HORMONAL RESPONSE TO PARTNER EXPOSURE IN FEMALE-FEMALE, FEMALE-MALE, AND MALE-MALE ROMANTIC PARTNERSHIPS

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AUTHOR NOTE

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Abstract

Love and affection have long been the subjects of human fascination. We posit that these feelings of love and affection are the cumulative manifestations of biological responses to prospective and current romantic partners. Such biological responses are linked especially to coordination of the hormone cortisol. Feelings of love and affection do not limit themselves to opposite-sex romantic partner pairs; they extend to female-female and male-male partner pairings. We assert that biological responses to romantic partner exposure should be similar amongst individuals of the same biological sex, regardless of the sex of their partner. Previous research shows that romantic partners display synchrony in their cortisol responses, or adrenocortical attunement. The focus of this study is on cortisol responses in individuals in response to partner exposure, measured in salivary samples taken at and around the time of partner exposure and assayed for cortisol. This study examines a series of specific hormonal snapshots related to partner exposure in opposite and same-sex romantic partnerships. Our data show homologous attunement patterns between same-sex and opposite-sex partnerships. Further, results indicate a strong connection between adverse childhood experiences, attachment anxiety, and mating orientation with potential to disrupt adrenocortical attunement between romantic partners.

Keywords: cortisol, dyadic attunement, adrenocortical attunement, attachment anxiety

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INTRODUCTION

Love, infatuation, and lust have for centuries been the foci of art, literature, theatre, and more (i.e. *Abraham & Sarah, Liang Shanbo & Zhu Yingtai, Ramayana,* etc.*)*. As this record shows, there has been and currently still is something very universally experienced by humans and described as love, infatuation, etc. It reasons that since this experience is so ubiquitous, it should have biological foundations. We posit that humans experience emotions of love and affection as a result of activity at the hormonal level. Specifically, we seek here to illustrate the connection of the hormone cortisol to the phenomenon of hormonal attunement (or synchronization) observed between individuals in romantic partnerships. Adrenocortical attunement is important for maintenance of social bonds between human and non-human animal dyads (i.e. mother-infant relationships, mates, etc.). Such bonds are likely fine-tuned to environmental cues during periods of development, particularly that which lies between the ages of 0 and 18 years. Such environmental tuning may consequently result in behavioral orientations (e.g. mating orientation) that ultimately present as disadvantageous to the wellbeing of a pair bond.

LITERATURE REVIEW

CORTISOL.

Primary amongst the glucocorticoids, cortisol is key in the metabolism of carbohydrates, proteins, and fats. It is perhaps most widely known for its adaptive role in the human stress response, especially in responses that result in physiological maintenance during periods of fasting. Here, however, we narrow our consideration of cortisol to its function in human and non-human animal behavior.

Cortisol is secreted from the adrenal cortex in response to stimulation by ACTH from the anterior pituitary. More broadly, this input of ACTH and output of cortisol is just a portion of the hypothalamus-pituitary-adrenal cortex (HPA) axis, which acts in response to external and psychological stimuli, those which could either pose a risk or potential benefit (Nesse & Young, 2000), and which are first received via the hypothalamus. Overstimulation and/or the non-functionality of the adrenal cortex can result in physiological conditions that appear maladaptive (or, in the medical profession, pathological) when the most extreme variations of such conditions are presented within an individual. Underneath observed stress-induced fluctuations of cortisol secretion, the secretion of cortisol naturally fluctuates throughout the day– that is, plasma cortisol concentration is observed in a diurnal rhythm in which a peak is reached at the point of waking in the morning and slowly decrease throughout the day, reaching its lowest concentration just before sleep at night.

Physiological cortisol levels are associated with behavior, in particular social behavior. Cortisol is associated with periods of alertness, particularly during stress and/or arousal. In a study done on meerkats (*Suricata suricatta*), intramuscular injection of cortisol successfully led to an elevation of circulating glucocorticoid levels, which resulted in a decrease in female foraging behaviors and an increase in the amount of time females spent in proximity with pups (Santema, Teitel, Manser, Bennett, & Clutton-Brock, 2013). In human children 6 to 16 years of age, higher levels of externalizing problem behavior were associated with lower early morning salivary cortisol levels (Shirtcliff, Granger, Booth, & Johnson, 2005); such externalizing behaviors have additionally been found to be moderated by age, with preschoolers displaying more externalizing behaviors with higher basal cortisol levels and elementary school aged children displaying more externalizing behaviors with lower basal cortisol levels (Alink et al., 2007).

