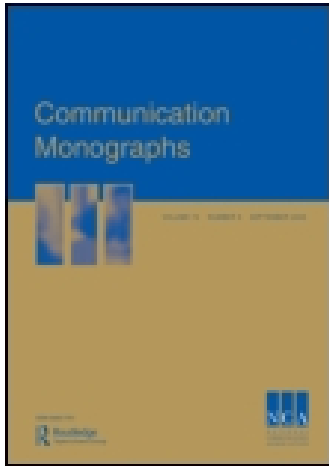


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State and Trait Affectionate Communication Buffer Adults' Stress Reactions

Kory Floyd, Perry M. Pauley & Colin Hesse

The present study tested the prediction that affectionate communication is positively associated with the release of oxytocin in response to stressors. One hundred participants completed questionnaire measures about their personal relationships prior to participation in a laboratory session that included a series of standard laboratory stressors. Both state and trait affectionate communication predicted increases in oxytocin during exposure to stressors, an effect that was not moderated by sex. The results demonstrate the stress-buffering effect of affectionate interaction.

Keywords: Affectionate communication; Stress; Health; Hormones; Affection Exchange Theory

For decades, social scientists have considered the desire to be loved and appreciated a fundamental human need (Baumeister & Leary, 1995; Brown & Levinson, 1987; Maslow, 1970). Perhaps unsurprisingly, a robust literature demonstrates the mental and physical health benefits of exchanging expressions of love and appreciation through affectionate behavior (see Floyd, 2006a). The communication of affection has been linked to mental health and well being (Floyd et al., 2005), cardiovascular health (Floyd, Hesse, & Haynes, 2007), relationship satisfaction and stability (Huston, Caughlin, Houts, Smith, & George, 2001), endocrine health (Floyd 2006b; Holt-Lunstad, Birmingham, & Light, 2008), and improvements in blood lipid levels (Floyd et al., 2009; Floyd, Mikkelsen, Hesse, & Pauley, 2007). In contrast, the lack of

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affectionate expression has been linked to elevated probabilities for psychological and physical distress (Schwartz & Russek, 1998), psychosomatic illness (Komisaruk & Whipple, 1998), clinical depression (Mackinnon, Henderson, & Andrews, 1993; Oliver, Raftery, Reeb, & Delaney, 1993), loneliness (Downs & Javidi, 1990), and substance abuse (Shuntich, Loh, & Katz, 1998).

Affectionate communication may contribute to well-being largely by modulating the body's stress response. Recent studies have indicated, for example, that the propensity to give and receive affectionate expressions directly predicts differentiation in 24-hr adrenocortical activity (Floyd, 2006b; Floyd & Riforgiate, 2008) and inversely predicts hormonal reactivity to acute stressors (Floyd et al., 2007a). Expressing affection in the wake of elevated stress has also been shown to accelerate endocrine recovery (Floyd et al., 2007b). Such findings have particular applied importance, given the range of physical health conditions known to be exacerbated by stress, including dyslipidemia and cardiovascular disease (Roy, Kirschbaum, & Steptoe, 2001), hypertension and coronary artery disease (Hotz, 1995; Potempa, 1994), and immunosuppression (Kiecolt-Glaser et al., 1984).

The present experiment seeks to extend these efforts in two important ways. First, attention is focused on the connection between affectionate communication and the pituitary hormone *oxytocin*, an endocrine marker whose association with the stress response has been the source of much theoretic speculation. The specific focus is on the efficacy of affectionate behavior—in both state and trait forms—to modulate changes in oxytocin in response to stressors. Second, in line with theories positing sex differences in reactivity to stress, this study adjudicates whether affectionate communication has differential effects on the oxytocinergic response for women and men.

This review begins by describing the body's stress response and explaining the role of various hormones, including oxytocin, the focus of the current experiment. It then draws on three interrelated theories to advance predictions about the stress-buffering outcomes of affectionate communication in personal relationships. Finally, it summarizes previous studies illustrating connections between affectionate behavior and stress, situating the present experiment within this corpus of research.

Stress and the Stress Response

Beginning with the pioneering work of Bernard (1865/1961), Cannon (1929), and Selye (1936, 1956), scientists have understood that the body responds physiologically to any perceived threat to its well being. Such threats are known as *stressors* and the body's response is known as *stress*. Stressors comprise events that individuals perceive as threats to their physical, psychological, emotional, financial, or relational safety. Both genuine threats (e.g., the rapid approach of a barking dog) and false threats (e.g., a health scare later found to be benign) produce a stress response if they are perceived to threaten one's well being. On the contrary, even genuine threats will not generate a stress response if they are not perceived (e.g., a serious disease one is unaware of having).

The body's response to stressors is primarily a defensive one. Physiologically, the body responds to short-term stressors (e.g., a job interview) by increasing activity of the sympathetic nervous system, which enhances the production of energy to facilitate the successful negotiation of the stressor. In contrast, long-term stressors (e.g., caregiving for a dependent relative) often blunt sympathetic arousal, so as to conserve energy under conditions when it is subject to constant depletion.

