THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF BIOBEHAVIORAL HEALTH

ADRENOCORTICOL LEVELS, REACTIVITY, AND ATTUNEMENT: THE ROLE OF RELIGIOUS AND SOCIAL SUPPORT

EMILY DRAKE
Fall 2009

A thesis
submitted in partial fulfillment
of the requirements
for baccalaureate degrees
in Psychology and Biobehavioral Health
with honors in Biobehavioral Health

Reviewed and approved* by the following:

Douglas A. Granger
Professor
Thesis Supervisor

Lori A. Francis
Assistant Professor
Honors Adviser

* Signatures are on file in the Schreyer Honors College.

ABSTRACT

The present study examined associations between salivary indicators of stress responses and religious and social support using data from the Family Life Project. Main effects of religious social support, social support, mother and infant levels of cortisol, mother and infant cortisol reactivity, and mother and infant levels of α-amylase were the primary variables, and partial correlations were calculated for each of them. Dyads were split at different times into groups of high and low levels of religious social support and social support in general based on the mothers' survey responses. Analyses revealed that different levels of religious and social support have some differing effects on baseline levels of the stress indicators and on cortisol reactivity in mothers. However, due to some limitations, future study is necessary.

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INTRODUCTION

The impacts of religious support and social support on health have been topics of interest for decades. However, the use of salivary α-amylase to assess stress response is relatively new, and has not yet been used to study these topics in conjunction.

Cortisol and α-amylase

Cortisol is a hormone that is a product of activation of the hypothalamic-pituitary-adrenal (HPA) axis, and its concentrations in saliva can be used to accurately assess HPA activation by stress (Schwartz, Granger, Susman, Gunnar, & Laird, 1998).

Salivary α-amylase is an enzyme whose concentrations are correlated with plasma norepinephrine (NE) levels both at baseline and in response to stress (Chatterton et al., 1997). Since NE is produced by activation of the sympathetic nervous system (SNS), another component of the stress response, concentrations of salivary α-amylase can be used to measure SNS activity from stress. Although salivary cortisol and α-amylase are both measures of components of the stress response (HPA and SNS, respectively), they do not appear to be associated with each other in response to a challenge (Granger et al., 2006). Therefore, measuring salivary α-amylase in addition to salivary cortisol is not redundant and can allow for a better measurement of the stress response than measuring one or the other individually (Nater et al., 2006).

One study by Kivlighan and colleagues (2005) examined cortisol and α-amylase in relation to biosocial relationships during infancy. 86 mother-infant dyads participated, with 45 boy and 41 girl infants (mean age = 7.22 months). For the experimental stressors, the infants engaged in a series of tasks, while their mothers were instructed not to intervene as they watched. The variables of interest were each mother's stress responsivity, infant's stress responsivity, and the degree of attunement within the mother-infant dyad.

They measured responsivity by collecting saliva samples from both mother and infant at three times. The first sample was taken before the task (baseline), then the second was taken 20 minutes after the infant's peak arousal, and the final sample was taken 40 minutes after the infant's peak arousal. The samples were then assayed to measure α-amylase and cortisol levels.

Results of this study showed that mothers exhibited α-amylase reactivity, but did not exhibit cortisol reactivity in response to the tasks. The infants, however, showed no α-amylase reactivity, but did show cortisol reactivity in response to the tasks. Finally, they found that mothers and sons showed corresponding levels of α-amylase or cortisol baseline levels, but that this effect was not present for mothers and daughters.

Psychobiology of stress

When an individual is exposed to acute psychological stressors, his or her HPA axis activates. This results in a hypothalamic response that causes the release of corticotrophin-releasing hormone, which causes the anterior pituitary gland to release adrenocorticotropic hormone. This hormone then goes to adrenal gland and results in the release of cortisol by the adrenal cortex into the bloodstream. This process takes minutes, with cortisol response peaking, on average, 20-40 minutes from the stressor's onset, then returning to baseline levels 40-60 minutes from the stressor's end (Dickerson & Kemeny, 2004).

Similarly, a variety of stressors can activate the SNS, which is one of the two components of the autonomic nervous system. When a perceived threat occurs, the SNS fibers release norepinephrine, which triggers the adrenal medulla to release epinephrine into the bloodstream. This process, compared to cortisol release by the HPA axis, is very quick, taking only seconds (Kemeny, 2003).

Attunement

Attunement between mothers and infants refers to each adapting to each others' behavioral and affective states, creating synchrony in the pair. Attunement has been recognized in the field of developmental psychobiology as an important aspect of the early caregiving environment (Hofer, 2006). Nachmias and colleagues (1996) found that toddlers with inhibited behavior and insecure attachment to their mothers show elevated cortisol levels when encountering novelty. When an infant and mother have synchronous behavioral exchanges, it is thought that the infant has a foundation upon which self-regulation can develop (Feldman, Greenbaum, & Yirmiya, 1999). In fact, the mother-infant relationship appears to mold the way that children respond to their environment both biologically and psychologically, even into adulthood (Hofer, 2006).

