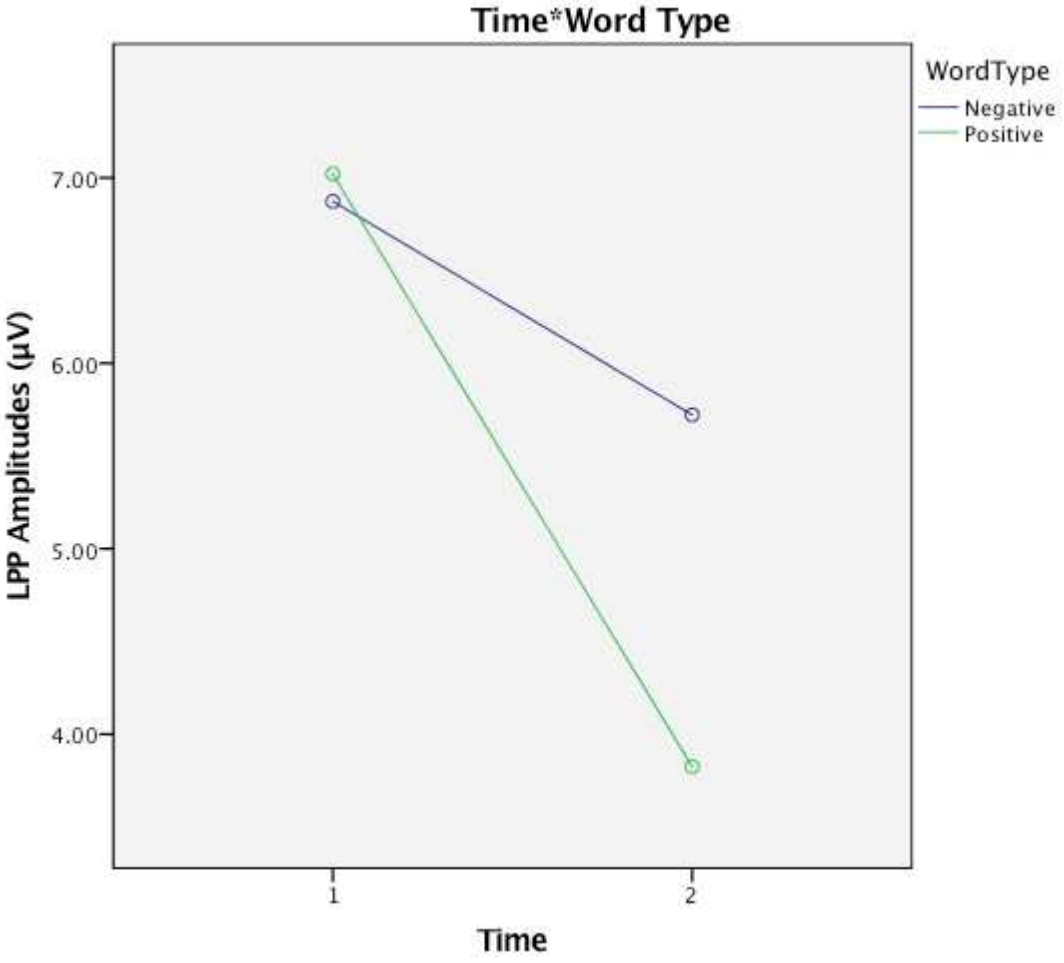

Figure 5. Time by word type interaction. Note. Time 1 is Early LPP time window (400ms - 600ms) and Time 2 is Late LPP time window (600ms - 800ms).

As mentioned earlier, of the 40 participants that took part in the study, 19 of them reported being in a relationship. We selected only these cases for further analysis related to the effect of attachment anxiety on ERP amplitudes. Initial inspection revealed a strong correlation between anxiety and the late LPP waveform for negative words (r = .58). A multiple linear regression was then performed to determine if attachment anxiety and/or avoidance was predictive of later LPP amplitudes for negative words. The regression model was significant, $F(2, 18) = 4.31$, $R^2 = .35$, $p = .032$, with greater anxiety predicting

greater LPP amplitudes for negative words (ß = 1.92, p = .022). Attachment avoidance still was not a significant predictor of LPP amplitudes (p = .603).