The focus in the present experiment is on the short-term stress response. Perception of an acute stressor activates multiple physiological systems to empower an effective response, whether by fighting, fleeing, tending, or befriending (Sapolsky, 1994; Taylor et al., 2000). The focus of the present study is on the role of the oxytocinergic system in stress reactivity. Oxytocin is a peptide hormone produced by the hypothalamus and released primarily by the posterior pituitary gland (Uvnäs-Moberg, Arn, & Magnusson, 2005). Oxytocin plays important roles in the reproductive process, initiating uterine contractions and stimulating the milk let-down reflex (see Uvnäs-Moberg, 2003). It is also secreted during breastfeeding and is correlated with feelings of calm and suppressed HPA responses to stress (e.g., Adler, Cook, Davidson, West, & Bancroft, 1986; Chiodera et al., 1991; Uvnäs-Moberg, 1996). Both sexes also experience increases in circulating oxytocin at sexual orgasm (Murphy, Seckl, Burton, Checkley, & Lightman, 1990; Richard, Moos, & Freund-Mercier, 1991) and in response to affectionate but nonsexual touch (Turner, Altemus, Enos, Cooper, & McGuinness, 1999).

Evidence regarding the exact nature of the oxytocinergic response to stressors has been somewhat inconsistent. Some studies suggest that oxytocin levels decrease in the wake of stress. In two studies, Light found that some participants experienced decreased oxytocin in response to public speaking stressors, although one (Light et al., 2004) identified that pattern only for cocaine users and the other (Light et al., 2000) identified it only for a portion of the sample. Some studies have also identified null results when examining the oxytocin reaction to stressors (e.g., Altemus, Redwine, Leong, Frye, Porges, & Carter, 2001; Jansen et al., 2006).

The most consistent findings from carefully controlled experiments indicate, in contrast, a positive relationship between stress and oxytocin levels that facilitates accelerated physiological recovery. For instance, two experiments found that participants who were administered exogenous oxytocin had blunted physiological responses to stressors, relative to a placebo group (Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003; Kirsch et al., 2005). A more recent experiment confirmed not only that oxytocin inhibited a stress response to relational conflict but also affected interpersonal behavior. In that study (Ditzen, Schaer, Gabriel, Bodenmann, Ehlert, & Heinrichs, 2009), 47 married or cohabiting couples were administered either oxytocin or placebo intranasally and then took part in a 10-min videotaped conflict conversation. The conversations were later coded for positive behaviors, including nonverbal immediacy and emotional self-disclosure, and negative behaviors, including defensiveness, belligerence, and contempt. Compared to placebo, oxytocin significantly increased the duration of positive behavior in relation to negative behavior for both women and men. Moreover, participants who

received oxytocin experienced lower increases in salivary cortisol after the conflict than did control participants, indicating that oxytocin attenuated the stress response to conflict. Other experiments, such as Kosfeld, Heinrichs, Zak, Fischbacher, and Fehr (2005), have shown that intranasal administration of oxytocin also increases trust behaviors between humans, relative to placebo. It is offered, therefore, that the best available data indicate that *increased levels of oxytocin buffer the body's stress response*. The next section describes three theories that, when considered together, suggest that affectionate communication leads to elevated oxytocin in response to acute stressors.

Theoretic Commitments

When considered in concert, three theories provide a framework for expecting affectionate communication to buffer the effects of stress. The first of these theories, the stress-buffering hypothesis (Cohen & Wills, 1985), posits that the receipt of social support mitigates the effects of stressful events. The second theory, affection exchange theory (Floyd, 2006a), proposes that affectionate expression is one form of communication that confers stress-alleviating benefits to both senders and receivers of affectionate messages. The final theory, tend-and-befriend theory (Taylor et al., 2000), proposes that the hormone oxytocin is released in response to stressful events and produces two outcomes: first, oxytocin is hypothesized to alleviate the physiological effects of stressful events, and second, oxytocin is hypothesized to increase affiliative (or affectionate) behaviors in response to stress.

Stress-buffering hypothesis. Cohen and Wills (1985) proposed that support derived from relational partners minimizes reactions to acute stressors (Cohen & Wills, 1985). According to the stress-buffering model, received support is particularly beneficial when it interacts with the occurrence of a stressful event. In moments such as those, individuals are likely to turn to significant relational partners to seek emotional or tangible assistance in managing the stressor (Goldsmith, 2004). The stress-buffering hypothesis also notes that the buffering effects of received emotional or tangible support are particularly important when the effects of multiple stressors accumulate. Termed *allostatic load*, the physiological and psychological strain associated with managing multiple stressors can have deleterious effects on total health including increased risk for heart disease and immune dysregulation.