Stress & immune function

Exposure to stressors can both decrease and increase certain immune functions. Wound healing slows, circulating lymphocyte levels decrease, and lymphocyte proliferation in response to a foreign substance is reduced in response to stressful life experiences (Ader, Felten, & Cohen, 2001). Furthermore, the SNS fibers that enter into immune organs alter how immune cells there function. Cortisol released by HPA activation can also suppress immune functioning by preventing the production of certain types of cytokines. Activation of the stress response can also enhance the inflammation response, which allows the body to better fight a pathogen. However, such a response in the absence of a pathogen, triggered instead by a psychological stressor, is inappropriate and is related to cardiovascular disease and autoimmune diseases (Kemeny, 2003).

Glaser and colleagues (1987) conducted a year-long study on the association between stress, immune function, and health. Various immune response indicators were measured to assess immune response changes in relation to changes in academic stress in first-year medical students. These included antibody titers to latent Epstein-Barr virus's virus capsid antigen, peripheral blood lymphocytes' production of interferons, leukocyte migration inhibition factor activity, and specific T-cell killing, in response to latent Epstein-Barr virus *in vitro*. As possible mechanisms for any observed changes in cellular immunity, intracellular and plasma levels of cyclic AMP in peripheral blood lymphocytes were also measured, as well as nutritional markers.

Self-report data consisted of amount of sleep during the previous 72 hours, a measure of distress during the previous week, medication and alcohol use during the previous week, weight changes during the previous week, and disease symptoms and subsequent interference with daily activities since their last sample.

22 men and 18 women (mean age = 22.2) participated in exchange for their immunological data feedback. Both immunological and self-report data made up the stress sample data, which were collected at six points of the academic year. The baseline samples were collected three times during the year, each time occurring one month before

an examination block. The examination samples were collected during the examination block.

They found changes in antibody titers to latent Epstein-Barr virus's virus capsid antigen, decreased peripheral blood lymphocytes' production of interferons, changes in leukocyte migration inhibition factor activity, and down-regulated specific T-cell killing, related to academic stress. They also found that self-reported interference with daily activities caused by acute illness was associated with examinations and decreased immunity. Furthermore, they determined that these changes were not likely due to any nutritional deficiencies. These data all suggest a link between stress, immune function, and health.

In another study on medical students, Kiecolt-Glaser and colleagues (1984) examined the association between a naturally occurring stressor and immune response. Immunologic measures were measured through blood samples and included natural killer cell activity, and plasma IgA, IgG, IgM, C-reactive protein, and salivary IgA were measured to assess the humoral immunologic component.

Self-report data consisted of an inventory of symptoms and the level of discomfort each symptom caused during the previous week, an assessment of life changes occurring during the previous year (divided into high and low groups), and a measure of loneliness (divided into high and low groups)

49 males and 26 females (mean age = 23) participated in exchange for their immunological data feedback. The immunological and self-report data were collected twice each. The baseline sample was collected one month after an examination and one

month before another examination, and the examination sample was collected on the first day of the students' final exam week.

They found decreased natural killer cell activity from the baseline sample to the examination sample, indicating again that the immune system is negatively affected by stress. Furthermore, they found that stressful life events were associated with decreased natural killer cell activity, suggesting that a greater number of stressful life events has a negative impact on an individual's health. They also found that loneliness was associated with decreased natural killer cell activity, and that this effect is likely independent of distress. Plasma IgA increased from the baseline sample to the examination sample, indicating changes in the humoral immunologic component due to stress, although plasma IgG and IgM, salivary IgA, and C-reactive protein failed to show significant change.

Stress, social support, & health care costs

To examine the relationship between occupational stress, social support, and health care costs, Manning and colleagues (1996) conducted a study among a sample of manufacturing and health insurance company workers. Health care costs were obtained from insurers during from a period from one year before the survey to one year after the survey. They were measured in categories of doctor's office costs, inpatient hospital costs, outpatient hospital costs, prescription drugs costs, and miscellaneous costs.

Stress-related variables included work events, subjective perceptions of strain, and social support. They were obtained through self-reported surveys, which were completed by the participants once, during work hours at their jobs.

85 men and 175 women (mean age = 36.88) participated on a voluntary basis as a part of a larger study. 128 of the individuals were managers with supervisory responsibility, and 132 of the individuals had no supervisory responsibility.

Findings of their study suggested that both main effects of stress and social support, as well as their interaction, accounted for a significant proportion of the variance in doctor's office costs, outpatient hospital costs, and miscellaneous costs. The general, overall finding of the study was that higher stress was positively associated with health care costs, and that higher social support appeared to be negatively associated with health care costs.

Religious support & longevity

Ironson and colleagues (2002) conducted a study to test their measure of spirituality and religiousness, the Ironson-Woods Spirituality/Religiousness Index, among people with HIV/AIDS. One of the questions of their study was whether health was related to spirituality/religiousness, specifically longer survival with AIDS, and another was whether social support might mediate this relationship. Each participant was put into one of two groups. 79 individuals were in the group of long-term survivors of AIDS, and 200 were HIV-seropositive individuals.

To measure spirituality/religiosity, they used shorter version of the Ironson-Woods Spirituality/Religiousness Index that included questions about an individual's spiritual or religious sense of peace, faith in God, religious behavior, and compassionate view of others. Various components of other measures of religiousness were also used, partially to validate the Ironson-Woods Spirituality/Religiousness Index.

