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Social Responses to Stress: The Tend and Befriend Model

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For decades, the scientific study of stress has been guided by the theory of 'fight-or-flight' (Cannon, 1932). From this standpoint, animals and humans exhibit two typical responses to external threats. If the threat is one that will yield to aggressive action, then "fight" responses will be seen. In animal studies, the fight response typically assumes the form of physical aggression, whereas in humans, the fight response may assume any of multiple forms, including physical aggression, verbal aggression, or other approach-based coping responses such as active problem solving. Likewise, the "flight" response usually assumes the literal form of fleeing in animals, but in humans, fleeing can take on additional forms, such as social withdrawal or withdrawal through substance use such as alcohol or drugs.

Although this viewpoint is consistent with most animal research, it ignores one of human beings' most basic ways of fending off threats, namely the fact that they live in small groups that afford joint protection. To characterize these affiliative responses to stress, we have developed a model of "tend-and-befriend" (S. E. Taylor, 2002; S. E. Taylor, Klein, Lewis, Gruenewald, Gurung, & Updegraff, 2000). Tending involves nurturant activities designed to protect the self and offspring that may promote safety and reduce distress. Befriending is the creation and maintenance of social networks that may aid in this process. Especially under conditions of stress, people protect their offspring and affiliate with others for protection and comfort. In this chapter, we review the evidence for tending and befriending under stress, explore the neural and neuroendocrine underpinnings of these responses, discuss gender differences in tend and befriend responses, and suggest clinical implications and directions for future work.

Stress and Affiliation

Social relationships are a significant part of life, and perhaps never more so than under conditions of stress. A large and growing body of research provides evidence that the perception

or use of social support under stressful conditions is associated with positive effects on an array of mental and physical health disorders, such as cardiovascular disease (e.g., Grace et al., 2002; Lett et al., 2005), depression (e.g., Sayal et al., 2002), systemic lupus erythematosus (Bae, Hashimoto, Karlson, Liang, & Daltroy, 2001), and progression in HIV infection (Lesserman et al., 2002). Importantly, both the quantity and quality of social relationships have also been reliably related to mortality (e.g., House, Landis, & Umberson, 1988).

The beneficial biological effects of social support are likely heavily mediated by two interacting bioregulatory systems, the sympathetic nervous system (SNS) and the hypothalamic pituitary adrenal (HPA) axis. Together these systems mobilize an organism for concerted efforts to combat or escape from threat, and as such, these biological systems are protective. However, over the long-term, repeated or prolonged engagement of these systems can lead to accumulating damage to the underlying stress systems. These changes can reduce the resiliency of stress systems, and the resulting wear and tear on the body's physiological systems has been termed allostatic load (McEwen, 1998). Alterations in the functioning of other systems, such as the immune system, are also implicated (Uchino, 2006). In interaction with genetic risks, accumulating allostatic load may enhance one's prospects for an array of chronic diseases. Tend and befriend is conceived of as affiliative responses to stress that may protect against the buildup of allostatic load.

Tending. Tending to offspring in times of threat, we argue, is a primary frontline response for ensuring survival of the species. In addition, on the short-term, tending responses to stress are beneficial because they reduce biological reactivity to stress in parent and offspring. Over the long-term tending helps offspring to develop socioemotional skills for managing stress, and it shapes their biological stress regulatory systems. Evidence from both animal and human studies

suggests that the beneficial effects of tending on physical and mental health begin with supportive familial contacts in early life.

The earliest evidence for the benefits of tending comes from Harlow and Harlow's (1962) studies with monkeys who were raised with an artificial terrycloth mother and who were isolated from other monkeys during the first six months of life. These monkeys showed disruptions in their adult social contacts, they were less likely than those raised by their mothers to engage in normal social behaviors such as grooming, their sexual responses were inappropriate, mothering among the females was deficient, and they often showed highly fearful or abnormally aggressive behavior toward their peers. Furthermore, monkeys who experienced total social isolation and had no surrogate mother for the first six months of life (or more) subsequently had severely damaged or destroyed social and sexual behavioral capabilities (Harlow, Dodsworth, & Harlow, 1965).

Building on work like this, Meaney and colleagues (Francis, Diorio, Liu, & Meaney, 1999; Liu et al., 1997) explicitly demonstrated the relationship between early nurturant contact and the development of stress responses in offspring and showed that maternal contact influences affective and neuroendocrine responses to stress across the lifespan. In their paradigm, infant rats are removed from the nest, handled by a human experimenter, and then returned. 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 and soothing immediate stimulation. On the-short term, this contact reduces SNS and HPA axis responses to stress in the pup (and in the mother as well). Over the long-term, this maternal behavior results in a better regulated HPA axis response to stress and novelty and to better regulation of somatic growth and neural development. This compelling animal model suggests that nurturant maternal stimulation modulates the responses of

offspring to stress in ways that have permanent effects on the offspring's behavioral and biological stress reactivity (Meaney, 2001).