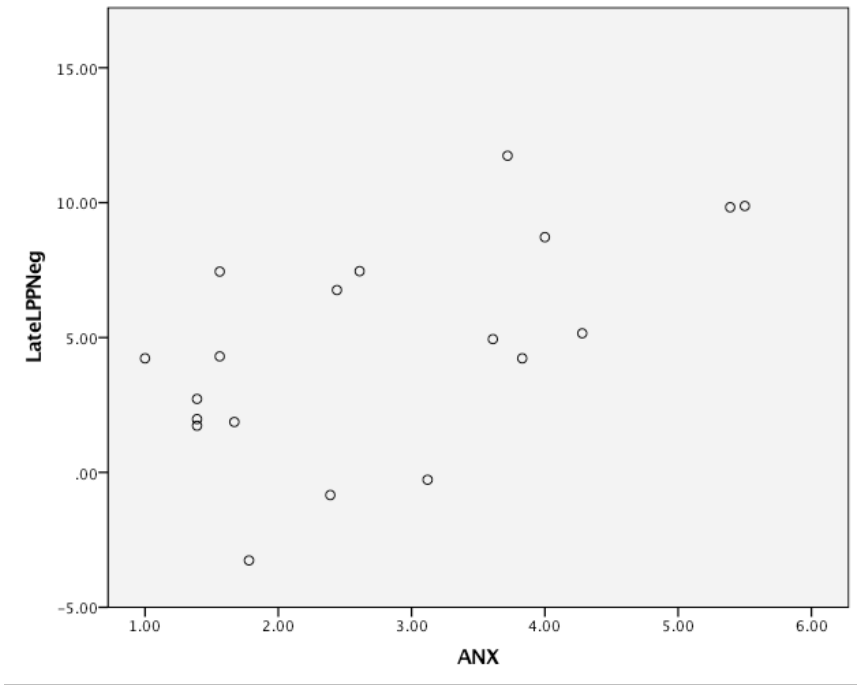

Figure 6. Plot of Late LPP amplitudes for negative words (600ms - 800ms) by anxiety level.

CHAPTER 4

DISCUSSION

In broad terms, the overarching goal for this study was to determine if there is evidence, from an electrophysiological perspective, that one's God serves as an attachment figure. The original hypotheses regarding attachment style and N400 amplitudes were not supported, such that N400 amplitudes did not vary significantly or in the predicted direction with attachment scores as the predicting variable. However, subsequent exploratory findings using later time windows in ERP measurements supported the relevance of attachment theory in interpreting how individuals perhaps relate to their God as an attachment figure. This discussion will explore interpretations of the null findings with consideration of the correspondence and compensation model of religious attachment. Further, there will be an examination of the significant findings regarding the analysis of the LPP waveforms. Finally, limitations of this study and future directions of studying religious attachment using electrophysiological measures will be discussed.

To begin with, *Hypothesis 1* predicted that N400 amplitudes would be more negative in general for rejection cues (negative words) compared to acceptance cues (positive words). However, the mean amplitude difference between N400s to negative and positive words did not significantly differ in either direction. The manipulation check conducted to see that nonword targets generated the greatest N400s was confirmed,

indicating that novel or out-of-context stimuli were processed differently. A possible reason that N400s for negative words were not different than for positive words is that the presence of nonwords in the paradigm were far more attention-grabbing and therefore, when real negative words were presented, they were not sufficiently surprising to generate an N400 different from real positive words.

In testing *Hypothesis 2a* it was predicted that high levels of attachment anxiety would predict greater (more negative) N400s to negative target words as these words should be more threatening and attention-grabbing to someone with an anxious attachment style. Such a finding would provide support for the correspondence model of religious attachment (*i.e.* same attachment-style in interpersonal relationships as with religious figures). Based on the finding of this study, this did not appear to be the case. Instead, greater attachment anxiety trended toward significance in predicting a more *positive* N400, meaning that stimuli were *less* attention-grabbing or out-of-context to more anxious individuals. Although not reported here, a subsequent multiple regression analysis was run using only participants that reported being in a relationship and this trend became significant for attachment anxiety ($p = .047$). Though this trend was in the opposite direction than predicted by *Hypothesis 2a* (and trending towards support of *Hypothesis 2b*), it offers insight to potential processing of rejection cues based on one's attachment style. In this case, this trend could be interpreted as anxious individuals are expecting to be let down or abandoned by their attachment figure, thus rejection cues are not as surprising to them. This could suggest God is still serving the role as a corresponding attachment figure that is just as likely to abandon or betray an anxious individual as in interpersonal attachment figure. On the other hand, if God is

serving as a compensatory attachment figure, the hyper-vigilance for threats to the attachment relationship are not as salient and the individual responds to the relationship more like a securely-attached person would, where negative or positive cues about the figure are not greatly different because one believes they can ultimately rely on this figure for support. In the context of trying to extrapolate whether these participants' interpersonal attachment styles *correspond* to their religious attachment or *compensate* for insecure attachments in daily life is challenging in light of the current findings. It could be that religious attachment is not typically as salient as interpersonal attachment, thus N400 patterns for partner rejection cues (Zayas et al., 2009) are different from God rejection cues. Further, interpersonal attachment figures have a tangible form and presence with specific memories associated with the past one has with their attachment figure. Essentially, it is likely easier to bring to mind a physical being. The tangibility and salience of memory and physicality associated with one's God could be less vivid.