Other self-reported psychosocial measures included perceived stress, anxiety, depression, hopelessness, optimism, social support, and hostility. Behaviors of interest were safe sex, adherence to prescriptions, telling partner HIV status, smoking, alcohol use, and helping others with HIV. Finally, cortisol was measured using individuals' urine samples that were collected by the individuals during the same 15 hour time period.

In their results, they found that religious behavior, faith, and compassion for others were significantly higher in the group of long survivors of AIDS than in the HIV-positive control group. They also found that lower levels of cortisol were strongly associated with having a sense of peace. These findings suggest that both public and private aspects of religion and spirituality are associated with better health. Another of their important findings was that public and private aspects of religion and spirituality both relate equally to health. This shows that social support is not the only driving force behind the effects of religion and spirituality on health.

Of the mediators explored to explain how religiousness/spirituality could affect health in this population, they found that cortisol, helping others with HIV, and optimism were related to both long survival status and religiousness/spirituality. Of these three, cortisol and helping others with HIV showed the strongest support.

Present Study

The present study examines how religious support and social support are related to cortisol and α-amylase activity in mothers and their infants. The primary variables for the study are infant and mother baseline cortisol and α-amylase levels, infant and mother cortisol reactivity, religious support, and social support. Prior studies have not yet examined how α-amylase relates to religious social support.

The first hypothesis of the study is that attunement will be greater in mother-infant dyads with higher levels of religious social support and social support, compared to lower levels of each. The second hypothesis is that this effect will be stronger for higher levels of religious social support than for higher levels of social support in general. The final hypothesis is that cortisol reactivity will be greater in groups with low levels of religious social support and social support in general.

METHODS

Participants

Data from this project come from the Family Life Project, which was developed to study children in families with high levels of poverty. These families were from either the rural South of eastern North Carolina or from northern Appalachia in central Pennsylvania. The infants were, on average, about 7 months old at the time (range = 5.0-10.0 months, M = 7.5 months). The mothers were about 26 years old (range = 14.7-58.2 years, M = 26.5 years). Based on the mother's race, the sample was 59% White and 41% African-American. Infants were 48% male and 52% female. 48% of the mothers were married and living with their spouses, while 52% were either single, not living with their spouse, divorced, separated, or widowed.

Procedures

During a home visit, mothers completed questionnaires regarding family demographics, income, social support, and religious support (Blair, Granger, & Kivlighan, 2008). In addition to these questionnaires, they were asked to participate in a free-play interaction with their infant (Cox, Paley, Burchinal, & Payne, 1999; National Institute of Child Health & Human Development, 1999). Using a given set of toys, mothers were asked to play with the infant the way that they typically would if they found some free time at some point in the day.

Next, three tasks were performed that have been previously validated to provoke a stress response (e.g., Buss & Goldsmith, 1998; Kochanska, Tjebkes, & Forman, 1998; Stifter & Braungart, 1995). Throughout these tasks, the infant was seated in an infant walker seat. The tasks included a mask presentation challenge, then a barrier challenge, and lastly, an arm restraint challenge task.

In the mask presentation challenge task, the experimenter presented four unusual masks in turn to the infant by wearing each of them for 10 seconds at a time and moving from side to side slowly in front of the infant while calling the infant's name.

In the barrier challenge task, the infant was given a desirable toy to play with for 30 seconds. After this period, the toy was taken away and put behind a clear plastic barrier that was out of the infant's reach for 30 seconds. The toy was then returned to the child, and then the whole procedure was repeated two more times, for a total of three rounds.

Finally, in the arm restraint challenge task, the mother was required to watch from out of the child's range of vision, but was instructed not to intervene, although she was informed that she had the option to end the task at any point. The experimenter then bent down beside the infant and restrained the infant's arms gently until either 2 minutes or 20 seconds of hard crying had passed.

HPA stress reactivity was determined by two saliva samples. The first was collected pretask to establish a baseline (this sample was also used to measure baseline SNS), and the second was collected 20 minutes after peak arousal occurred. "Peak arousal" was defined by specific guidelines of the experimental protocol and was determined by the data collectors. For most of the infants, peak arousal occurred after the emotional challenge task. However, if the infant reacted with hard crying during any of the tasks for 20 seconds and the infant's arousal was determined to be too high to complete the tasks, this was defined as that infant's peak arousal instead. Across the sample, time of day of the saliva collection varied because of uncontrollable characteristics such as economic disadvantage, rurality, and single parent households, which required a degree of flexibility. Therefore, time of day was controlled for in all cortisol and α-amylase analyses.

Either cotton or hydrocellulose absorbent material was used to collect unstimulated whole saliva, and the sample was expressed into 2-ml cryogenic storage vials either using a needleless syringe (cotton) or by centrifugation (hydrocellulose). These different collection techniques have been found by two prior studies to be equivalent in cortisol concentrations (Granger et al., 2007; Harmon, Granger, Hibel & Rumyantseva, 2007).

A questionnaire was completed by the mothers regarding the health and state of the infant, as well as any medications taken by the infant during the past 48 hours. Because children who had taken acetaminophen showed lower levels of cortisol at 20 minutes after peak arousal compared to those who had not taken it (Hibel, Granger, Kivlighan, Blair, & the Family Life Project Investigators, 2006), consumption of acetaminophen was controlled for in all further analyses.