Cross-fostering studies in which highly reactive or less reactive rat pups are cross fostered to exceptionally nurturant or normal mothers indicate that the maternal style of the foster mothers can be adopted independent of the rat pups' temperamental reactivity (e.g., Francis et al., 1999). Highly reactive females raised by especially nurturant mothers not only show lower reactivity themselves, but learn nurturant parenting behaviors, which they then pass on to their offspring. Genomic factors contributing to these effects include glucocorticoid receptor expression (with respect to stress reactivity) and oxytocin receptor expression (with respect to maternal behavior) (see Meaney, 2001, for a review), but non-genomic pathways are also involved; that is, there is evidence of intergenerational transfer of nurturing over and above genetic predispositions (Francis et al., 1999). Tending behavior, thus, is critical not only for modulating immediate responses to stress in both mother and offspring, but also for crafting the psychosocial and biological stress reactivity systems that will serve offspring across the lifespan. These tending skills appear to be transferred intergenerationally through both genomic and non-genomic pathways.

Warm, nurturant, and supportive contact with parents affects physiological and neuroendocrine development in human infants and children as well (Repetti, Taylor, & Seeman, 2002). Families characterized by unsupportive relationships have damaging consequences for the mental, physical, and social health of their offspring, not only on the short-term, but across the lifespan. Neglect of offspring, overt family conflict, and/or relationships that are cold and unsupportive have been tied to a broad array of adverse physical and mental health outcomes long into adulthood (Repetti, Taylor, & Saxbe, 2007). The chronic stress of an unsupportive early

environment produces repeated or chronic stimulation of stress responses. Over time, such alterations may lead to pathogenic changes in the functioning of these systems that permanently alter the neuroendocrine responses and the stress-related behavior of offspring. Indeed, as reviewed by Sanchez (2006), in nonhuman primate infants, early disruptions in the mother-infant relationship are stressful for the infants, and the chronicity and intensity of these experiences appear to have long-term effects on the infants' biological stress responses and socioemtional behavior. For instance, it was found that sustained HPA axis activations early in life resulted in below average functioning of the axis over development. Evidence was also reviewed, however, showing that nurturant caregiving (responsive and sensitive mothering) can buffer against these adverse effects of early adversity. Thus, early nurturant contact, or lack thereof, shapes biological stress responses and lays the groundwork for future mental and physical health and for the development of social competencies.

Befriending. Affiliation with others, "befriending," is vital for managing threatening circumstances. Social interaction is critical for health across the lifespan, and social isolation has been found to be a risk factor for mortality in both animals and humans. For instance, House and colleagues (1988) reviewed evidence from six large prospective studies indicating that mortality is higher among more socially isolated individuals, even when controlling for biomedical risk factors for mortality. They have argued that the data on social support suggest that insufficient social support is an important risk factor for morbidity and mortality, with an effect size similar to that for more well-known risk factors such as cigarette smoking, obesity, physical activity, cholesterol, and blood pressure. The beneficial effects of social support on both mental and physical health are well established (see Taylor, 2007; Uchino, 2006 for reviews), which is due in

part to the ability of social support to mitigate the negative impact of stressors (see Uchino, Cacioppo, & Kiecolt-Glaser, 1996 for a review).

Gender Differences in Tend and Befriend

There appear to be significant gender differences in tending and befriending which may reflect, in part, a robust and biologically-based difference in how men and women cope with stress. Although the behaviors of fight or flight may be especially characteristic of men's responses to stress, tending to offspring and befriending of others may be more characteristic of women's responses to stress (Taylor et al., 2000). This argument is based on the assumption that during early human prehistory, men and women faced somewhat different adaptive challenges, and as a result, developed different stress responses to meet these different challenges. Specifically, females of most species, including humans, have the primary responsibility for the early nurturing of offspring through pregnancy, nursing, and care in early life. Stress responses in females, then, are likely to have evolved in such a way as to simultaneously protect both self and offspring, such as by tending to offspring and befriending others in the social group.

