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Abstract

The Tend and Befriend theory builds on the observation that human beings affiliate in response to stress. Under conditions of threat, they tend to offspring to ensure their survival and affiliate with others for joint protection and comfort. These responses are underpinned by an affiliative neurocircuitry that appears to be based on oxytocin and endogenous opioid peptides. When close relationships are threatened or one is socially isolated, a rise in plasma oxytocin occurs, a biological marker that may signal a need for affiliation: Oxytocin prompts affiliative behavior in response to stress, in conjunction with the opioid system. Together with positive social contacts, oxytocin attenuates biological stress responses that would otherwise arise in response to social threats. These social responses to stress and their biological underpinnings appear to be more characteristic of women than men. The model helps to unravel puzzles not only in the research literature but also with respect to health and may shed light on why women live longer than men.

Social relationships are vital resources for managing the demands of the environment. Human beings' social nature may have evolved in part because of the needs that we have for contact with others to ensure safety from threat. Whereas other species have thick skin, sharp teeth, quick reflexes, or camouflage to protect themselves, human beings have adopted group living as the primary solution to problems of survival and reproduction. Social isolation is both psychologically and physically toxic, and it is associated with a heightened risk of death and early mortality (Cacioppo & Hawkley, 2003; House, Landis, & Umberson, 1988). In addition to survival benefits, social relationships serve important regulatory functions. For example, contact with a nurturant caregiver early in life is essential for the development of biological stress regulatory systems (e.g., Repetti, Taylor, & Seeman, 2002; Repetti, Taylor, & Saxbe, 2007), and social support is protective across the lifespan (Taylor, 2009, for a review).

Responses to Threat: Fight or Flight

Despite the centrality of the social group to human wellbeing and survival, research on stress and threat has, until recently, largely ignored the importance of social mechanisms for addressing responses to threat. Instead, stress research has been guided heavily by the fight or flight metaphor, responses that may protect individuals but that are not social in nature. First articulated by Walter Cannon (1932), the fight or flight response has two components, a behavioral component and a biological component. In response to a threat, a person can become aggressive and mount an active or antagonistic response to the threatening circumstances, or the person can flee, either literally or metaphorically. Among the responses that contemporary stress researchers interpret as flight behavior are social withdrawal and substance use, especially alcohol and drug use.

The biological component of fight or flight depends on two interacting stress systems, the sympathetic nervous system and the hypothalamic pituitary adrenocortical (HPA) axis. The actions of the sympathetic adrenomedullary (SAM) system are mediated primarily by the catecholamines norepinephrine and epinephrine, which produce, among other changes, increased heart rate and blood pressure, dilation of the airways, and enhanced availability of glucose and fatty acids for energy. Engagement of the HPA axis begins with the release of corticotrophin releasing hormone (CRH), stimulating the secretion of adrenocorticotropin hormone (ACTH) by the anterior pituitary gland, resulting in the release of glucocorticoids, such as cortisol. Cortisol helps to restore processes that prime homeostatic defense mechanisms, and as such, HPA axis reactivity modulates a wide range of functions, including energy release and immune activity.

These two systems are important because they account for the protective short-term effects of stress responses but also their long-term costs. On the short term, they shunt reserves of energy for fight or flight, and the subjective experience is often arousal and feelings of anger, fear, or anxiety. As such, these systems mobilize the body to meet the demands of pressing situations and then engage homeostatic mechanisms that return the body to its previous functioning. With repeated or recurrent stress, however, these biological stress responses have long-term costs that have implications for health (McEwen, 1998). The theory of allostatic load (McEwen, 1998) maintains that repeated or chronic engagement of stress systems interacts with genetic vulnerabilities and acquired risks (such as poor health habits) to erode the resiliency of biological stress regulatory systems and increase the likelihood of disease. These include such chronic disorders as coronary heart disease, hypertension, Type II diabetes, and some cancers. These long-term costs provide important conceptual underpinnings to the tend and befriend theory to be articulated, because, as will be seen, social contact during times of stress and social

relationships more generally exert protective effects against these potential long-term costs of stress.

When stress researchers began to study stress in human beings, they borrowed from animal research in ways conducive to identifying fight or flight responses in humans (Taylor, Klein, Lewis, Gruenewald, Gurung, & Updegraff, 2000). Although fighting and fleeing are unquestionably part of the human repertoire for responding to threat, there are at least two reasons to suspect that they are unlikely to be the only or primary responses. First, fighting can leave vulnerable offspring at risk for predation. Likewise, fleeing with an infant or toddler might slow the caregiver down to be at enhanced risk for attack.

Human beings would not have survived as a species had they not developed stress responses that protected their offspring as well as self in times of danger. Humans evolved in small hunter-gatherer groups, and so coming together as a group instead of fighting or fleeing would provide greater defense as well as information about resource location for combating threats. In short, there are many reasons to believe that humans have used social relationships not only as a basic accommodation to the exigencies of life, but also as a primary resource for dealing with stressful circumstances.

Responses to Threat: Tend and Befriend

To characterize these social responses to threat, we developed the theory "tend and befriend" (Taylor, 2002; Taylor et al., 2000). The theory maintains that under conditions of threat, tending to offspring and affiliating with others (befriending) are common responses in humans.

Development of the Theory

The theory of tend and befriend was initiated in 1998 when the members of our laboratory group went to hear a prominent animal stress researcher present his work. He made the statement "we shocked the animals and, of course, they all attacked each other." This was an arresting statement, in large part because it is quite contrary to what one sees in human beings. When there is an immediate threat, human beings are more likely to affiliate with one another and to offer each other aid or solace than to attack one another. Accordingly, our lab group began a series of discussions to develop what would become the theory of tend and befriend as a characterization of human social responses to stress.