Affection exchange theory. Floyd's (2006a) affection exchange theory (AET) posits that affectionate interaction is one mechanism that can alleviate the negative outcomes associated with stressful events. As a neo-Darwinian theory, AET holds as its central premise that the expression of affection is a fundamental necessity that serves humans' superordinate goals of survival and procreation. AET further claims that, although the need for affectionate feelings is both necessary and beneficial, individual communicators differ in their ability to effectively communicate affectionate feelings. In that way, affectionate communication is an *adaptive* trait insofar as it increases affectionate individuals' probability of survival (as indicated by levels of total health) and access to potential mating partners. Early studies

demonstrated that affectionate communication is inversely correlated with stress and depression and positively associated with happiness, self-esteem, and overall mental health (Floyd, 2002; Floyd et al., 2005). AET further posits that, as an activity that increases both viability and fertility, affectionate communication must have corresponding physiological pathways that encourage individuals to engage in the exchange of affectionate messages. AET specifically identifies the immune system and the various systems associated with both responses to stress and reward as three areas that are moderated by the exchange of affectionate communication. Overall, AET posits that the expression of affectionate communication (that is, both sending and receiving all varieties of affectionate messages) should contribute to enhanced immune function, attenuated stress responses, and increased activity of physiological reward pathways such as the release of oxytocin in the presence of a romantic partner (Grewen, Girdler, Amico, & Light, 2005).

Tend-and-befriend theory. Taylor et al.'s (2000) tend-and-befriend theory (TBT) provides another evolutionary perspective on the benefits of relational support. TBT provides an alternative to the fight-or-flight mechanism that pervades the stress literature. The central premise of TBT is that fight-or-flight is not always the most adaptive response to stress. The disadvantages of fight-or-flight are particularly salient for the female population of most animal species; in addition to being physically smaller and weaker than their male counterparts (a fact that can make females vulnerable to intraspecies threats from males), females lack the androgen hormones that have been associated with violence and aggression. Perhaps the most significant reason that many females might avoid engaging in fight-or-flight behavior is the fact that the female members of most species assume the primary responsibility of caring for and tending to offspring. Given these significant challenges, engaging in flight-or-flight would be a maladaptive response for many females; fighting could expose them to injury or perhaps death, outcomes that would decrease their own chances of survival and perhaps leave their offspring unprotected from the threat. Fleeing likewise would involve abandonment of offspring, ensuring their exposure to the threatening situation.

TBT posits that, in moments of crisis, most females' primary concern is to ensure the safety of their offspring (Taylor et al., 2000). Although this sometimes includes physically aggressive behaviors enacted in defense of offspring (Taylor et al. cite several rodent studies that have demonstrated this behavior), for most females in most situations, the preferred responses to crisis are tending and befriending behaviors. Tending behaviors refer broadly to actions taken by mothers to soothe, quiet, or otherwise reassure their offspring in the face of threat. Befriending behaviors refer to the tendency of many females to associate with large social networks that mobilize for mutual protection when presented with a stressor. TBT speculates that the processes of tending and befriending are borne from individuals attachment needs, therefore, when presented with a stressor, engaging in relational contact can help to alleviate the negative effects of stress.

As with AET, TBT identifies specific physiological systems that reinforce the tendency to engage in tending and befriending behaviors in response to stress. Specifically, TBT posits that the body's oxytocinergic system is activated in response to some stressors, particularly those that require some type of affiliative response in order to enhance coping (Taylor, 2006; Taylor et al., 2000). This effect is thought to be particularly strong for females; Taylor et al. (2000) note that the effects of oxytocin seem to be particularly strong in females and that the behaviors of tending and befriending are ultimately more adaptive for females than males. Numerous studies have implicated oxytocin in social behaviors including mother–infant bonding (including breastfeeding), sexual intercourse, and touch (for review, see Uvnäs-Moberg et al., 2005); those authors also review several studies that have linked oxytocin with decreased reactivity to stress.

On the basis of TBT, it is proposed that the experience of stress will be associated with increases in oxytocin for at least some individuals (TBT specifically predicts this effect for women but only briefly mentions that affiliative behavior might produce smaller stress-alleviating effects for men). Given that oxytocin facilitates affiliative behavior and bonding, it is further proposed that engaging in affectionate communication predicts the release of oxytocin in individuals exposed to a stressful situation. The following section reviews studies that have examined the effects of affectionate communication and oxytocin on physiological responses to stress.

Affectionate Communication and the Stress Response

One of the primary physiological processes identified within AET (Floyd, 2006a) is the body's multifaceted stress response. According to the theory, the exchange of affectionate messages alleviates the physiological effects of stress. Empirical studies examining the effects of affection on physiological reactions to stressors have validated that claim. Floyd (2006b) and Floyd and Riforgiate (2008) both reported that affectionate interaction is positively associated with the degree of morning-to-evening change in cortisol, a steroid hormone for which diurnal variation indicates efficient stress management. A pair of studies has additionally demonstrated that affectionate communication accelerates physiological recovery from elevated stress (Floyd et al., 2007a; Floyd, Hesse, & Pauley, submitted).