Social hierarchies are likely formed, in part, due to cortisol function in individuals in response to social stimuli. Mehta, Jones, and Josephs indicate that cortisol acts in coordination with testosterone to moderate the formation of male social hierarchies (2008)– that is, men with high basal testosterone levels were likely to respond to a competitive loss with an increase of cortisol, whilst men with similarly high levels of basal testosterone respond to a competitive win with a decrease in cortisol; this resulted in the continuation of competition by winners and an aversion to competition amongst losers.

The secretion of cortisol via the HPA axis (e.g., the sensitivity of the HPA axis to stimuli) is largely influenced by individual development, particularly in infancy. There is an apparent sensitization of the HPA axis in children whose mothers endured higher levels of stress during their child's infancy (Esex, Klein, Cho, & Kalin, 2002). Similar effects have been reported during adolescence, wherein 13-year-old adolescents who had been exposed to postnatal maternal depression displayed higher and more variable morning salivary cortisol concentrations (Halligan, Herbert, Goodyer, & Murray, 2004). More generally, socioeconomic status during early development is indicative of salivary cortisol levels– that is, children of lower socioeconomic status families presented higher salivary cortisol levels than their peers of higher socioeconomic status families as early as six years of age (Lupien, King, Meaney, & McEwen, 2000).

ADRENOCORTICAL ATTUNEMENT.

Changes in salivary cortisol concentration can be detected in humans as soon as fifteen minutes following the application of a stimulus. *Adrenocortical attunement* is the synchronization between the HPA axes of two or more close individuals and can be monitored via salivary cortisol concentration. For example, salivary cortisol concentrations have been shown to correlate/synchronize between non-human great apes, between human mothers and their children, and between heterosexual spouses.

Kuhar, Bettinger, & Laudenslager (2005) observed three young adult, male western lowland gorillas (*Gorilla gorilla*) and found that cortisol concentrations were patterned as higher in the morning and lower in the afternoon– that is, the diurnal pattern of cortisol in western lowland gorillas appears to be the same or similar to that of humans. The same study indicated that salivary cortisol concentrations correlated across the three males.

In humans, adrenocortical attunement has been displayed in mother-infant dyads and heterosexual mating pairs. Neu, Laudenslager, and Robinson (2009) have found a co-regulation in salivary cortisol between mothers and infants during the time that mothers held their offspring. Heterosexual newlyweds, when asked to discuss relationship conflicts, displayed a sharp increase of cortisol followed by a sharp decline (Beck, Pietromonaco, DeBuse, Powers, & Sayer, 2013). The same study also indicated that anxious wives and avoidant husbands displayed cortisol responses in anticipation of conflict.

Much of the previous research in regard to human adrenocortical attunement includes intentional evocation of a response by inducing stress via nearly artificial or artificial scenarios. While such studies provide valuable information about how close individuals display synchrony during times of distress, cortisol has been shown to function in roles outside of a stress response.

It is unclear as to whether or not there is a base level of adrenocortical attunement between close conspecifics in low-stress environments. Additionally, previous research specifically excludes individuals in female-female and male-male romantic partnerships. There is a clear need to deepen and broaden the literature.

CURRENT STUDY

The current study seeks to identify whether or not a base level of adrenocortical attunement exists, particularly in response to time spent with a romantic partner. This study also seeks to provide a broader picture of human adrenocortical attunement by including female-female and male-male dyads in addition to female-male dyads. We hypothesized that romantic partners display adrenocortical attunement throughout the time they spend together in a non-stressful environment. We further hypothesized that if such a display of adrenocortical attunement is found, it will not reveal differences in regard to sexual orientation/conformation of the dyad. Finally, we hypothesized that developmental factors (e.g. adverse childhood experiences) will alter displays of adrenocortical attunement.

MATERIALS & METHODS

RECRUITMENT. A total of 24 dyads participated in this study (2 female-female, 20 female-male, and 2 male-male) for a total of 48 individuals (24 female, 24 male). Participants were deemed qualified for this study if they were at least 18 years old and no older than 39 years; if they had neither a thyroid disorder nor endocrine/gland disorder; and if they had been in their current romantic relationship for at least two months and were willing to participate in the study with their romantic partner.