Our point of departure was evolutionary theory. A dilemma with any evolutionary-based theory of social behavior, however, is the potential for "just so" stories, a reference to Rudyard Kipling's fables about how the leopard got his spots, the elephant, his trunk, and the like. Such stories can seem plausible, but have no basis in fact. Accordingly, in building our theory, we imposed constraints on its development. Our method of constraint was to build parallel and mutually constraining biological and behavioral models. For every hypothesis we developed that generated a behavioral statement for the tend and befriend theory, we required evidence at the biological level. The reverse was also true. Any biological literature that yielded a potential insight for the theory was constrained by a requirement of evidence at the behavioral level. Using these criteria, we jettisoned a number of otherwise promising hypotheses early on. Thus, the following characterization of the theory meets the criteria for evidence at both the biological and behavioral levels.

Overview of the Theory

Drawing on animal and human studies, we maintain that there is an affiliative neurocircuitry that monitors that adequacy of social contact in light of the demands of the

environment and prompts affiliation when necessary, regulating social approach behavior. We suggest that this system works in much the same way as occurs for other appetitive needs. That is, just as people have basic needs of hunger, thirst, and sexual drive, they also need to maintain an adequate level of protective and rewarding social relationships.

We hypothesize that there is a biological signaling system that comes into play when affiliations fall below an adequate level. Once signaled, the appetitive need is met through purposeful social behavior, such as affiliation. If social contacts are hostile and unsupportive, then psychological and biological stress responses are heightened and efforts toward social affiliation may be redoubled. If social contacts are supportive and comforting, stress responses decline. These positive contacts, then, lead to a decline in the need for affiliation and, in the context of stress, a decline in biological stress responses. The model is pictured in Figure 1.

On the biological level, the theory draws heavily on oxytocin and the opioid system. Oxytocin and endogenous opioid peptides are released in response to at least some stressors, especially those that trigger affiliative needs. Oxytocin prompts affiliative behavior in response to stress in conjunction with the opioid system; and oxytocin together with positive social contacts attenuates biological stress responses that otherwise arise in response to social threats. We suggest that this oxytocin-opioid system is an appetitive system that regulates social approach behavior and recruits the neurocircuitry for reward in its enactment. Finally, we maintain that some of the health benefits associated with social support and social integration are mediated by this appetitive social approach system via attenuation of threat responses.

Tend and befriend responses to stress may be particularly characteristic of women. At the time when human stress responses evolved, generally thought to be the Pleistocene Era, tasks of daily living were largely sex-segregated, with men heavily responsible for protection and

hunting and women primarily responsible for childcare and foraging. Consequently, women's responses to threat would have evolved so as to protect not only self but also immature offspring in their care. Affiliating with the social group for joint protection of self and offspring would have had substantial survival benefits, helping to ensure that offspring would reach an age when they could reproduce.

This is not to suggest that tend and befriend responses are exclusive to women. A large literature indicates that under stress, both men and women turn to others for protection and solace (see Taylor 2009, for a review). A gender difference exists such that women are somewhat more likely to seek and use social support in response to stress than men are (Tamres, Janicki, & Helgeson, 2002). However, this difference, although robust, is relatively modest in size, and thus, men's social responses to stress are well documented.

Theoretical Principles and Evidence for Tend and Befriend

Biological Signaling System: Social Pain/Separation

Because affiliation is vital to the survival of human beings, there are likely to be biobehavioral mechanisms that are sensitive to social threats or loss of social contact, resulting in social distress and consequent efforts to establish or restore positive social contacts. One paradigm for such a system is separation distress, which has been studied primarily in young animals and human infants. When the young are separated from the caregiver, separation distress can result leading to distress vocalizations (e.g., crying in human infants) or active efforts to find the caregiver.

This system appears to depend in part on brain opioids. Evidence consistent with this pathway includes the fact that brain opioids reduce separation distress and opioid-based drugs, such as morphine, reduce distress vocalizations in animal offspring separated from the mother

(Panksepp, 1998). Similarly, depriving animals of companionship can increase their consumption of exogenous opioids. Genetic evidence, likewise, suggests a role for opioids in the separation distress process. Mice that lack the μ-opioid receptor gene emit fewer distress vocalizations when separated from their mothers (Moles, Kieffer, & D'Amato, 2004). Of interest, the opioid system is also vital to the experience and management of physical pain, and so researchers have inferred that the experience of social pain and separation distress may build on the neurocircuitry for physical pain. Recent genetic and neuroimaging studies with humans have lent credibility to this idea (Eisenberger, Lieberman, & Williams, 2003; Way & Taylor, 2009).