In looking at brain activation patterns beyond the N400 waveform, an interesting interaction between word type and time emerged. This interaction indicated that negative words and positive words underwent a similar amount of early processing (400 - 600ms) after they were presented, but the amount of processing for negative words remained significantly higher later on (600 - 800ms). These finding show that rejection cues concerning one's God elicit more sustained attention allocation than acceptance cues. In other words, these individuals sustain attention to negative words in the context of their God, while positive words are resolved more quickly by the individual.

The effect of participants' relationship status was also investigated since findings from previous studies (Lathrop, Davis, & Kisley, 2015) indicate being in a relationship

amplifies the impact of attachment anxiety on LPPs, perhaps by making the attachment relationship(s) more salient (Edelstein & Gillath, 2008). In this case, we found that those participants in a relationship at the time of the recording showed a stronger correlation between attachment anxiety and late LPP waveforms for negative words. This finding in particular could lend support to the correspondence model of religious attachment, whereby anxious insecurity in interpersonal relationships is evident in attachment related contexts regarding one's God. A recent study demonstrated similar results to negative cues about one's partner where greater LPP amplitudes were generated from these negative cues when attachment anxiety was high (Lathrop, Davis, & Kisley, 2015). In essence, for more anxious individuals, negative cues about one's partner or about one's God generate greater sustained attention than positive cues. These negative cues are seen as threats to a relationship that is more concerning to individuals that are higher in attachment anxiety.

Limitations

There were several limitations to this study that should be considered before interpreting the findings. These limitations could have impacted the results reported, but offer potential future directions for studies concerning religious attachment. One limitation revealed during the data collection phase was the very low response rate of participants when they were asked to come into the lab for the EEG recording. For the purposes of this study it was necessary to prescreen participants based on their level of religiosity as non-religious or low-religiosity individuals would not have been appropriate for a study regarding religious attachment. Initially, only participants scoring 4.0 of above on the *Centrality of Religiosity Scale* were contacted, however, there were very

few participants scoring in this range and collecting enough participants in the EEG recording would have been very difficult. Therefore, we expanded the religiosity criteria to include those scoring 3.0 and above on the CRS. While multiple attempts were made to contact the participants that scored moderately to highly religious on the CRS, less than half of those contacted came into the on-campus lab for the EEG recording. Furthermore, we chose to change the form of compensation for the EEG recording session from 2 points of extra credit awarded through SONA to a $20 cash payment for their participation. An analysis of the observed power of the recruited sample indicated achieved power of only .31. A priori analyses of estimated sample size to achieve sufficient power indicated we need a sample size of 44 participants based on effect sizes reported by Zayas et al. (2009). Effect sizes regarding the influence of attachment style on potential religious attachment scenarios measured by the N400 clearly are not of similar size to effect sizes in attachment styles in interpersonal attachment scenarios. With this small effect size found in the present study (R^2 = .079), a G*Power estimate of sample size needed to achieve sufficient power indicated we would need a total of 74 participants to detect an effect. Given the small effect size in this reported sample, it would be beneficial to collect a larger sample to determine if there is a true effect of attachment style on acceptance and rejection cues related to God. Regardless, these findings suggest that the effect of processing rejection cues, as measured by the N400 amplitudes, may be stronger for interpersonal relationships than for religious figures.

Effect sizes reported when we selected only cases in which the participant reported being in a relationship, however, were much larger (*e.g.* R^2 = .35 for anxiety predicting late LPP for negative words). Given this effect size and a sample of 19

participants, observed power was .82. For the multiple regression for the N400 amplitudes for negative words, sufficient power was also observed when single participants were excluded (.80). For future studies, it could be helpful to recruit only participants that report being in a relationship as this apparently increases the salience and effect of attachment relationships. However, as a caution, response rates were already quite low for this study and any further exclusion criteria could hamper data collection.