To properly store and transport the saliva samples, they were placed on ice immediately after collection, then stored frozen (-20^{o}C) at the interviewers' homes. They were then placed on dry ice and shipped to the Behavioral Endocrinology Laboratory at Pennsylvania State University overnight, where they were stored frozen (-80^{o}C) until assay. On the day the samples were to be tested, they were brought to room temperature, then centrifuged for 15 minutes at 3,000 RPM, and finally had the clear top-phase of the sample pipetted by robot into the appropriate test wells.

Measures

Salivary cortisol. A highly sensitive enzyme immunoassay U.S. Food and Drug Administration 510k cleared for use as a diagnostic measure of adrenal function *in vitro* was used to assay all samples for salivary cortisol (Salimetrics, State College, Pennsylvania). For the test, 25 µl of saliva was used (for singlet determinations), there was a 0.007 to 1.8 µl/dl range of sensitivity, and there were average intra- and interassay coefficients of variation of less than 10% and 15%, respectively. Samples were all assayed in duplicate. The repeat testing criterion was a greater than 20% variation between duplicates, and analyses all used the average of the duplicates.

Income-to-need ratio. Income from all sources and income from other members of the household were reported by the primary caregivers. To compute an income-to-need ratio, this number was used as an estimate of the total income of the household and was then divided by the 2004 federal poverty threshold, adjusted for number of persons in the home. Family income at or below the poverty level, adjusted for family size, was indicated by an income-to-need ratio of 1.00 or lower.

Religious support. To assess religious support of the participants, the Religious Social Support Scale (RSS) was used. The RSS is a measure that was created to assess social support in the context of religion. The measure consists of 21 items and takes approximately 5 minutes for the mother to complete. It measures three types of religious support: God support (e.g., "God cares about my life and situation."), congregational support (e.g., "I can turn to others in my congregation for advice when I have problems."), and clergy support (e.g., "My church leaders give me the sense that I belong"). Each item was to be responded to using a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree," with an "NA" response also provided as an option.

Social support. The Questionnaire of Social Support (QSS) was used to assess social support of the participants. The QSS is a measure that was created to assess the satisfaction with social support relating to family, friendship, community involvement, and intimate relationships. It consists of 16 items and, like the RSS, takes approximately 5 minutes for the mother to complete. It measures four types of social support satisfaction: family (e.g., "How satisfied are you with the amount of visiting you do in person with your parents?"), friendship (e.g., "How satisfied are you with the number of times you talk on the phone with your friends during a typical week?"), community involvement (e.g., "How satisfied are you with your involvement in your neighborhood?"), and intimate relationships (e.g., "If you have a relationship with a spouse or partner, how satisfied are you with this situation?"). It also included one global satisfaction item ("When you take everything into consideration—your child, your adult life, etc.—how would you describe your current life situation?"). Each item was to be responded to using a 4-point Likert scale that ranged from "Very Dissatisfied (I wish things were very different)" to "Very Satisfied (I'm really pleased)," with an "NA" response also provided as an option.

Missing data. In data collected, 1,204 of the 1,292 families recruited for participation in the study were present. Saliva samples were missing from 54 of the participants, so they were not included in any further analyses. Out of the 1,150 remaining participants, 5% or fewer were missing values for variables other than cortisol levels.

RESULTS

Analytic Strategy

RSS and QSS differences in levels of cortisol and α-amylase in mothers and their infants were tested using partial correlations that used the mother's age; infant's age, gender, and race; income/needs ratio; and time of day as control variables. RSS and QSS were then split by their mean values, and the same partial correlations were repeated, first using the non-split measure as a variable, then as a control variable for the split variable. Directional hypotheses used one-tail tests ($p<0.05$). Prior to testing, log transformations were performed on raw data distributions for stress indicators with skew statistic >1 (mother and infant baseline cortisol and α-amylase levels, and cortisol reactivity). Furthermore, in all analyses using cortisol reactivity, baseline levels of cortisol were controlled for. To assess the RSS and QSS measures, reverse-coded questions were accounted for by transposing response values accordingly, and then the mean of each measure was calculated, excluding "N/A" responses. As the raw data distribution for the RSS measure had a skew statistic >1, a square transformation was performed on it to reduce this statistic.

RSS and QSS Correlations with Stress Indicators

Before splitting RSS and QSS into groups, there was a weak positive correlation between mother and infant's baseline cortisol levels, $r=0.36$, $p<0.01$ (See Table 1). However, after splitting RSS into groups, there was no longer a significant correlation for the low RSS group ($r=0.14$, *ns*) but there was a moderate correlation for the high RSS group, $r=0.43$, $p<0.01$ (See Tables 2-3). When QSS was split into groups, both groups maintained weak positive correlations (*r*=0.28, *p*<0.05 for the low QSS group; *r*=0.40, *p*<0.05 for the high QSS group) (See Tables 4-5). This effect remained with QSS as a control variable for the RSS groups (*r*=0.15, *ns* for the low RSS group; *r*=.45, *p*<0.01 for the high RSS group) (See Tables 6-7) and with RSS as a control variable for the QSS groups (*r*=0.29, *p*<0.05 for the low QSS group; *r*=0.39, *p*<0.01 for the high QSS group) (See Tables 8-9).