Oxytocin also appears to be implicated in distress due to social isolation. Adults as well as young children encounter gaps in their social relationships and may experience an analogue of separation distress. To address this point, in a laboratory study, we gave women measures of psychological and social functioning and related their responses to their levels of plasma oxytocin (Taylor, Gonzaga, Klein, Hu, Greendale, & Seeman, 2006). The questionnaires assessed gaps in the women's relationships, including recent declines in contacts with significant others and how positive and negative their relationships were. Women who were experiencing gaps in their social relationships had high levels of oxytocin. They were more likely to report reduced contact with their mothers, with their best friend, with a pet, and with the social groups to which they belonged. Oxytocin levels were also related to the absence of positive relations with a partner. Specifically, women who reported that their husbands were not supportive, did not understand how they felt about things, and did not care for them had higher levels of oxytocin. These women reported that they could not open up to their husbands if they needed to share their concerns. Poor quality of the marital relationship and infrequent displays of affection

were also associated with high levels of oxytocin. These findings suggest that oxytocin is sensitive to the absence of positive significant social relationships. Similar results were reported by Turner and colleagues (Turner, Altemus, Enos, Cooper, & McGuinness, 1999) who found that elevated oxytocin was associated with anxiety over relationships, not being in a primary relationship, or having cold, intrusive relationships (see also Taylor, Saphire-Bernstein, & Seeman, 2009).

It is, of course, possible that women with high levels of oxytocin are inclined to construe their social relationships as unsupportive. Some evidence argues against this direction of causality: women who reported declines in contact with a pet and mother often had experienced their deaths, and women's oxytocin levels are unlikely to have caused these deaths. A recent animal study provides more definitive evidence regarding the direction of causality. Specifically, Grippo and colleagues (Grippo et al., 2007) isolated female prairie voles and found that oxytocin levels increased in response to social isolation.

In summary, social pain and separation are psychologically distressing, and the opioid and oxytocin systems are implicated in these responses.

Affiliation

The tend and befriend theory maintains that in response to either a psychological or biological impetus to affiliate or both, people seek contact with others. As an affiliative hormone, oxytocin may provide this impetus for social contact. Manifold evidence from animal studies shows that exogenous administration of oxytocin leads to affiliation in species as varied as rats, monkeys, and sheep. The injection of oxytocin leads to increases in maternal behavior, in grooming, and in other prosocial behavior (e.g., Carter, Lederhendler, & Kirkpatrick, 1999, for a review).

Opioid mechanisms also appear to be implicated in these processes. Administration of an opioid antagonist, for example, such as naloxone or naltrexone, results in less caregiving and protective behavior toward infants in rhesus monkeys (Martel, Nevison, Rayment, Simpson, & Keverne 1993), inhibits maternal behavior in sheep (Kendrick & Keverne, 1989), and diminishes the rewarding aspect of maternal cues in rats (Panksepp, Nelson, & Bekkedal, 1999). Animals demonstrate a preference for other animals in whose presence they have previously experienced high levels of oxytocin and opioid activity (Panksepp, 1998). Administration of an opioid antagonist can suppress juvenile social behavior (Jalowiec, Calcagnetti, & Fanselow, 1989), and opioid-blocking agents have been tied to reduced social activity and grooming in rhesus monkeys (Martel et al., 1993).

There is suggestive evidence that opioid-blocking agents may suppress human social behavior as well. Specifically, in one study (Jamner, Alberts, Leigh, & Klein, 1998), administration of an opioid-blocking agent increased the amount of time that women chose to spend alone, reduced the amount of contact they had with friends, reduced the likelihood that they would contact their friends, and reduced the pleasantness of interactions with friends. Exogenous administration of oxytocin appears to enhance prosocial behavior and instill a sense of trust (Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005; Zak, Kurzban, & Matzner, 2004).

Thus, a broad array of affiliative behaviors appear to be subserved by oxytocin and opioid mechanisms in both animals and humans, although the animal data are more plentiful at this point in time.

Tending and Responses to Stress

The original tend and befriend model maintained that maternal nurturance and tending under stressful conditions have specific advantages for offspring by protecting them from

physical harm and increasing the likelihood that they will grow to adulthood and reproduce. Recent empirical developments indicate that the importance of tending to offspring in response to threat is far broader than the early theoretical statements would imply.

Animal Studies

In an important animal model, Meaney and colleagues (Francis, Diorio, Liu, & Meaney, 1999; Liu et al., 1997) explicitly linked early nurturant maternal contact following a stressful encounter to the development of stress responses in offspring. In their paradigm, infant rats are removed from the nest, stroked, and then returned to the nest. The response of the mother to this separation and reunification is intense licking and grooming and arched-back nursing, which provides the pup with nurturant, soothing immediate stimulation. On the short term, this contact reduces SAM and HPA axis responses to stress in the pups.

Over the long term, this maternal behavior results in a better regulated HPA axis response to stress and novelty, and better regulation of somatic growth and neural development, especially hippocampal synaptic development in the pup. These rat pups also show more open field exploration, which suggests lower levels of fear. This compelling animal model suggests that nurturant stimulation by the mother in response to stressful encounters modulates the responses of offspring to stress in ways that have permanent effects on the offspring's HPA axis responses to stress, on behavior suggestive of anxiety/fearfulness, and on cognitive function (see also Suomi, 1999).

Human Studies

Warm, nurturant, and supportive contact with a caregiver affects physiological and neuroendocrine stress responses in human infants and children just as in these animal studies. Early research on orphans reported high levels of emotional disturbance, especially depression,

in infants who failed to receive nurturant stimulating contact from a caregiver (Spitz & Wolff, 1946). More recent findings from Eastern European abandoned infants confirm that, without the affectionate attentions of caregivers, infants may fail to thrive and many die (Carlson & Earls, 1997).

Building on observations such as these, attachment theory characterizes how vital early nurturant contact is to psychological and biological development (Bowlby, 1969/1982). Through the comforting behavior of attachment figures, typically parents, infants learn to understand and respond to the world. Bowlby regarded attachment behavior as regulated by an innate motivational system to ensure physical and psychological proximity to a caregiver. When a child experiences the attachment figure as responsive, effective self-regulation, exploratory behavior, and normative biological responses to challenges may result. However, when there is a threat to this relationship, the child may react biologically and behaviorally with signs of stress and seek attention and comfort.