Consistent with this perspective, research indicates that women draw on socially supportive networks more consistently in times of stress than do men, that women may be more benefited by social support than men, and that women provide more frequent and effective social support to others than men provide (Taylor, 2002; Thoits, 1995). Although men typically report larger social networks than women do, in part because of their historically greater involvement in employment and community organizations, studies indicate that women are more invested in their relationships and see their relationships with others as more intimate (e.g., Belle, 1987). Adolescent girls, college age women, and adult women all maintain more same sex close relationships than men do and they turn to their female friends more than men turn to their male

friends (Taylor, 2002). Two meta-analyses (Luckow, Reifman, & McIntosh, 1998; Tamres, Janicki, & Helgeson, 2002) have also found that women were significantly more likely than men to seek and use social support to deal with a broad array of stressors. Women also appear to be more benefited by social contacts in times of stress than men. For example, a meta-analysis on the social support and health literature conducted by Schwarzer and Leppin (1989) found that the correlations between social support and good health were consistently higher for women than for men. In fact, the gender differences in the relationship between social support and health were the most reliable findings of this meta-analysis. Finally, studies of caregiving have found that women are more likely to be support providers than are men. Over eighty percent of care to disabled children, parents, and spouses is provided by mothers, daughters, and wives. Men, by contrast, appear to be more likely to institutionalize their wives in response to the most common causes of care giving such as stroke or Alzheimer's disease. (e.g., Freedman, 1993).

Providing Social Support

Is tending and befriending inherently costly, though, potentially undermining any benefits? In the past, the receipt of social support has been thought to be highly beneficial both biologically and psychologically, but providing social support has been thought to be inherently costly to the provider. On the surface, this is a reasonable concern. The provision of advice, emotional support, or tangible assistance can be costly to a support provider in time and resources. Some evolutionary perspectives on altruism also suggest that altruistic acts can put the provider at risk (Hamilton, 1963). The idea that providing social benefits to others is inherently costly is also given credence by the research on caregiving. Caregiving can be a harmful, even fatal undertaking, as caretakers are at high risk for physical and mental health disorders. Evidence of immunocompromise is often present in caregivers, which can leave them vulnerable to disease

(e.g., Kiecolt-Glaser, Glaser, Gravenstein, Malarkey, & Sheridan, 1996; Newsom & Schulz, 1998). Caregiving can have adverse effects on wound repair (Kiecolt-Glaser, Marucha, Malarkey, Mercado, & Glaser, 1995), on the regulation of sympathetic nervous system responses to stress (Mills et al., 1997), and on natural-killer cell function (Esterling, Kiecolt-Glaser, & Glaser, 1996) among other adverse effects. Although evidence such as this would seem to bear out the viewpoint that giving social aid is costly, the majority of these studies have focused on populations that involve particularly burdensome caregiving.

In recent years, the benefits of giving social support have become better understood, and research now suggests that providing social aid to another may be stress-reducing for the provider as well as the recipient. For example, Trivers' (1971) reciprocal altruism perspective suggests that providing aid to others increases the likelihood that there will be others there for you when your needs arise. Giving support to others may cement a personal relationship, provide a sense of meaning and purpose, and signify that one matters to others, all of which promote wellbeing (J. Taylor & Turner, 2001; Batson, 1998). Helping others may also reduce psychological distress (Midlarsky, 1991) and contribute to good health and longevity (Brown, Nesse, Vinokur, & Smith, 2003; Luoh & Herzog, 2002; Schwartz & Sendor, 2000).

Although the exact mechanisms underlying the benefits of giving support to others are not fully understood, the animal studies on the impact of nurturing behavior on offspring may represent a useful model. That is, not only are offspring soothed by nurturant contact, but the animal providing the nurturant contact, namely the mother, is benefited as well, in the form of reduced sympathetic arousal and signs of reduced agitation, among other benefits (Liu et al., 1997; Coplan et al., 1998). Thus, it is possible that the benefits of providing support to others

operate through some of the same physiological and neuroendocrine pathways through which the receipt of support from others achieves its benefits.

Biological Bases of Tend and Befriend

The tend and befriend system is conceived of as an affiliative neurocircuitry that may piggyback onto other basic drives such as hunger, thirst, sexual drives, and other appetites. Fundamentally, tend and befriend is a behavioral approach system that may be chronically in place, but that becomes especially important in times of threat or stress. As occurs for other appetites, we suggest that there is a biological signaling system that comes into play if one's affiliative contacts fall below an adequate level. Once signaled, the appetitive need is met through purposeful social behavior. If contacts are hostile, unsupportive, or also under threat, then psychological and biological stress responses may increase, but if social contacts are supportive and comforting and provide protection, then stress responses are likely to decline. Such positive contacts, in turn, should lead to a decline in the need and a decline in stress responses.

Biological underpinnings of the tend and befriend responses appear to be based at least in part on oxytocin and on the endogenous opioid peptide system. Oxytocin and opioids are both released in response to at least some stressors, and oxytocin, potentially in consort with opioids, attenuates biological stress responses. Additionally, because biological neurocircuitries tend to be efficient, the dopamine and opioid systems that are recruited for other reward-based systems are likely to be recruited for the satisfaction of affiliative needs as well (see Depue & Morrone-Strupinsky, 2005). Indeed, affiliation, including affiliative activities related to stress reduction (Depue & Morrone-Strupinsky), and cues of loved ones (e.g., Aron, Fisher, Mashek, Strong, Li, & Brown, 2005) can activate the dopamine-mediated reward system in the brain.