Prior to splitting RSS and QSS into groups, there was a moderate negative correlation between infant cortisol baseline level and reactivity, *r*=-0.46, *p*<0.01. After splitting RSS and QSS into groups, there was little change in this association (*r*=-0.45, *p*<0.01 for the low RSS group; *r*=-0.47, *p*<0.01 for the high RSS group; *r*=-0.57, *p*<0.01for the high QSS group), except that the correlation weakened for the low QSS group, *r*=-0.24, *p*<0.05. This effect remained with QSS as a control variable for the RSS groups (*r*=-0.45, *p*<0.01 for the low RSS group; *r*=-0.48, *p*<0.01 for the high RSS group) and with RSS as a control variable for the QSS groups (*r*=-0.23, *p*<0.05 for the low QSS group; *r*=-0.56, *p*<0.01 for the high QSS group).

Before splitting RSS and QSS into groups, there was a very weak negative correlation between infant baseline cortisol and α-amylase levels, *r*=-0.15, *p*<0.05. After splitting RSS and QSS into groups, however, the only significant correlation between these two variables remained in the low RSS group with a weak correlation, *r*=-0.27, *p*<0.05. The high RSS group and both QSS groups had no significant associations (*r*=-0.13, *ns* for the high RSS group; *r*=-0.10, *ns* for the low QSS group; *r*=-0.17, *ns* for the high QSS group). This effect was the same once QSS and RSS were used as control variables for the other's groups (*r*=-0.27, *p*<0.05 for the low RSS group; *r*=-0.13, *ns* for the high RSS group; $r=-0.11$, *ns* for the low QSS group; $r=-0.16$, *ns* for the high QSS group).

Prior to splitting RSS and QSS into groups, there was a weak negative correlation between mother cortisol baseline level and reactivity, $r=-0.25$, $p<0.01$. Once RSS and QSS were split into groups, there was no longer a significant correlation between these variables in the high RSS group ($r=-0.17$, *ns*), only in the low RSS, low QSS, and high QSS groups ($r=-0.39$, $p<0.01$; $r=-0.34$, $p<0.01$; $r=-0.22$, $p<0.05$, respectively). However, when RSS controlled for QSS groups, then QSS controlled for RSS groups, all groups once again had weak negative correlations ($r=-0.39$, $p<0.01$ for the low RSS group; $r=-0.20$, $p<0.05$ for the high RSS group, $r=-0.34$, $p<0.01$ for the low QSS group; $r=-0.22$, $p<0.05$ for the high QSS group).

Although there was no significant correlation between infant baseline α-amylase and mother cortisol reactivity before splitting RSS and QSS into groups ($r=-0.10$, *ns*), there was a weak negative correlation in only the high RSS group after splitting RSS, $r=-0.22$, $p<0.05$. After controlling for QSS, the correlation remained, $r=-0.22$, $p<0.05$.

Similarly, although there was no significant correlation between mother baseline α-amylase and cortisol reactivity before splitting RSS and QSS into groups ($r=0.05$, *ns*), there was a weak positive association between the two variables in only the low RSS group after splitting RSS into groups, $r=0.24$, $p<0.05$. After controlling for QSS, the correlation remained, $r=0.24$, $p<0.05$.

RSS mean and mother cortisol reactivity also showed no significant correlation before splitting QSS into groups, $r=0.31$, *ns*. However, after QSS was split into groups, the high RSS group showed a weak negative correlation between the two variables, r=-0.30, $p<0.05$.

QSS mean and mother baseline cortisol were very weakly positively associated before splitting RSS into groups, r=0.18, $p<0.05$. However, after RSS was split into groups, there was no longer a significant correlation for either group (r =0.20, *ns* for the low RSS group; r=0.15, *ns* for the high RSS group).

Mother and infant baseline α-amylase were weakly positively correlated before RSS and QSS were split into groups, r=0.26, $p<0.01$. After splitting them into groups, this effect remained for all groups (r=0.25, $p<0.05$ for the low RSS group; r=0.28, $p<0.01$ for the high RSS group; r=0.33, $p<0.01$ for the low QSS group), with the exception of the high QSS group, which had no significant association, r=0.18, *ns*. After controlling for QSS in the RSS groups and then controlling for RSS in the QSS groups, however, positive correlations were once again significant for all groups (r=0.25, $p<0.05$ for the low RSS group; r=0.28, $p<0.01$ for the high RSS group; r=0.35, $p<0.01$ for the low QSS group; r=0.21, $p<0.05$ for the high QSS group).

Before splitting QSS into groups, there was a very weak negative correlation between mean RSS and infant baseline α-amylase, r=-0.18, $p<0.05$. After splitting QSS into groups, however, there was only a weak negative correlation between the two variables in the high QSS group (r=-0.22, $p<0.05$), and not in the low QSS group, r=-0.07, *ns*.

Finally, there was a weak positive correlation between mean QSS and mean RSS, r=0.24, $p<0.01$.