Attachment also moderates biological responses to stress. Studying 15-month old children receiving well-baby examinations, Gunnar and her associates found that securely-attached infants were less likely to show elevated cortisol responses to normal stressors such as inoculations than were less securely attached infants (Gunnar, Brodersen, Krueger, & Rigatuso, 1996; see also Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996). The protective effects of secure attachment were especially evident for socially fearful or inhibited children (see also Levine & Wiener, 1988; Hart, Gunnar, & Cicchetti, 1996; see Collins & Feeney, 2000, for a discussion of attachment in adult supportive relationships).

Early on, children depend critically on physical contact with primary caregivers, but over time, they develop internal working models of these interactions that may buffer them when the

primary caregiver is absent. If significant others are perceived to be warm, responsive, and available, a secure attachment will result. If significant others are cold, rejecting, unpredictable, or insensitive, however, an anxious or insecure attachment may result. Instead of being able to draw on an internal working model of caregivers for comfort and solace, the child may instead regulate his or her behavior by withdrawing from others or excessively demanding attention.

To a degree, the attachments laid down early in life provide a model for adult attachments (Fraley, 2002). That is, warm, nurturant contact with parents provides a model not only for stress responses and emotion regulation throughout childhood, but also for adult social relationships, and children who come from families in which they experienced warm, attentive behavior are more likely to develop the social skills that serve them well across their lifespan (Repetti et al., 2002). A broad array of evidence demonstrates that children from supportive families are more likely than those from unsupportive families to form secure attachments, and to develop effective emotion regulation skills and social competencies that help them to regulate their responses to stress (Repetti et al., 2002).

In essence, then, the early family environment may provide the groundwork for emotion regulation skills and social competencies for managing stress across the lifespan. In families that are warm and nurturant, children develop secure attachments and learn to manage threat effectively with a lesser physiological/neuroendocrine toll. If they are raised in non-nurturant or conflict-ridden families, children instead experience threatening events more commonly and learn fewer socioemotional skills for managing stress.

Biological Mechanisms

Families characterized by unsupportive relationships have damaging outcomes for the mental, physical, and social health of their offspring, not only on the short term, but across the

lifespan. Overt family conflict, manifested in recurrent episodes of anger and aggression, deficient nurturing, and family relationships that are cold, unsupportive, and/or neglectful have been associated with a broad array of adverse mental and physical health outcomes long into adulthood (Repetti, Taylor, & Seeman, 2002; Repetti, Taylor, & Saxbe, 2007). The chronic stress of unsupportive families produces repeated or chronic sympathetic nervous system (SNS) activation in children, which in turn, may lead to wear and tear on the cardiovascular system.

Epigenetic factors appear to be involved in these pathways as well. That is, maternal nurturance can induce long lasting changes in the function of genes, which is an additional mechanism by which experiences of early nurturance can induce long term behavioral alterations in emotional and social functioning. For example, Suomi (1987) reported that highly reactive monkeys cross-fostered to nurturant mothers develop good socioemotional skills and achieve high status in the dominance hierarchy, whereas monkeys with reactive temperaments who are peer-raised develop poor socioemotional skills and end up at the bottom of the dominance hierarchy.

Such long-term effects of maternal care appear to be a result of epigenetic structural alterations (methylation) to the glucocorticoid receptor gene that affect its expression throughout the lifespan (Meaney & Szyf, 2005). Mothers showing high levels of nurturant behavior exhibit greater increases in oxytocin receptors during pregnancy, which is the thought to trigger maternal responsivity (Meaney, 2001), and have higher levels of dopamine release when caring for their pups (Champagne et al., 2004). This especially nurturant mothering triggers greater increases in serotonin turnover in the pup, which initiates the cascade leading to the altered glucocorticoid receptor expression that affects adult reactivity to stress (Meaney & Szyf, 2005).

Related evidence has been uncovered with humans. For example, the harshness or nurturance of the early family environment is implicated in the expression of the serotonin transporter gene (5-HTTLPR). People with two copies of the short allele (short/short) of this gene and who have experienced childhood maltreatment are more likely to be diagnosed with major depressive disorder than individuals with one or two copies of the long allele who have experienced similar environments (Caspi et al., 2003; Kaufman et al., 2004). However, a study from our laboratory (Taylor, Way, Welch, Hilmert, Lehman, & Eisenberger, 2006) qualifies this conclusion: the short allele may function not only as a risk allele for depression in conjunction with an adverse early environment, but as an allele reflecting general sensitivity to the environment, providing protection from symptoms of depression when the environment is nurturant. Using a non-clinical sample of 118 adult men and women, we assessed nurturance of the early family environment, depressive symptomatology, and 5-HTTLPR genotype. As expected, a stressful early family environment by itself was significantly related to depressive symptomatology. However, a significant gene-by-environment interaction between the 5-HTTLPR and the nurturance of the early family environment qualified this risk. Specifically, individuals with two copies of the short allele had greater depressive symptomatology if they had experienced early familial adversity compared to participants with the short/long or long/long genotypes, but significantly less depressive symptomatology if they reported a nurturant early environment.

Thus, long-term, often permanent effects of early nurturance are evident not only at the behavioral level, but also at the biological level and can include the functioning of relevant genes. Tending to offspring in times of stress, then, offers not only immediate protection, but long-term protection in the form of biological and behavioral responses to stress.