Affectionate communication as a stress buffer. Several recent studies have analyzed the efficacy of affectionate expression as a prestress buffer. In a pair of studies, Floyd and colleagues (Floyd et al., 2007b, 2009) demonstrated that participants' self-reports of expressed affection predicted their cortisol reactivity in response to stressors. As predicted by AET, affectionate communication was negatively associated with the magnitude of cortisol change. Other tests of the stress-buffering efficacy of affectionate communication have examined the effect of brief periods of interaction on stress reactivity. Grewen, Anderson, Girdler, and Light (2003) reported that experimental participants who participated in a ten-minute period of warm contact with a romantic partner experienced lower levels of cardiovascular reactivity in response to a public speaking task than participants who sat alone in silence for ten

minutes. Pauley, Floyd, and Hesse (2009) reported similar results with platonic friends, and Coan, Schaefer, and Davidson (2006) likewise found that physical contact with a romantic partner buffered participants against the effects of stress.

Hypotheses and Research Question

As those studies demonstrate, affectionate communication attenuates the physiological effects of stressful events, a prediction derived from the framework of AET. Other studies have demonstrated that oxytocin helps to mitigate the effects of stress, a finding that accords with TBT. Both AET and TBT make specific predictions about the role of oxytocin in behavior: AET predicts that the release of oxytocin is correlated with the expression of affection (as part of the body's physiological reward system) and TBT predicts that oxytocin increases in response to a stressful event (to induce calm and promote tending and befriending behaviors). On the basis of these theories and empirical findings, it is proposed that affectionate communication potentiates the release of oxytocin in response to a stressful stimulus.

H1: Trait affectionate communication directly predicts oxytocinergic reactivity to stressors.

H2: State affectionate communication directly predicts oxytocinergic reactivity to stressors.

Whereas AET posits that the beneficial effects of affectionate communication should apply to individuals regardless of sex, TBT argues that women are more affected by the release of oxytocin than their male counterparts. To resolve these differing predictions regarding the role of sex in the release of oxytocin, the following research question is posed:

RQ1: Is the relationship of oxytocinergic reactivity to stressors and trait or state affection moderated by sex?

Method

Participants

Participants ($N = 100$) were equal numbers of healthy adult women and men who ranged in age from 18 to 55 years ($M = 26.83$ years, $SD = 6.86$). The majority (60 percent) were Caucasian, whereas 26 percent were Asian/Pacific Islander, 8.0 percent were Hispanic, 3.0 percent were African American, and 3.0 percent were of other ethnic origins. At the time of the study, one participant had only a high school diploma, seven had completed some college but had no degree, 45 had completed an associate's or bachelor's degree, 41 had completed a master's degree, and six had completed a doctoral degree.

Procedure

This study was a federally registered Phase I clinical trial (registry #1001 R03 MH075757-01A1), and was approved by the university's institutional review board. Some details of the study procedures are also reported in Floyd et al. (submitted).

Recruitment and prescreening. Participants were recruited from among the staff, undergraduate student, and graduate student populations at a large university in the southwestern United States. The study was advertised via an electronic advertisement on the university's online campus newspaper and via announcements sent to various university listservs. In both cases, prospective participants were directed to an online prescreening measure to ascertain their eligibility for the study. A total of 281 prospective participants completed and submitted the online prescreening questionnaire; of that number, 188 (66.9%) met all of the qualifications. Women and men were equally likely to be qualified for the study ($p > .05$).

Inclusion and exclusion criteria. To be eligible for the study, prospective participants had to: (a) be 18 years of age or older; (b) be able to speak and read English; (c) weigh at least 50 kg; (d) be normotensive; (e) report no history of diagnosis or treatment for Type I or Type II diabetes mellitus, cancer of any form, coronary artery disease, clinical depression, endocrine disease, or significant arrhythmia; (f) report that they were not colorblind; (g) report no current use of alpha or beta blockers, steroids, or anticoagulants; (h) report that they were not currently pregnant or breastfeeding; (i) report that they were not currently taking hormone replacement therapy; (j) report no experience of hot flashes in the previous six months; and (k) report no more than mild anxiety about venipuncture. The most common reasons for disqualification were a history of clinical depression and a body weight of fewer than 50 kg.¹

Laboratory procedures and instrumentation. Laboratory sessions occurred in the university's Clinical Research Center, a 14,000-square-foot facility composed of dedicated laboratory space for clinical testing and sample processing and storage. Upon arrival, participants were consented by a research assistant and then instrumented by a registered nurse (RN) with an indwelling catheter inserted into the median cubital vein in the antecubital region of the nondominant arm. An 18–21-gauge catheter was inserted into the vein using a sterile technique and was held in place with surgical tape. The catheter was kept patent with a heparin lock flush between blood draws. Instrumentation was followed by a 15-min acclimation period. The RN then took one 6 ml baseline blood draw and one baseline saliva sample.