Table 1

Means (Cortisol in μg/dL, α-amylase in U/mL), SDs, and Partial Correlations of the Study's Primary Variables for Mothers and Infants (Controlling for Mother's Age; Infant's Age, Gender, and Race; Income/Needs Ratio; and Time of Day)

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. Infant baseline cortisol	0.23	0.32	—							
2. Mother baseline cortisol	0.23	0.32	.36**	—						
3. Infant cortisol reactivity	0.49	1.52	–.46**	–.15*	—					
4. Mother cortisol reactivity	–0.21	0.3	–.01	–.25**	–.00	—				
5. Infant baseline α-amylase	41.24	34.73	–.15*	–.01	.18*	–.10	—			
6. Mother baseline α-amylase	75.03	72.96	.11	.08	–.01	.05	.26**	—		
7. Religious Social Support	4.31	0.88	.03	.09	–.01	–.12	–.18*	.14*	—	
8. Social Support	3.45	0.5	–.04	.18*	.02	.03	–.03	–.02	.24**	—

* $p < 0.05$

** $p < 0.01$

Table 2

Partial Correlations of the Study's Primary Variables for Mothers and Infants in the Low Religious Social Support Group (Controlling for Mother's Age; Infant's Age, Gender, and Race; Income/Needs Ratio; and Time of Day)

Variable	1	2	3	4	5	6	7
1. Infant baseline cortisol level	—						
2. Mother baseline cortisol level	.14	—					
3. Infant cortisol reactivity	–.45**	–.06	—				
4. Mother cortisol reactivity	.01	–.39**	.00	—			
5. Infant baseline α-amylase	–.27*	–.10	.12	.09	—		
6. Mother baseline α-amylase	.03	–.04	.03	.24*	.25*	—	
7. Social Support	–.03	.20	.11	–.06	.03	.05	—

* $p < 0.05$

** $p < 0.01$

Table 3

Partial Correlations of the Study's Primary Variables for Mothers and Infants in the High Religious Social Support Group (Controlling for Mother's Age; Infant's Age, Gender, and Race; Income/Needs Ratio; and Time of Day)

Variable	1	2	3	4	5	6	7
1. Infant baseline cortisol level	—						
2. Mother baseline cortisol level	.43**	—					
3. Infant cortisol reactivity	–.47**	–.18	—				
4. Mother cortisol reactivity	–.01	–.17	–.02	—			
5. Infant baseline α-amylase	–.13	.04	.17	–.22*	—		
6. Mother baseline α-amylase	.12	.12	.03	–.01	.28**	—	
7. Social Support	–.05	.15	–.02	.12	–.03	–.09	—

* $p < 0.05$

** $p < 0.01$

Table 4

Partial Correlations of the Study's Primary Variables for Mothers and Infants in the Low Social Support Group (Controlling for Mother's Age; Infant's Age, Gender, and Race; Income/Needs Ratio; and Time of Day)

Variable	1	2	3	4	5	6	7
1. Infant baseline cortisol level	—						
2. Mother baseline cortisol level	.28*	—					
3. Infant cortisol reactivity	–.24*	–.12	—				
4. Mother cortisol reactivity	–.15	–.34**	–.20	—			
5. Infant baseline α-amylase	–.10	–.03	.06	.08	—		
6. Mother baseline α-amylase	.02	.14	–.05	–.12	.33**	—	
7. Religious Social Support	–.08	.05	.19	–.30*	–.07	.19	—

* $p < 0.05$

** $p < 0.01$

Table 5

Partial Correlations of the Study's Primary Variables for Mothers and Infants in the High Social Support Group (Controlling for Mother's Age; Infant's Age, Gender, and Race; Income/Needs Ratio; and Time of Day)

Variable	1	2	3	4	5	6	7
1. Infant baseline cortisol level	—						
2. Mother baseline cortisol level	.40**	—					
3. Infant cortisol reactivity	–.57**	–.16	—				
4. Mother cortisol reactivity	.06	–.22*	.06	—			
5. Infant baseline α-amylase	–.17	.04	.26*	–.15	—		
6. Mother baseline α-amylase	.17	.08	.03	.15	.18	—	
7. Religious Social Support	.09	.07	–.16	–.06	–.22*	.12	—

* $p < 0.05$

** $p < 0.01$

Table 6

Partial Correlations of the Study's Primary Variables for Mothers and Infants in the Low Religious Social Support Group, Controlling for Social Support (Also Controlling for Mother's Age; Infant's Age, Gender, and Race; Income/Needs Ratio; and Time of Day)

Variable	1	2	3	4	5	6
1. Infant baseline cortisol level	__					
2. Mother baseline cortisol level	.15	__				
3. Infant cortisol reactivity	–.45**	–.09	__			
4. Mother cortisol reactivity	.01	–.39**	.01	__		
5. Infant baseline α-amylase	–.27*	–.10	.12	.09	__	
6. Mother baseline α-amylase	.03	–.05	.03	.24*	.25*	__

* $p < 0.05$

** $p < 0.01$

Table 7

Partial Correlations of the Study's Primary Variables for Mothers and Infants in the High Religious Social Support Group, Controlling for Social Support (Also Controlling for Mother's Age; Infant's Age, Gender, and Race; Income/Needs Ratio; and Time of Day)