Befriending and Responses to Stress

Just as offspring are benefitted through tending, so befriending confers stress regulatory benefits.

Animal Studies

Animal studies with rats, sheep, prairie voles, and other species show that exogenous administration of oxytocin or stimulation of oxytocin secretion via stroking decreases sympathetic reactivity, blood pressure, pain sensitivity, and glucocorticoid levels, among other findings suggestive of reduced biological stress responses (Carter, 1998; Insel, 1997; Petersson, Alster, Lundeberg, & Uvnäs-Moberg, 1996; Uvnäs-Moberg, 1997; Uvnäs-Moberg, Ahlenius, Hillegaart, & Alster, 1994). Oxytocin also reduces psychological distress, having anxiolytic properties (McCarthy, 1995). For example, exogenous administration of oxytocin enhances sedation and relaxation, is tied to signs of reduced fearfulness in rodent studies, and is tied to enhanced exploratory behavior (Uvnäs-Moberg et al., 1994; Mantella, Vollmer, Li, & Amico, 2003; McCarthy, 1995).

Human Studies

Similar findings have been identified in human studies. For example, high levels of oxytocin or exogenous administration of oxytocin in humans produce decreases in sympathetic activity (e.g., Light et al., 2000; Uvnäs-Moberg, 1997) and inhibit secretion of ACTH and cortisol (Altemus, Deuster, Galliven, Carter, & Gold, 1995; Chiodera & Legros, 1981). Heinrichs and colleagues (Heinrichs, Baumgartner, Kirshbaum, & Ehlert, 2003) found that exogenous administration of oxytocin produced lower anxiety and lower cortisol levels during a laboratory stress challenge; the reduced cortisol response was especially pronounced in men who also experienced social support from a friend (see also, Kosfeld et al., 2005; Zak et al., 2004).

Breastfeeding mothers in whom oxytocin levels are high have lower anxiety, depression, and stress following breastfeeding as compared with bottle-feeding (Modahl & Newton, 1979). Oxytocin increases the sensitivity of brain opioid systems and so, when oxytocin injection is accompanied by an opioid-blocking agent, cortisol levels do not change. Thus, some of the anti-stress pathways properties of oxytocin are probably mediated via an opioid pathway.

Social Support

When people affiliate in response to stress, they commonly experience social support. Social support is defined as the perception or experience that one is loved and cared for by others, esteemed and valued, and part of a social network of mutual assistance and obligations (Wills, 1991). Social support may come from a partner, relatives, friends, coworkers, social and community ties, strangers, and even a devoted pet (Allen, Blascovich, & Mendes, 2002).

Taxonomies of social support typically classify it into several specific forms. Informational support occurs when one person helps another to understand a stressful event better by providing information about the event. Instrumental support involves the provision of tangible assistance, such as services, financial assistance, and other specific aid or goods. Emotional support involves providing warmth and assistance to another person and reassuring that person that he or she is a valuable person for whom others care. Social support may involve the reality of using the social network for benefits such as these, but it can also involve simply the perception that such resources are available should they be needed. That is, just knowing that one is cared for and that one could obtain support from others is often comforting in its own right.

Social contacts and social support are psychologically beneficial. Social support reduces psychological distress such as depression or anxiety during times of stress (e.g., Fleming, Baum,

Gisriel, & Gatchel, 1982; Lin, Ye, & Ensel, 1999; Sarason, Sarason, & Gurung, 1997). It promotes psychological adjustment to chronically stressful conditions, such as coronary artery disease (Holahan, Moos, Holahan, & Brennan, 1997), diabetes, HIV (Turner-Cobb et al., 2002), and cancer (Penninx, van Tilburg, Boeke, Deeg, Kriegsman, & van Eijk, 1998; Stone, Mezzacappa, Donatone, & Gonder, 1999), among many other health-related disorders. Social support protects against cognitive decline in older adults (Seeman, Lusignolo, Albert, & Berkman, 2001), heart disease among the recently widowed (Sorkin, Rook, & Lu, 2002), and psychological distress in response to traumatic events, such as 9/11 (Simeon, Greenberg, Nelson, Schmeider, & Hollander, 2005), among other psychological benefits.

Health Benefits of Social Support

Social support has been tied to a variety of specific health benefits among individuals sustaining health risks. These include fewer complications during pregnancy and childbirth (Collins, Dunkel-Schetter, Lobel, & Scrimshaw, 1993), less susceptibility to herpes attacks among infected individuals (VanderPlate, Aral, & Magder, 1988), lower rates of myocardial infarction among individuals with diagnosed disease, a reduced likelihood of mortality from myocardial infarction (Kulik & Mahler, 1993; Wiklund, Oden, Sanne, Ulvenstam, Wilhemsson, & Wilhemsen, 1988), faster recovery from coronary artery disease surgery (King, Reis, Porter, & Norsen, 1993; Kulik & Mahler, 1993), better diabetes control (Marteau, Bloch, & Baum, 1987), longer survival in patients with end-stage renal disease (Cohen, Sharma, Acquaviva, Peterson, Patel, & Kimmel, 2007), and less pain among arthritis patients (Brown, Sheffield, Leary, & Robinson, 2003).

Social support also contributes to survival. In a classic study of 7,000 community residents in Alameda County, CA, epidemiologists Lisa Berkman and Leonard Syme (1979)

found that people who lacked social and community ties over the previous 9 years were more likely to die of all causes during the follow-up period than those who cultivated or maintained their social relationships. Having social contacts predicted an average 2.8 years increased longevity among woman and 2.3 years among men, and these differences persisted after controlling for socioeconomic status, health status at the beginning of the study, and health habits (Berkman & Syme, 1979; see also Rutledge et al., 2004).