Stress induction. The stress induction was composed of four standard laboratory stressors presented in this order: cold pressor test, Stroop color–word test, mental arithmetic challenge, series of conflict videos, and second Stroop color–word test. With the exception of the cold pressor test, each stressor lasted 4 min. Details of each stressor appear subsequently.

Cold pressor test. This required participants to immerse a forearm into a bucket of ice water and to hold it there for a period of time (see Denton, Burlison, Hobbs, Von Stein, & Rodriguez, 2001). Participants in this study held the forearm of their dominant hand in a 3-gal galvanized steel bucket filled with water and eight frozen Airgas Ice gel refrigerant packets (Airgas, Inc., Radnor, PA) for 75 sec.

Stroop color–word test. This presented participants with a 4-min series of words on a computer screen that are names of colors (Alansari, 2004). Most of the names

appeared in letters of a color different from the one being named (e.g., the word “yellow” written in blue letters), and participants were instructed to call out the color of the letters, not the color named in the word. The words appeared at varying speeds and at various places on the computer screen.

Mental arithmetic challenge. This required participants to complete a series of challenging math problems while performing all calculations mentally. The problems included adding numbers with four integers, doing long division, and doing multiplication. During the arithmetic challenge, the researchers used mild verbal harassment (e.g., “talk louder,” “go faster”) and violated the personal space of the participant to increase the stress response (Bishop & Robinson, 2000).

Videos of marital conflict. These were selected from the documentary “Couples Arguing” (View Film & Video, Inc., 1985). While watching each video, participants were instructed to pay attention to the behavior of the couple and to “try to put yourself in their position.” Each segment featured the same couple engaging in conflict behaviors ranging from mild disagreement to mutual screaming and swearing.

Biochemical collection. At five points during the experimental session, the RN collected samples of blood and saliva from each participant: at baseline, halfway through the stress induction, at the conclusion of the stress induction, and then twice during additional procedures not reported here. Blood samples were drawn into chilled 6 ml evacuated tubes (Vacutainer; Becton Dickson, Franklin Lakes, NJ) containing 10.8 mg K₂ ethylenediaminetetraacetic acid (EDTA), an anticoagulant. Each blood sample was treated with 0.257 ml Aprotinin bovine (Sigma Aldrich, St. Louis, MO), a broad-spectrum serine protease inhibitor. The samples were then centrifuged at $1,600 \times g$ for 15 min at 0°C. From each Vacutainer, 2 ml of plasma was aliquotted into a bar-coded cryovial and stored at -70°C. At the end of the data collection, the plasma samples were shipped on dry ice to a service laboratory for oxytocin assay.

For use in the manipulation check, the RN also collected samples of saliva for determination of cortisol. Saliva samples were collected using Salivettes (Sarstedt, Nümbrecht, Germany) containing a synthetic cotton roll. Participants were asked to chew on the cotton roll for approximately 60 s to saturate it with saliva. The Salivettes were then frozen at -70°C before being shipped on dry ice to the service laboratory for cortisol assay.

Self-Report Measures

State affectionate communication. For each of the seven days preceding their laboratory visits, participants kept a forced-choice diary in which they indicated the extent of their expressed and received affection. On nine-point scales, in which higher scores indicate more agreement, participants reported their agreement with the following items: “I expressed a great deal of affection to others today,” “Other people expressed their affection for me today,” “I didn’t receive much affection from others

today” (reverse-coded), and “I didn’t express much affection to others today” (reverse-coded). Those items were embedded within others relating to stress, conflict, and mood. To create a state affectionate communication score, each participant’s scores for each item across their seven days of diary-keeping were aggregated and then subjected to a principal components factor analysis with oblimin rotation, $KMO = .73$, Bartlett’s test of sphericity $\chi^2(105) = 627.44$, $p < .001$. The factor analysis produced three factors accounting for 57.85% of accumulated variance. The first factor contained items relating to the amount of affectionate communication given and received during the week, and was labeled *state affectionate communication* ($\alpha = .99$). This factor was used to test the hypothesis and research question regarding state affection.²

Trait affectionate communication. To assess the amount of affectionate communication typically expressed to others and received by others, participants completed the ten-item Trait Affection Scale-Given (TAS-G: Floyd, 2002) and the six-item Trait Affection Scale-Received (TAS-R: Floyd, 2002). TAS-G asks participants to assess how demonstrative they generally are of their affection for others by indicating their level of agreement with statements such as “Anyone who knows me would say I’m pretty affectionate;” TAS-R asks participants to report how much affection they typically receive from others, using items such as “People are always telling me how much they love or care about me.” Both measures have been extensively validated (for discussion, see Floyd, 2006a). To create an index of *trait affectionate communication*, the researchers followed the procedure used by Hesse and Floyd (2008) and aggregated the scores from the two subscales, given and received ($\alpha = .93$).