Variable	1	2	3	4	5	6
1. Infant baseline cortisol level	__					
2. Mother baseline cortisol level	.45**	__				
3. Infant cortisol reactivity	–.47**	–.18	__			
4. Mother cortisol reactivity	–.01	–.20*	–.02	__		
5. Infant baseline α-amylase	–.13	.04	.17	–.22*	__	
6. Mother baseline α-amylase	.12	.13	.03	.00	.28**	__

* $p < 0.05$
** $p < 0.01$

Table 8

Partial Correlations of the Study's Primary Variables for Mothers and Infants in the Low QSS Group, Controlling for Religious Social Support (Also Controlling for Mother's Age; Infant's Age, Gender, and Race; Income/Needs Ratio; and Time of Day)

Variable	1	2	3	4	5	6
1. Infant baseline cortisol level	__					
2. Mother baseline cortisol level	.29*	__				
3. Infant cortisol reactivity	–.23*	–.13	__			
4. Mother cortisol reactivity	–.19	–.34**	–.15	__		
5. Infant baseline α-amylase	–.11	–.03	.08	.06	__	
6. Mother baseline α-amylase	.03	.13	–.09	–.06	.35**	__

* $p < 0.05$

** $p < 0.01$

Table 9

Partial Correlations of the Study's Primary Variables for Mothers and Infants in the High Social Support Group, Controlling for Religious Social Support (Also Controlling for Mother's Age; Infant's Age, Gender, and Race; Income/Needs Ratio; and Time of Day)

Variable	1	2	3	4	5	6
1. Infant baseline cortisol level	__					
2. Mother baseline cortisol level	.39**	__				
3. Infant cortisol reactivity	–.56**	–.11	__			
4. Mother cortisol reactivity	.07	–.22*	.05	__		
5. Infant baseline sAA	–.16	.06	.23*	–.17	__	
6. Mother baseline sAA	.16	.07	.05	.15	.21*	__

* $p < 0.05$

** $p < 0.01$

DISCUSSION

In a sample of mothers and their infants coming from rural families with high levels of poverty, several relationships were observed between levels of cortisol and α-amylase and high and low levels of RSS and QSS. It was found that baseline cortisol levels of mother-infant dyads were weakly correlated overall, but that when RSS was divided into high and low groups, there was no longer this association in the low RSS group, but the high RSS group's association was stronger, and QSS could not account for this effect. This suggests that higher levels of religious social support increase attunement between mother and infant baseline cortisol levels. This provides partial support for our first hypothesis that attunement would be greater in mother-infant dyads with higher levels of religious social support and social support in general, in that this effect was found, but only for religious social support. However, this hypothesis was not supported by cortisol reactivity, where no associations were found for any groups. When baseline α-amylase levels were examined, there was a weak positive correlation between mother and infant levels. This did not change when RSS was split into groups, but when QSS was split, there was no longer this association in the high QSS group. When RSS was used to control for QSS, however, the weak positive correlation was once again present. This does not support the first hypothesis, either. Because the first hypothesis was supported only by the finding that mother-infant attunement of baseline cortisol levels increased with higher levels of RSS, it appears that the second hypothesis, which is that the effect of the first hypothesis would be stronger for religious social support than for social support in general, is supported only where the first hypothesis is also supported. For the third hypothesis, which was that cortisol reactivity would be greater in groups with low levels of religious social support and social support in general, no evidence was found among infants, where no associations were found between cortisol reactivity and levels of RSS or QSS. Among mothers, however, although there was no main effect between cortisol reactivity and levels of RSS or QSS, the high QSS group showed a weak negative association between cortisol reactivity and RSS mean. This may suggest that, for those with high social support in general, religious social support can decrease cortisol reactivity. This only partially supports the third hypothesis though, due to the absence of main effects and the fact that the association was found in high QSS groups, but not high RSS groups. Several other findings that were unrelated to this study's hypotheses were also found. One was a very weak correlation between RSS mean and infant baseline α-amylase before splitting QSS into groups, but no significant correlation for the low QSS group and a weak negative correlation for the high QSS group. This demonstrates that RSS was only correlated with α-amylase when QSS was also high.

Because this is the first study to examine α-amylase in conjunction with religious social support, its results cannot be compared to the literature. However, the findings regarding cortisol and religious and social support mostly seem to support the literature. Relating to Kiecolt-Glaser and colleagues' (1984) study with medical students, Manning and colleagues' (1996) study on employees, and Ironson and colleagues' (2002) study on persons with AIDS or HIV, the current study found that, among the mothers with high social support in general, higher religious social support was associated with lower levels of cortisol reactivity. However, higher levels of social support were actually related to higher maternal baseline cortisol levels, which would oppose the findings in the literature.

Possible explanations for this discrepancy could be that Kiecolt-Glaser and colleagues' and Manning and colleagues' (1996) studies used samples on medical students and employees, respectively, whereas the present study used a sample of low-income mothers. There could be inherent differences in baseline stress levels between those stressed by academics or occupation and those stressed by their financial situation and raising an infant. Sleep deprivation could also be a significant factor for new mothers. In terms of the social support factor, maybe mothers with lower levels of social support were relieved to have the researchers come to their homes, so that their stress levels decreased in anticipation of the company, whereas those with higher levels of social support may have viewed the visit with neutrality or even as a hassle, maintaining or increasing their stress levels. In relation to the study by Ironson and colleagues (2002) in particular, several of the current study's findings support their findings. One is that baseline cortisol levels of the mother-infant dyads were more strongly attuned in those with higher levels of religious social support, even after controlling for social support in general. It supports their finding that the social support cannot sufficiently explain the effect of religious social support, and that there may be a more private component of religion that is beneficial to the stress response and health, which social support does not have. Another is that there was some association between higher levels of religious social support and lower levels of both maternal cortisol reactivity and infant baseline α-amylase in the groups with higher social support in general. These two associations suggest that religious social support only has a beneficial effect on maternal cortisol or infant baseline α-amylase when there is already high generic social support.