The positive impact of social contacts on health is as powerful or more powerful a predictor of health and longevity than well-established risk factors for chronic disease and mortality, with effect sizes on par with smoking, blood pressure, lipids, obesity, and physical activity (House, Landis, & Umberson, 1988). And as noted, in both animal and human studies, social isolation is tied to a significantly enhanced risk of mortality (House, Landis & Umberson, 1988) and a heightened risk of both chronic and acute health disorders (Taylor, 2009).

Mechanisms Underlying Health Benefits

Although not all the mechanisms explaining these strong relationships are known, one key pathway is via stress responses (Cacioppo & Hawkley, 2003). When humans are socially isolated, their sympathetic nervous system and HPA axis responses to stress may continue unabated. Consistent with the theory of allostatic load described earlier, to the extent that contact with others in times of stress reduces sympathetic and HPA axis activity in response to threats, cumulative wear and tear on biological functioning is lessened. Social contact, then, may leave people less vulnerable to immunologic compromise in response to stress and to health disorders tied to the excessive or recurrent functioning of the sympathetic nervous system and HPA axis.

Whether the attenuation of stress responses by oxytocin and opioids contribute to these clinical effects of social support is, at present, unclear. However, animal research using a wound healing paradigm suggests that this is a promising avenue for research (Detillion, Craft, Glasper, Prendergast, & DeVries, 2004). In this study, female Siberian hamsters received a cutaneous wound and were then exposed to immobilization stress. The stressor increased cortisol concentrations and impaired wound healing, but only in socially isolated and not in socially housed animals. Thus, social housing acted as a stress buffer. Removing cortisol via adrenalectomy eliminated the impact of the stressor on wound healing, thereby implicating the HPA axis in the wound healing process. Of particular relevance to the current arguments, treating the isolated hamsters with oxytocin eliminated the stress-induced increases in cortisol and facilitated wound healing; treating socially-housed hamsters with an oxytocin antagonist delayed wound healing. These data strongly imply that social contacts protect against the adverse effects of stress through a mechanism that implicates oxytocin-induced suppression of the HPA axis. Thus, there appear to be discernible clinical consequences (wound healing) of oxytocin in conjunction with social contact.

To summarize, evidence that social responses to threat in the form of tending and befriending are associated with beneficial mental and physical health outcomes is overwhelming. Both animal and human studies attest not only to the beneficial effects of social contact in times of stress, but also to the mechanisms that may underpin these relations.

Sex Differences in Tend and Befriend

Most, but not all, of the research demonstrating both the psychological effects of oxytocin and endogenous opioid peptides as well as their effects on downregulating stress responses has been conducted with female animals or with women. Although there is evidence

that these processes may be implicated in men's reduced stress responses as well (e.g., Heinrichs et al., 2003), the research is less plentiful. Moreover, the biological underpinnings of the theory would appear to be more consistent with what is known about women's hormonal profiles than men's. For example, oxytocin's effects are enhanced in the presence of estrogen (see Taylor et al., 2000).

There is, however, a hormone, vasopressin (AVP), that is very similar in molecular structure to oxytocin and whose effects appear to be enhanced in the presence of androgens, and so it may play a parallel role in male social behavior (Panksepp, 1998). AVP is important to stress responses because it is involved in the maintenance of plasma volume and blood pressure during shock, among other functions. In certain monogamous species, most notably the prairie vole, it has also been tied to males' prosocial responses to stress, for example, guarding and patrolling of territory, defense of mate, and defense of offspring against intruders. The AVP receptor gene has also been tied to pair bonding, monogamous behavior (Lim et al., 2004), empathy, and altruistic behavior (Anckarsäter & Cloninger, 2007; Knafo et al., 2008). In a recent test of the potential role of AVP in men's social behavior, Taylor, Saphire-Bernstein, and Seeman (2009) examined whether elevations in vasopressin and oxytocin were associated with dissatisfaction in the pair bond relationship in men and women. Consistent with previous research described earlier, oxytocin was elevated in women experiencing distress, but vasopressin was not. Exactly the reverse pattern was found for men, such that men who were in distressing pair bond relationships had elevated AVP but not OT. Thus, elevated plasma AVP in men may act as a signal that the pair bond relationship is jeopardized, just as elevations in plasma OT have been found to signal relationship distress in women. Whether vasopressin

underlies additional aspects of men's affiliative responses to stress is currently unknown, but this issue merits additional exploration.

Social Issue Implications of Tend and Befriend

What critical social issues and problems are raised or resolved by insights generated by the tend and befriend theory? One important social issue on which the theory helps to shed light is sex differences in life expectancy. Men are especially vulnerable to early mortality due to homicide, suicide, coronary heart disease, and disorders related to substance abuse for coping with stress. Women, on the other hand, enjoy a substantial advantage in mortality in most countries of the world. Only countries in which women are denied access to healthcare or those in which deaths during childbirth are still common show a reverse gap. Of interest is the fact that the causes of death that largely account for men's early mortality are those related to the fight or flight response, namely, aggressive responses to stress, withdrawal in the form of substance abuse, and coronary artery disease, the risk for which is exacerbated by frequent or recurrent stress exposure. By contrast, women more reliably turn to their social contacts in times of stress, responses that are, as just noted, protective of health and longevity. The fact that men may be somewhat more likely to cope with stress via fight or flight and women to cope with stress via tend and befriend may help to explain the world-wide gender gap in mortality.