Biochemical Measures

Oxytocin. Biochemical assays for oxytocin were conducted by Salimetrics LLC, a professional service laboratory in College Park, PA, associated with the department of biobehavioral health at Pennsylvania State University. Oxytocin was assayed in picograms per milliliter (pg/ml) from plasma samples in duplicate using a competitive immunoassay (Assay Designs, Ann Arbor, MI). Upon arrival in the laboratory, plasma samples were organized and immediately placed in a -80°C freezer. On the day of testing, samples were defrosted at room temperature ($22-25^{\circ}\text{C}$) for a minimum of 30 min, centrifuged at 3,000 RPM for 15 min, and pipetted onto 96-well assay plates. Samples were returned to the freezer upon completion of pipetting. The oxytocin assay procedure requires overnight incubation at $2-8^{\circ}\text{C}$ and assay completion on day two. Reliability indices appear in Floyd et al. (submitted).

Cortisol. Cortisol (used here as a component of the manipulation check) was assayed in micrograms per deciliter ($\mu\text{g}/\text{dl}$) from saliva samples in duplicate using a highly sensitive enzyme immunoassay (Assay Designs, Ann Arbor, MI). Upon arrival in the laboratory, saliva samples were organized and immediately placed in a -20°C freezer. On the day of testing, samples were defrosted at room temperature ($22-25^{\circ}\text{C}$) for a minimum of 30 min, centrifuged at 3,000 RPM for 15 min and pipetted onto

96-well assay plates. Samples were returned to the freezer upon completion of pipetting. Samples needing to be retested were thawed, analyzed, and refrozen. Reliability indices appear in Floyd et al. (submitted).

Manipulation Checks

Four measures were used to ensure that the stress induction elevated participants' stress levels as intended. These included repeated assessments of (1) positive affect; (2) negative affect; (3) self-reported stress; and (4) salivary cortisol. The first three indexed how participants responded to the induction emotionally, and the fourth indexed their adrenergic response. Positive and negative affect were measured with the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988). Participants completed PANAS at the beginning of each experimental session and at the end of the stress induction. Coefficient alphas were .87 and .91 for the assessments of positive affect, and .81 and .87 for the assessments of negative affect. For the manipulation check, self-reported stress was assessed by means of a single item added to the PANAS items asking participants the extent to which they felt stressed at the time they were completing the scale. Responses were elicited on a 7-point scale. Salivary cortisol levels were assessed as previously described.

Results

Manipulation Checks

Manipulation checks, reported in detail in Floyd et al. (submitted), confirmed that the stress induction led to a significant decrease in positive affect and significant increases in negative affect, self-reported stress, and salivary cortisol. None of those effects was moderated by participant sex, with the exception of self-reported stress, which evidenced an ordinal time-by-sex interaction in which stress increased significantly for both women and men. All four sets of results therefore suggest success for the stress induction.

Descriptive Statistics

Table 1 reports high and low mean scores, standard deviations, and intercorrelations between trait affection, state affection, oxytocin at T_1 (baseline), T_2 (halfway through stress induction), and T_3 (end of stress induction), and oxytocin response (ΔO), calculated by subtracting the baseline level from oxytocin at the end of the stress induction. Potential associations with demographic variables were examined for descriptive purposes and to identify necessary control variables. Two-tailed independent-samples t -tests indicated that men's T_3 oxytocin level ($M = 345.96$, $SD = 245.43$) significantly exceeded women's ($M = 234.57$, $SD = 92.27$), $t(96) = 2.25$, $p = .03$. Sex differences were nearly significant for T_1 and T_2 oxytocin levels, as well, with men's scores exceeding women's at both time points. Oxytocin scores for women and men are graphed over the three time periods in Figure 1. Participant age

Table 1 Descriptive Statistics and Intercorrelations for Study Variables ($N = 100$)

Variable	Low	High	SD	2	3	4	5	6
1. Trait Affection	1.92	6.92	4.87	.47**	-.10	.06	.01	.19
2. State Affection	2.68	5.93	4.40		-.07	.16	.18	.26**
3. T ₁ Oxytocin	79	946	293.94			.84**	.87**	.24*
4. T ₂ Oxytocin	65	1697	309.57				.93**	.56**
5. T ₃ Oxytocin	57	1520	317.47					.68**
6. Δ_O	-270.52	574.99	22.05					-

Note. Trait affection was measured in a 1–7 scale, and state affection was measured on a 1–9 scale; in both cases, higher scores index greater affectionate communication. Oxytocin and Δ_O were measured in picograms per milliliter.