The mean age for participants was 19.9 years with a standard deviation of 1.59 years and range of 18 to 25 years old. The majority of participants spent the majority of their development (from 0 to 18 years) in Oklahoma (n=36) with the remaining participants originating from elsewhere in the United States; no participants indicated having spent their development abroad. On a Kinsey scale ranging from 0 ("entirely heterosexual") to 6 ("entirely homosexual"), 39 individuals self-reported as being at a "0" on the scale, 1 as a "1" on the scale, 3 as a "4" on the scale, 3 as a "5" on the scale, and 2 as a "6" on the scale.

In regard to ethnic identity, participants were 72.34% White, 4.26% Black or African American, 2.13% American Indian or Alaska Native, 2.13% Asian, and 19.15% Multiple or Other. In regard to Hispanic, Latino, and/or Spanish origin, 12.5% of participants claimed at least one form of Hispanic, Latino, or Spanish origin.

The mean duration of romantic relationship was 24.56 months (2.04 years) with a standard deviation of 20.42 months (1.70 years). The most common relationship status was "dating" with 95.83% of couples, with the remaining 4.17% identifying as "engaged". The majority of romantic partnerships were sexually active (83.33%), while the majority of female participants (62.5%) did not claim use of hormonal birth control.

RESEARCH DESIGN AND DATA COLLECTION. This study was naturalistic in design, utilizing a method of separation followed by reuniting of romantic partners. Upon arrival, partners were screened for qualification of participation. Partners were asked to separate and individuals were brought to separate, adjacent rooms where informed consent was attained. Each dyad was assigned a number (1 - 24) and individuals were randomly assigned a partner number (1 or 2). Participants were then read a standardized script (~7 minutes), which explained the process of saliva donation via passive drool and the general expectations of participants. Once participants had been given an opportunity to ask questions, research assistants started a timer (set for 30 minutes and 15 seconds) and left the room. Participants then completed four questionnaires: a biographical and personal health and history inventory; the ACE-10 Questionnaire; the MD-SOI-Kirkpatrick Questionnaire (Jackson & Kirkpatrick, 2007); and the Adult Attachment Scale Questionnaire. Following the completion of these questionnaires, participants started a neutral task (e.g. a puzzle).

At the sound of the time, which the research assistant set, participants began the donation of saliva samples. All tubes and straws were sourced via Salimetrics. Following the completion of this initial baseline donation ("T0"), participants were separately, one after the other, taken to a second novel location. Upon first contact, participants donated an additional saliva sample ("T1") followed by two more samples ("T2" and "T3") at fifteen- and thirty-minutes after reuniting, respectively.

Salivary samples were collected at the end of the trial session (total time = ~1 hour 30 minutes) and frozen at ~ –20ºC. Samples were then assayed for salivary cortisol concentration with a prepared assay kit by Salimetrics. Salivary cortisol concentrations where then calculated as individual means, interval changes (e.g. T0 to T2, T2 to T3), and a dyad "synchrony score", calculated as: $Abs(Conc_{Partner1} - Conc_{Partner2})$. Samples for T1 were not assayed. Questionnaire data was coded an analyzed. Statistical tests were run for correlation and linear regression.

RESULTS

Salivary Cortisol. No correlation was found between partners salivary cortisol concentration. Some synchrony was displayed in the interval between T2 and T3, but trends were weak. An increase in attachment anxiety, as reported by the Adult Attachment Scale Questionnaire, characterized a decrease in synchronized cortisol response ($F(2,22 = 3.26$, Beta – 0.52, $p=0.014$). Across data, no variation was found with respect to sex or sexual orientation.

Attachment, Adverse Childhood Experiences, and Mating Orientation. An increase in adverse childhood experiences was positively correlated with an increase in preference of a *short term mating orientation* (STMO) (r= .521, p< .01) and inversely correlated with preference of a *long term mating orientation* (LTMO) (r= –.461, p< .01). STMO and LTMO were inversely correlated to one another (r= –.833, p< .01) (see Figure 1).