The lack of significant findings regarding attachment style predicting N400 amplitudes could potentially have been limited by the overall LPPs we observed for the different word types. For instance, brain responses for negative words were more positively deflected overall compared to nonword and positive target words. This is particularly obvious in the interaction results of Time X Word Type where negative words had more positively sustained attention allocation than positive words. What this could mean is that this greater positive deflection actually pulled the preceding N400 amplitudes (which should typically remain negative) up higher due to the need for greater processing. This can be seen in Figure 4 where the overall waveform for negative words shows higher amplitudes, especially during the last 500ms of word presentation. This greater overall amplitude influenced earlier epochs as well.

The content of the surveys that were given to participants offers another possible limitation that could be remedied in the future. In particular, the questions in the Centrality of Religiosity Scale are, in part, made up of questions regarding the public domain of religion in one's life. These types of questions are often contrasted with questions about the personal, intrinsic significance of one's religion in the private domain. In the future, it might be prudent to measure not just the importance, or centrality

of religion to one's life as in the CRS, but more specifically, to measure how intrinsically motivated they are by their religion. Thus, while the participants we collected were considered moderate to highly religious, perhaps they were motivated by the social appeal of religious practice rather than a reliance on the divine for comfort or identity as intrinsic religiosity measures might provide. If this were the case, perhaps the intrinsically religious may have different attachment-related responses to acceptance or rejection cues. We did collect data on how loving a participant viewed their God to be (*i.e.* a private-domain construct) and no significant correlations emerged with regard to ERP data or anxiety and avoidance measures. This could indicate that intrinsic religious motivations do not play a significant role outside of extrinsic motivations in how one attaches to their religious figure. However, precluding the direction of religious motivation (i.e. intrinsic vs. extrinsic) could hamper future studies in religious attachment as attachment theory posits the process to be internally motivated to gain security and proximity with important figures in our lives.

While the predicted results of this study were not found, some interesting trends relating to attachment anxiety and religious attachment were explored. Further, overall attention allocation for acceptance and rejection cues showed a difference in this moderate to highly religious sample of participants, indicative of greater processing needs to interpret negative words in the context of one's God. Future explorations into religious attachment as measured with electrophysiological measures should consider lower-than-expected response rates as it was unforeseen that so few participants would reply to requests for the EEG recording session. Finally, perhaps assessing religiosity through the domain of intrinsic religiosity may be useful as this construct might generate a sample of

individuals that use their religion in a more inward-focused fashion that could lend itself better to assessing religious attachment.

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APPENDIX

University of Colorado Colorado Springs

Institutional Review Board (IRB) for the Protection of Huma n Subjects

Date: 2/12/2015

IRB Review

IRB PROTOCOL NO.:15-115
Protocol Title: Religious Perceptions
Principal Investigator: Jennifer Poe
Faculty Advisor if Applicable: Michael Kisley
Application: New Application
Type of Review: Expedited 7
Risk Level: No more than Minimal Risk
Renewal Review Level (If changed from original approval) if Applicable: N/A No Change
This Protocol involves a Vulnerable Population: N/A (No Vulnerable Population)
Expires: 11 February 2016
*Note, if exempt: If there are no major changes in the research, protocol does not require review on a continuing basis by the IRB. In addition, the protocol may match more than one review category not listed.
Externally funded: ☒ No ☐ Yes
OSP #: Sponsor:

Thank you for submitting your Request for IRB Review. The protocol identified above has been reviewed according to the policies of this institution and the provisions of applicable federal regulations. The review category is noted above, along with the expiration date, if applicable.

Once human participant research has been approved, it is the Principal Investigator's (PI) responsibility to report any changes in research activity related to the project:

- The PI must provide the IRB with all protocol and consent form amendments and revisions.
  - The IRB must approve these changes prior to implementation.
- All advertisements recruiting study subjects must also receive prior approval by the IRB.
- The PI must promptly inform the IRB of all unanticipated serious adverse (within 24 hours). All unanticipated adverse events must be reported to the IRB within 1 week (see 45CFR46.103(b)(5). Failure to comply with these federally mandated responsibilities may result in suspension or termination of the project.
- Renew study with the IRB ***prior to expiration***.
- Notify the IRB when the study is complete

If you have any questions, please contact Research Compliance Specialist in the Office of Sponsored Programs at 719-255-3903 or irb@uccs.edu

Thank you for your concern about human subject protection issues, and good luck with your research.

Sincerely yours,

Michele Okun, PhD
IRB Reviewer