* $p < .05$; ** $p < .01$. Probability values are two-tailed.

was linearly related to oxytocin at T₁, $r(98) = .24$, p (two-tailed) = .02; T₂, $r(98) = .21$, $p = .04$; and T₃, $r(98) = .28$, $p = .01$. Participant education level was also linearly related to oxytocin at T₁, $r(98) = .24$, p (two-tailed) = .02; T₂, $r(98) = .21$, $p = .04$; and T₃, $r(98) = .22$, $p = .03$. Neither age nor education level was significantly associated with Δ_O .

Hypotheses and Research Question

The first hypothesis was that trait affectionate communication predicts oxytocinergic reactivity to stressors, with higher trait affection associated with greater increases in oxytocin. The research question asked whether the relationship between trait affection and oxytocinergic reactivity is moderated by sex. The prediction was tested using hierarchical regression analysis, with Δ_O as the criterion variable. Δ_O values were positive when oxytocin increased in response to the stressors and negative when it decreased. The first step of the regression contained participant sex (dummy coded as male = 0, female = 1), participant age, and participant education level. The second step contained trait affectionate communication. The latter variable was grand mean centered, although raw mean scores are reported herein for ease of interpretation. To test the RQ, a third step containing the interaction effect of participant sex and trait affectionate communication was entered. The interaction effect was nonsignificant, so the third step was removed in the service of parsimony.

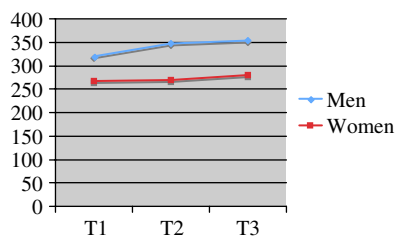


Figure 1 Oxytocin levels (pg/ml) at baseline (T₁), halfway through stress induction (T₂), and after stress induction (T₃) ($N = 100$).

Table 2 Regression Predicting Oxytocin Response From Trait Affectionate Communication ($N = 100$)

Step	Variables	<i>B</i>	SE <i>B</i>	β	ΔR^2
1.	Participant Sex	-26.54	22.48	-.12	.05
	Participant Age	3.09	1.79	.19	
	Participant Education	1.04	10.27	.01	
2.	Trait Affectionate Communication	24.77	10.46	.24*	.06*

Note. $R^2 = .10$; adjusted $R^2 = .07$; $F(4, 92) = 2.66$, $p = .037$.

* $p < .05$.

As hypothesized, with the effect of participant sex controlled, trait affectionate communication predicted oxytocin response to stressors, $\beta = .24$, $p = .02$. Full regression results appear in Table 2. Hypothesis 1 is supported. In response to RQ1, the effect of trait affectionate communication on oxytocinergic reactivity was not moderated by sex.

The second hypothesis was that state affectionate communication also predicts oxytocinergic reactivity to stressors, with higher state affection associated with greater increases in oxytocin. The research question asked whether the relationship between state affection and oxytocinergic reactivity is moderated by sex. The hypothesis was tested in a regression identical to that used for H1, except that the predictor in the second step was the diary measure of affectionate communication given and received in the previous week. As with trait affectionate communication, the diary measure was grand mean centered but raw scores are reported herein. To test the RQ, a third step containing the interaction effect of participant sex and state affectionate communication was entered. The interaction effect was nonsignificant, so the third step was again removed. As hypothesized, with the effect of participant sex controlled, state affectionate communication predicted oxytocin response to stressors, $\beta = .24$, $p = .02$. Full regression results appear in Table 3. Hypothesis 2 is supported. In response to the RQ, the effect of state affectionate communication on oxytocinergic reactivity was not moderated by sex.

Table 3 Regression Predicting Oxytocin Response From State Affectionate Communication ($N = 100$)

Step	Variables	<i>B</i>	SE <i>B</i>	β	ΔR^2
1.	Participant Sex	-30.38	22.66	-.14	.05
	Participant Age	3.18	1.79	.20	
	Participant Education	-.08	10.27	.00	
2.	Trait Affectionate Communication	58.04	18.79	.31*	.09*

Note. $R^2 = .15$; adjusted $R^2 = .11$; $F(4, 90) = 3.81$, $p = .007$.

* $p < .05$.

Discussion

As expected, both state and trait affection were directly predictive of oxytocinergic response to stressors. Participant sex did not moderate either relationship. These findings suggest that the more affectionate communication people share, the better prepared they are to respond physiologically to external stressors. Affectionate communication, therefore, acts as a buffer, making stressors less physiologically aversive. Herein are discussed the implications of these findings, the strengths and limitations of the study design, and important directions for future research.