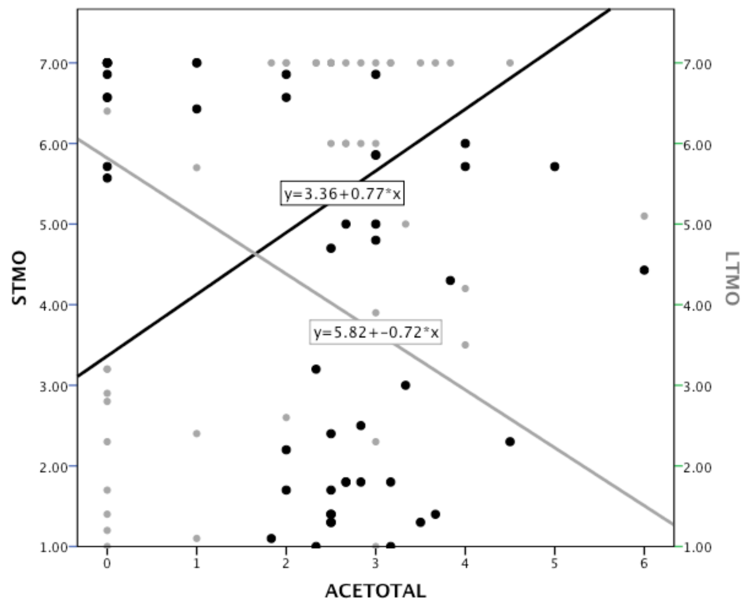

Figure 1: Summation of individually reported Adverse Childhood Experiences with Short Term Mating Orientation (STMO) and Long Term Mating Orientation (LTMO) preferences.

Adverse childhood experiences (ACE) were also significantly correlated to the Adult Attachment Scale sub-score *anxiety* (AAS Anxiety) (r= .387, p< .01). AAS Anxiety was also positively correlated with STMO (r= .520, p< .01) and negatively correlated with LTMO (r= –.520, p< .01) and the Adult Attachment Scale sub-score *close* (AAS Close) (r= –.601, p< .01) (See Figure 2).

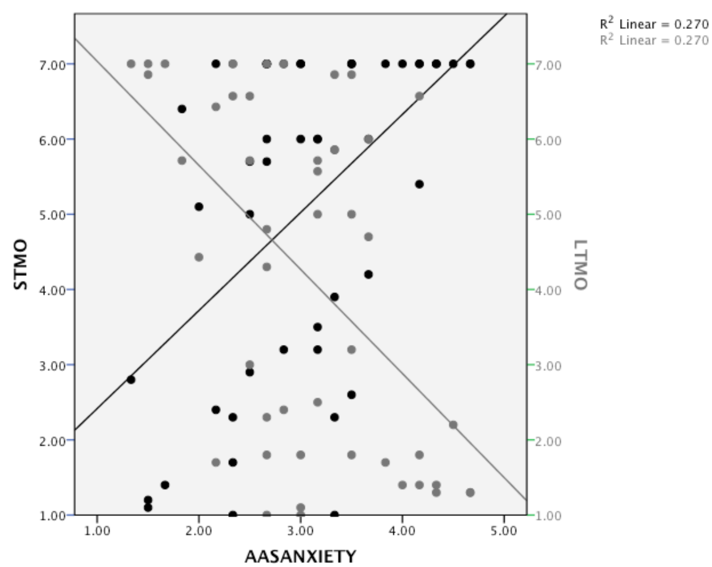

Figure 2: Attachment Anxiety as reported by the Adult Attachment Scale Questionnaire (AAS Anxiety) with Short Term Mating Orientation (STMO) and Long Term Mating Orientation (LTMO) preferences.

AAS Close was positively correlated with LTMO (r= .858, p< .01) and negatively correlated with STMO (r= –.860, p< .01) (see Figure 3), ACE (r= –.459, p< .01), and AAS Anxiety (r= –.601, p< .01). The Adult Attachment Scale sub-score *depend* (AAS Depend) was negatively correlated with an emotional infidelity score (r= –.514, p< 0.01), which was attained via the MD-SOI-Kirkpatrick questionnaire.