Applied implications

Although no associations were found between cortisol reactivity or baseline α-amylase levels, the finding that higher levels of religious social support increase attunement between mother and infant baseline cortisol levels still implies that religious social support may help to provide a basis for infants to develop self-regulation. As the only type of social support found to affect attunement was religious social support, it appears that this type of support differs from social support in general in a way that could affect health. Because the only effect of religious social support on cortisol reactivity was found in mothers who had high social support in general, it may be the case that religious social support has a positive impact on cortisol reactivity only in conjunction with social support. Taken altogether, the results of this study's hypotheses suggest that religious social support may benefit the development of infants by increasing attunement in baseline cortisol levels, and that it may benefit mothers who also have high social support by decreasing their cortisol reactivity.

These findings can be applied to the public by encouraging religious organizations to reach out to their communities more. Some widely known examples of community organizations with a religious base are Alcoholics Anonymous and Boy Scouts of America. These groups have no prerequisite of religion, but they have religious foundations. An idea that could help this study's population is that churches could offer free or low-cost childcare to families with low income while hosting a dinner for the parents. This would show the families that the religion cares about them and about their needs, while providing a social atmosphere. In time, the family may become more involved with the religious organization and gain even more benefit, but even if this does not occur as the end result, this childcare and dinner would still provide a religious network of social support that would help these families to know that people care about them.

Theoretical implications

This study reemphasizes how behavior, biology, and health are all related. It suggests that, if a mother's behavior seeks less religious social support, her attunement with her baby may not be as strong, and her cortisol reactivity will be greater. Her child may then not adjust as well growing up due to deficient attunement in infancy, which could lead both her and her child to further stress, which could negatively impact the health of both of them, preventing them from seeking the support that they lacked to begin with. This is the vicious circle possibility. The more positive possibility is that a mother seeks more religious social support, her attunement with her baby is stronger, and her cortisol reactivity is lower. Her child may then adjust well growing up, thanks to stronger attunement in infancy, and nothing will prevent either of them from continuing to pursue their source of their support.

Limitations and future directions

A limitation of this study is that saliva samples were collected at baseline, then at 20 minutes after the stressful tasks. However, α-amylase levels peak more rapidly, so these collection times could not accurately measure α-amylase reactivity. Another limitation is that a better measure would be needed to elicit a stress response from the mother and infant at the same time, rather than just the infant. The mothers likely realized that the researchers had good intentions and that their infants were in no harm, and therefore had no increase in cortisol. Possibly, the decrease in their cortisol levels could be due to the fact that they knew that someone else was "in charge" of their infant, so this actually decreased their stress levels. Another possibility is that the arrival of the experimenter actually functioned as social support for those who reported low social support, which would also alter their stress levels. Finally, the low-income status and rurality of the population makes it impossible to generalize associations found in this study.

Although further research and analyses are needed to assess the relationships between cortisol and α-amylase responses to stress in mothers and infants based on religious social support and social support in general, this study suggests several possible associations. It appears that religious social support, sometimes independently of social support in general, may benefit baseline cortisol attunement between mothers and their infants, and may also benefit mothers' cortisol reactivity. Future studies hoping to examine α-amylase reactivity should be careful to sample saliva in a timely manner, so that it can be accurately assessed along with cortisol reactivity. Fixing the issue of accurate detection of mother-infant attunement is not as simple, unfortunately. Clearly, it would be unethical to make the mother truly believe that her baby is in danger, so different alternatives must be explored if the measurements are to occur by experiment. Although a longitudinal study would be unable to assess reactivity to an acute stressor, it would be able to measure changes in cortisol and α-amylase levels over time, and could match these changes with the real stressors of everyday life without attempting to manufacture a response.

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ACADEMIC VITA of Emily S. Drake

Emily S. Drake
724 S. Pugh Street
State College, PA, 16801
esd5004@psu.edu

Education:

Bachelor of Science Degree in Psychology, Penn State University, Fall 2009
Bachelor of Science Degree in Biobehavioral Health, Penn State University, Fall 2009
Honors in Biobehavioral Health
Thesis Title: Adrenocorticol Levels, Reactivity, and Attunement: The Role of Religious and Social Support
Thesis Supervisor: Douglas A. Granger, Ph.D.

Experience:

Data Entry for Hospitality Market Intelligence
Research Assistant for the Pennsylvania Housing Research Center

Awards:

Dean's List

Activities:

Director of Grace Notes a cappella group
Member of Pennharmonics a cappella group
Participant in Relay for Life
Participant in THON
Volunteer with Penn State Student Red Cross Club
Member of Penn State Student Chapter of the National Association of Home Builders