Building on this point, the theory may help to explain sudden increases in mortality rates that are seen in countries experiencing substantial economic and political turmoil. For example, following the end of the Soviet Union in 1989, destabilization of the Eastern European social environment left many people socially unattached. Whereas unattached women often came together in informal groups with other women and children and shared the management of tasks of daily life, men more often coped with the same instability through alcohol abuse, smoking,

and aggressive encounters with other males (Bobak & Marmot, 1996; Stone, 2000). Men in the former Eastern European nations subsequently experienced an abrupt decline of approximately 7 years in life expectancy in a mere 5 years, worse than that sustained during World War II. This decline in life expectancy was explained substantially by deaths among unattached men (Bobak & Marmot, 1996; Stone, 2000). Having a theoretical basis for explaining events such as these, and the psychological and biological mechanisms that underpin them, constitutes an advance that may help governments to anticipate similar problems and intervene, so that similar upheaval does not result in similar carnage.

The theory and the evidence consistent with tend and befriend also point to the importance of making affiliative opportunities available to people when they are under stress. Affiliation is inherently comforting, even when no explicit efforts at social support are elicited or provided. Although questions have recently been raised about the necessity or value of making psychological counseling available to people in the immediate aftermath of a trauma or highly stressful event, providing people with opportunities for companionship which they may utilize in whatever ways are most comforting may be useful interventions.

A final issue on which the tend and befriend model sheds light concerns the relative benefits and costs of altruistic behavior. Conceptualizations of altruism and social support have been guided by the implicit assumption that support is beneficial for the recipient but costly for the provider. This viewpoint has been shaped by the evolutionary perspective on altruism which addresses the paradox: How do we pass on our altruistic genes to future generations if those genes put us at potential risk? That is, when one person helps another in times of threat, the likelihood that the helper will be harmed can be high. Research on the physical and psychological costs of caregiving, would seem to support the position that altruism is inherently

costly. From an evolutionary perspective, altruism is largely rescued by the concept of reciprocal altruism (Hamilton, 1963; Trivers, 1971).

Evidence consistent with the tend and befriend model, however, demonstrates that the nurturant behavior of tending not only benefits the offspring but also benefits the tender. That is, tending behavior following a stressful encounter not only downregulates the stress systems of offspring, but also the stress systems of the mother; thus, to the extent that caregivers are providing nurturant behavior to others, their own stress systems may be benefitted in cumulative fashion. Research by Brown and colleagues (Brown, Nesse, Vinokur, & Smith, 2003) found that death rates were significantly lower among people who provided instrumental support to friends, relatives and neighbors, and emotional support to their spouses. Receiving support did not affect mortality, once giving support was statistically controlled. Thus, this study provides important evidence that the giving of support can promote health or retard illness progression. There are psychological benefits of giving support to others as well. Giving support may cement personal relationships, provide a sense of meaning or purpose, and signify that one matters, all of which have been found to promote wellbeing.

It is likely, then, that the benefits of providing support and the apparent absence of anticipated costs may work through some of the same physiological and neuroendocrine pathways whereby the receipt of support or perception of it from others achieves its benefits. In addition, the anxiolytic properties of oxytocin coupled with its established role in downregulating SNS and HPA axis responses to stress, may help to provide an understanding of the mental and physical health benefits of providing social support as well as receiving it.

Thoughts for the Future

Useful theories in social psychology are marked not only by their ability to explain a body of data and generate specific hypotheses, but also by their ability to expand and grow as new evidence emerges. The tend and befriend theory is no different. Among the extensions that have occurred since the original publication of the theory in 2000 (Taylor et al., 2000) is the accumulating evidence for a biologically-based signaling system that may alert people to the need to enhance their social contacts and impel them to do so as well; the fact that plasma oxytocin in women and plasma vasopressin in men are elevated in conjunction with breaches in social contact is a relatively recent discovery.

A second extension involves the integration of evidence concerning the biological stress regulatory effects of maternal nurturance into the theory. Although insights regarding the importance of maternal nurturance for developing offspring's biological stress regulatory systems has been accumulating, the mechanisms underlying these effects remained unknown until relatively recently. Both animal and human evidence now points to some of the biological mechanisms, including epigenetic mechanisms, that help to explain why maternal nurturance in times of stress is so vital to the development of offspring biological systems and socioemotional skills for managing stress. Integrating this evidence more fully with the literature on the biological and psychological bases of attachment is an important future step.

A third advance concerns potential genetic contributions to the processes detailed in the tend and befriend theory. At the time the theory was developed, little was known about what specific genes might contribute to tending, befriending, and social behavior more generally. The only evidence for genetic contributions to social behavior was from twin studies indicating a large genetic contribution to the experience of social support (Kessler, Kendler, Heath, Neale, & Eaves, 1992). Research has now enabled the identification of specific genes within the opioid,

oxytocin, vasopressin, dopamine, and serotonin systems that may be implicated in the processes detailed here (see Way & Taylor, 2009, for a review).

Just as accumulating evidence has expanded the theory in certain ways, so additional research has identified certain problems to be resolved. For example, elevated plasma oxytocin is tied to social distress, whereas exogenous administration of oxytocin is tied to a sense of calm and relaxation. This paradox has yet to be fully resolved. As noted, biological underpinnings of men's social responses to stress have yet to be as rigorously explored, although some recent progress has been made (Taylor et al., 2009). No doubt the future will pose additional challenges for the theory.