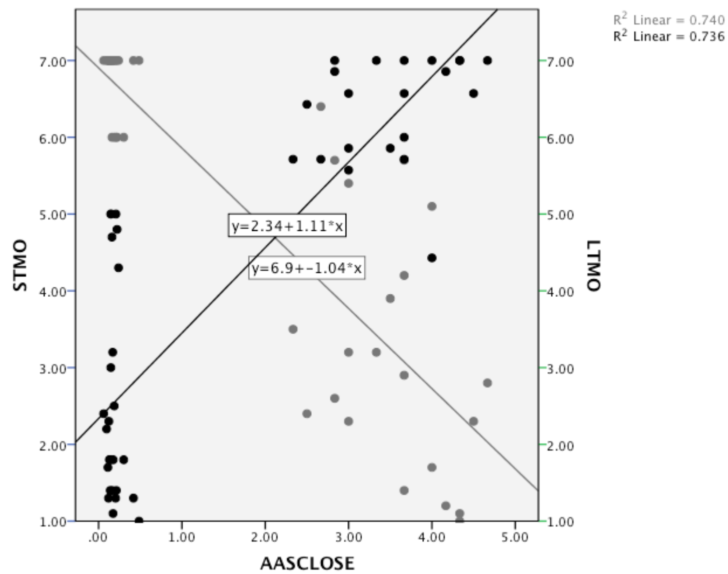

Figure 3: Close Attachment as reported by the Adult Attachment Scale Questionnaire (AAS Close) with Short Term Mating Orientation (STMO) and Long Term Mating Orientation (LTMO) preferences.

DISCUSSION

The current study sought to identify whether or not a base level of adrenocortical attunement exists, particularly in response to time spent with a romantic partner, as well as to provide a broader picture of human adrenocortical attunement by including female-female and male-male dyads in addition to female-male dyads. We hypothesized that romantic partners display adrenocortical attunement throughout the time they spend together in a non-stressful environment, and that if such a display of adrenocortical attunement is found, it will not reveal differences in regard to sexual orientation/conformation of the dyad. We also hypothesized that developmental factors (e.g. adverse childhood experiences) will alter displays of adrenocortical attunement. Our results fail to significantly support that romantic partners display adrenocortical attunement throughout the time in which they spend time together; however, theses early results show some indication that with a greater sample size, a theme of synchrony is likely to immerge. Sex and sexual orientation did not seem to add significant variation to these results, whereas developmental factors (particularly adverse childhood experiences) and attachment style (i.e., anxious social attachment) were significantly involved in the addition of variation. We hypothesize that attachment style can dramatically alter adrenocortical response to ones romantic partner.

Attachment anxiety characterized a decrease in synchronized cortisol response. It reasons that while individuals with attachment styles characterized by close or depend may response in a similar, predictable way (i.e., their mean salivary cortisol concentration decreases as they spend time with their partner, individuals with an attachment style of anxiety likely respond in one of three alternative ways, which we will describe as R_1, R_2, R_3. Our first response type, R_1, is characterized by a plateau in cortisol response– that is, an individual shows no change in their cortisol response over time, but instead maintains the same mean salivary cortisol concentration (MSCC). The second response type (R_2) is characterized by an increase in MSCC, which begins just before the time of partner exposure and continues throughout the continued exposure. R_3 would indicate a delayed response, characterized by an initial lack of change in MSCC followed by an expected decrease in MSCC throughout the time of continued exposure. We also generally expect, based on the findings of Beck et al., that individuals with attachment anxiety would display a higher baseline cortisol level (See Figure 4).

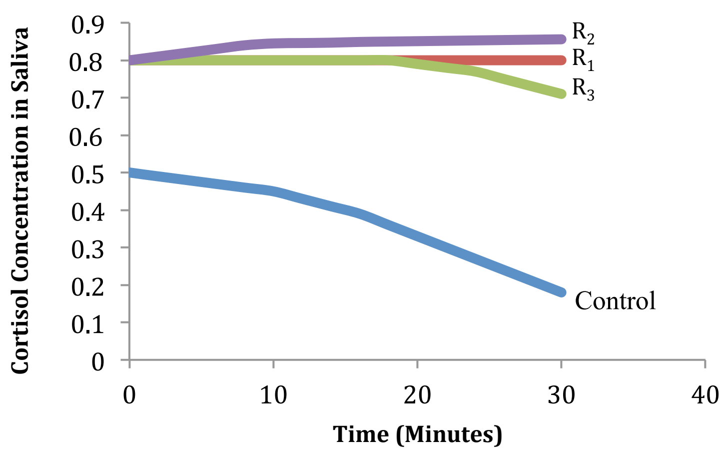

Figure 4: Proposed alternative cortisol responses of individuals with attachment anxiety. Time 0 minutes indicates a point of initial partner exposure, and the remaining time is time spent proximal to a romantic partner.