Implications

The stress-buffering effect of affectionate communication has implications for theory, research, and intervention. First, this study supported AET by identifying another relationship between physiological well-being and affectionate communication. Whereas previous research has indicated effects of affectionate communication in the adrenal, metabolic, and cardiovascular systems, the present study indicates involvement of the oxytocinergic system as well, which AET specifically predicts but which had not previously been tested. More broadly, the present findings support theoretic perspectives that predict a relationship between supportive relational behavior and health. These theories, most of which are neo-Darwinian in nature, argue that supportive communication acts enhance the ability of an individual to fulfill superordinate evolutionary goals of survival and reproduction. When the findings of the current study are taken in concert with the host of previous research explicated above delineating a relationship between affectionate communication and health, it becomes apparent that communication theorists should endeavor to understand further how aspects of communication relate to individual health and adaptive quality.

Second, this study furthers the discourse surrounding oxytocin and its effect on individual responses to stress. Specifically, the data support the findings from experiments showing that higher levels of circulating oxytocin lead to an accelerated physiological recovery from stress (e.g., Ditzen et al., 2009; Heinrichs et al., 2003). They also extend research illustrating a relationship between oxytocin and individual communicative behavior (Kosfeld et al., 2005). It was potentially meaningful for TBT that the oxytocin effects were not moderated by sex, insofar as TBT identifies oxytocin as particularly efficacious for females as opposed to males. Although it would be premature to draw conclusions from null results, the findings warrant additional tests to determine whether TBT's sex-differentiation claim is tenable.

Finally, the current study may contribute to the development of behavioral interventions for individuals suffering from high levels of stress. If affectionate behavior, as both a state and a trait, buffers the body from the effects of stressors via elevated oxytocin, then individuals might be advised to increase affectionate behaviors in their relationships to acquire such a benefit. Previous experiments,

such as Floyd et al. (2009), have shown efficacy for such interventions in other physiological realms.

Strengths, Limitations, and Future Directions

The current experiment was characterized by at least three important strengths, the first of which is its use of objective physiological markers of the stress response. Some previous studies (e.g., Floyd, 2002, 2005) have relied on self-report instruments to assess stress. Although such measures have their place, they are subject to both self-awareness and self-presentation biases that can skew their results. In contrast, studies such as the present study benefit from employing direct hormonal measures of the body's response to stress, which are practically immune to self-awareness and self-presentation biases, yielding a more accurate view of the stress experience.

A second strength, relevant for external validity, is the inclusion of both state and trait measures of affectionate communication. Whereas the trait measure indexes one's global assessment of affection exchange, the diary measure provided a week-in-the-life accounting of levels of affection exchanged. Including both types of measures as predictors mitigated the possibility that observed patterns were operationally bound either to trait-level or state-level assessments. Contrariwise, oxytocinergic response to stressors was significantly predicted both by people's global assessments of their affectionate behavior and by their seven-day accounting of affectionate behavior.

Finally, although the sample size was moderate relative to that typically seen in interpersonal communication research, it was considerably larger than that commonly used in studies employing psychophysiological assessments (e.g., Kurup & Kurup, 2003; Marazziti & Canale, 2004; van Niekerk, Huppert, & Herbert, 2001). Although a relative lack of error inherent in hormonal measures (as opposed to self-report instruments) argues for the adequacy of smaller samples, the relatively large sample in the present experiment ensures greater statistical power and higher external validity than are often seen in studies using these methods.

An important limitation of the current study was that both the stress induction and the hormonal assessments required extensive prescreening of potential participants and the enforcement of multiple inclusion and exclusion criteria. Those criteria helped to ensure that the hormonal assays would be valid and that participants would not be placed at undue risk by the venipuncture or the stressors. They also ensured, however, that the participants in the sample were healthier, on average, than the population from which they were drawn, raising valid concerns about the generalizability of the findings.

An important focus for future research would be the causal nature of the associations between affectionate, oxytocin, and stress. Because state and trait affection were measured prior to analyzing participants' oxytocin responses to stressors, it was evident that the affection measures predicted the oxytocinergic response. Because affectionate communication was not *manipulated*, however, it is uncertain whether affectionate communication, or some aspect of it, directly caused

the hormonal response. Future studies could add empirical clarity to these relationships by examining the associations in the context of experimental manipulations.

Future research should also continue to identify links between affectionate communication and the stress response in other areas of the endocrine system as well as in other physiological systems. Such efforts could include examining the influence of affection on immune responses or investigating brain images of individuals who are both skilled and unskilled at communicating affection while they are experiencing high levels of stress. Finally, to the extent that affectionate communication has diverse physiological benefits, communication researchers should understand how certain psychological traits limit the ability of the individual to communicate affection, perhaps leading to the development of interventions to help such individuals become more skilled.

Notes

- [1] According to Department of Health and Human Services guidelines, nonpregnant adults participating in studies involving venipuncture must have a minimum body weight of 50 kg if the blood volume to be drawn exceeds 240 ml within an eight-week period. Although the volume drawn in the present study was below that threshold, this inclusion criterion was nonetheless imposed, both to enhance participant safety and to increase the comparability of present findings with those of previous studies in which larger blood volumes were drawn.
- [2] Two other factors were produced but were not used in the present analyses. Details of those factors are available from the lead author.

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