Tend and Befriend: Biobehavioral Redundancy?

Many of the benefits of social contact appear to result from sheer proximity and not necessarily from the socially supportive transactions that have typically been studied by social psychologists and health psychologists. For example, social ties are consistently found to be mentally and physically health protective in both stressful and non-stressful environments, whereas social support transactions appear to be most beneficial in situations of stress. Qualifying this last finding further, a large number of circumstances have been identified in which social support transactions are unsuccessful or have unintended negative consequences. Bolger and colleagues (e.g., Bolger & Amarel, 2007), for example, have suggested that invisible support, that is, support provided by a person without the recipient's awareness, is more beneficial to emotional functioning than social support efforts that are recognized by both the giver and the recipient as intended. Awareness that one is being supported may represent a threat to self-esteem. Research on the matching hypothesis, namely the idea that social support is most effective when it matches the need of the recipient (Cohen & McKay, 1984), also

indicates a variety of circumstances under which mismatches between the type of support delivered or the person delivering it exacerbate stress (see Taylor, 2009, for a review). Social contacts during stressful times have the potential to be negative, and research has shown that negative interactions can have a worse effect on mental and physical health functioning than positive effects achieve beneficial effects (e.g., Rook, 1984). Other misfired efforts at social support have also been identified (see Taylor, 2009, for a review).

These findings suggest that simple proximity and the perception of support may be especially beneficial but not necessarily its use. That is, much of the benefit of social support may come from the perception that it is available and not necessarily its actual engagement (Thoits, 1995; Taylor, 2009). A biobehavioral theory of affiliation, as tend and befriend is, has little trouble with this paradox. Either the psychological benefits associated with social contact, the hormonal underpinnings of social contact, or both may produce many of the beneficial biological and psychological consequences that consistently predict wellbeing both in stressful and non-stressful times.

A common observation in biological research concerns the redundancy that exists in the human being for sustaining vital biological functions. For example, there are five different mechanisms that ensure that the stomach can digest food. Similarly, people are endowed with two eyes, two hands, two legs, two kidneys, and the like. Not all vital functions are backed up through redundancy, of course, the heart being an obvious counterexample. However, many are, and it may be useful to think about psychological processes as contributing to the human beings' redundancy to ensure vital processes.

At the outset of this chapter, the point was made that social living in general and affiliation in response to threat in particular are essential to human survival. It is unlikely that

these critical responses would be left to chance or even to a single underlying psychological or biological mechanism. Rather, the fact that there is both biological and psychological evidence for tending and befriending in response to stress suggests that these may be interrelated but semi redundant pathways that ensure that social responses to threat take place, so as to protect human beings and ensure their survival.

Although a theory that focuses on affiliative responses to threat, as the tend and befriend theory does, stresses the important protective role that these processes have, it must be noted that tending and befriending also promote human growth as well. Through affiliation with others in times of stress and the ability to draw on mental representations of relationships, people acquire the resources to explore and grow both emotionally and intellectually in environments that ensure social connection.

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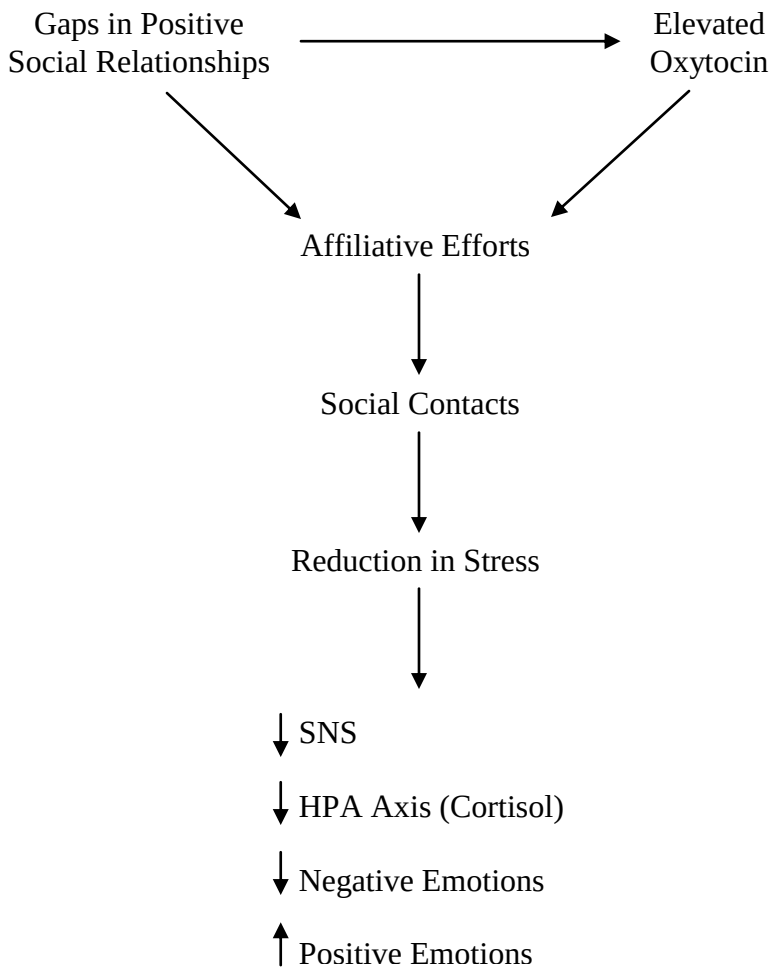

Figure 1. Tend and Befriend