Pietromonaco, DeBuse, and Powers examined romantic partners and their HPA function in the context of adult attachment and stress stimuli (2013). Results of this study indicate that before, during, and after a distress task, individuals with avoidant and anxious attachments showed higher overall cortisol levels, and men with high attachment anxiety showed anticipatory effects via a higher cortisol level prior to the distress task. Men with more securely attached partners displayed lower cortisol reactivity and a quicker recovery. In a prior study, attachment avoidance was shown to have moderated the effect of a partner's emotionality on both their own HPA axis function and the function of their partners HPA axis (Laurent & Powers, 2007). Graphically presented, the 2013 study seems to provide support for a scenario of higher baseline cortisol levels and a delayed recovery, much like the scenario proposed by R_3 in Figure 4. The findings of this study seem consistent with those of Pietromonaco, DeBuse, and Powers, even in its less distressing scenario of separation and reuniting.

The formation of secure attachments is crucial for the maintenance of social bonds, both in dyads and in larger groups. Secure attachments, characterized more by dependency and closeness, lead to cooperation in parent-offspring relationships, romantic partnerships, and in social hierarchies. Further, secure attachment is generally related with increased adrenocortical attunement and stable environments during early development. However, secure attachments should not be confused as more evolutionarily adaptive than attachments characterized by anxiety. As indicated by the findings of this study, more adverse childhood experiences are positively correlated with an anxious adult attachment style and a short term mating orientation. This suggests that and increase of adverse experiences in early development serve to calibrate individuals for environments in which high dependency, closeness, and a long term mating strategy are disadvantageous. An increased disturbance in adrenocortical attunement shows biological support for this calibration.

This study takes a novel approach to the study of human adrenocortical attunement by including populations typically excluded from the literature and additionally by approaching adrenocortical attunement from a perspective not restricted by scenarios of intentional researcher induced stress. Future directions should include an increase in participant quantity. Additionally, this study and future studies would benefit from an increase in trial duration and sampling frequency. The extension of the duration of a trial (e.g., another fifteen minute time lapse) would allow for the determination of a lag effect in individuals with anxious attachment styles. Increased sampling throughout each trial would add further detail to cortisol behavior in response to partner exposure.

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The content of this study is currently being prepared for publication. Preliminary data were presented on March 31, 2015 at the Oklahoma EPSCoR Program, "Research Day at the Capitol" at the Oklahoma State Capitol in Oklahoma City, Oklahoma. Another presentation of preliminary data took place on April 24, 2015 at the Oklahoma State University Undergraduate Research Symposium in Stillwater, Oklahoma. Future venues for the presentation of this study will include that of the May 2015 meeting of the Human Behavior and Evolution Society in Columbia, Missouri.

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APPENDIX A

INDIVIDUAL DONORS VIA EXPERIMENT.COM

BALP, MICHAEL
BELSKI, MAREK
BONJOUR, SOPHIA
BROOKS, KELSIE
BRUN, MORGAN
BUCHANAN, RICHARD
CAMPBELL, AARON
CHEN, DIANE
CLOWER, ROBIN
CRISS, MIKE
DRUMMOND, ALLISON
DUGGER, HALEY
ELLEFSON, RANDI
GIPSON, JOANNA & MARTHA
GREGORY, ALYSSA
HADIDI, BARB HEMMINGSEN
HARTSON, STEVE
HILL, JENNIFER
HINES, WENDY
HUBACH, RANDOLPH
JASKLOWSKI, OSCAR
LARSON, RILEY
LONG, STEPHEN
LOWER, RYAN
MANTUA, JANNA
MATTEN, SHARLENE R.
MEYER, MITCHELL
MYERS, ROSS
PILLIOD, JIM
POIRIER, JENNIFER
PROUDFOOT, SHAWN
ROARTY, MATTHEW
ROGERS, BILL
SCHROECKENTHALER, ERIC
SHANKLE-KNOWLTON, AMANDA
SMITH, COLTON
WATSON, OLIVIA
WEST, JANE
WEST, SARAH
WHITE, PHILIP
WILFORD, EVAN