Role of Oxytocin

Oxytocin (OT) is a neural hormone that is produced in the paraventricular (PVN) and supraoptic nuclei of the hypothalamus and is released into circulation from the magnocellular neurons which extend down to the posterior pituitary. Oxytocin is additionally released by parvocellular neurons within the PVN that may project to many other areas within the brain including the hypothalamus, amygdala, locus coeruleus, the dorsal motor nucleus of the vagus nerve, and the periaqueductal grey matter and nuclus raphe magnus (Millan, 2002; Sofroniew, 1983). Oxytocin is most widely known for its roles in childbirth, lactation, pair bonding (e.g., mother-infant, female-male), and sexual behavior. Positive social contact, such as affectionate contact, can also induce the flow of oxytocin (e.g., Uvnas-Möberg, 1999). As previously mentioned, oxytocin has consistently been found to reduce anxiety and biological stress responses. Because the impact of oxytocin is modulated by estrogen (see Insel, 1992), oxytocin's effects are thought to be stronger in females than in males, and may be implicated in the maternal tending of offspring seen in response to stress.

Biological Signaling System. 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. Evidence for this idea comes from research on separation distress. In a variety of species, when the young are separated from the mother, separation distress in offspring can result, leading to distress vocalizations which may prompt the return of the caregiver. This system appears to be dependent, in part, on oxytocin and brain opioids (Panksepp, 1992).

Adults experience separation distress as well, and oxytocin may act as a signal prompting affiliative behavior. Research from our laboratory examined the relation of plasma oxytocin levels to reports of relationship distress in adult women and found that women who were experiencing gaps in their social relationships had significantly elevated levels of oxytocin

(Taylor et al., 2006). Specifically, women with high levels of oxytocin were more likely to report reduced contact with their mothers, their best friends, a pet, and the social groups of which they were a part. In addition, the women with significant others were more likely to report that their partners were not supportive, did not understand the way they felt about things, and did not care for them compared to women with lower levels of oxytocin. Poor quality of the marital relationship and infrequent displays of affection by the partner were also associated with higher levels of plasma oxytocin. Plasma oxytocin was unrelated to general psychological distress, only to gaps or problems in positive relationships, and whereas oxytocin appeared to signal gaps in relationships, cortisol levels were not similarly elevated. These points suggest discriminant validity for the relation of oxytocin to relationship distress. Similar findings have been reported by Turner, Altemus, Enos, Cooper, and McGuinness (1999), who found that elevated plasma oxytocin was associated with anxiety over relationships, perceived coldness or intrusiveness in relationships, and not being in a primary romantic relationship. Thus, elevated levels of plasma oxytocin appear to signal relationship distress, at least in women.

Relation of Oxytocin to Affiliation. If oxytocin is related to social distress, then as an affiliative hormone, oxytocin may provide an impetus for social contact to ameliorate stress. There is manifold evidence that oxytocin promotes affiliation, much of which has come from animal studies (e.g., Panksepp, Nelson, & Bekkedal, 1999; see Insel, 1997 for a review). Exogenously administered oxytocin has been related to increases in physical proximity, increased maternal behavior, grooming, and preferences for members of one's own species in whose presence elevated oxytocin was experienced (see Panksepp, 1998; Taylor, 2002 for reviews). Oxytocin is thought to underlie affiliative activities in humans as well, including maternal behavior and social bonding more generally (e.g., Carter, 1998; Carter, Lederhendler, &

Kirkpatrick, 1999; Taylor, 2002). Thus, it appears that affiliative behaviors may be subserved by oxytocin.

Relationship of Oxytocin to Stress Responses. Oxytocin can reduce the magnitude of stress responses, and as such, may be a proximal hormonal stimulus for the beneficial effects of social contact during stress. Animal studies have shown that exogenous administration of oxytocin or stimulation of oxytocin secretion results in enhanced sedation and relaxation, reduced anxiety, decreased sympathetic activity, decreased activity of the HPA axis, and elevated vagal nerve tone (associated with parasympathetic functioning), among other effects suggestive of reduced biological reactivity (Carter, 1998; Uvnas-Möberg, 1997; Uvnas-Möberg, 1998a). Oxytocin also has analgesic effects that may aid in combating certain kinds of stressors (e.g., Petersson, Alster, Lundeberg, & Uvnas-Möberg, 1996).

Research with humans, while more sparse, suggests similar effects. For example, in breastfeeding women (Light et al., 2000) and women reporting more frequent hugs from partners (Light, Grewen, & Amico, 2005), (both of which are populations in which oxytocin levels have been found to be elevated), and in men receiving exogenous administration of oxytocin (Heinrichs, Baumgartner, Kirshbaum, & Ehlert, 2003), psychological and biological stress responses are lower. Breastfeeding women report less anxiety than bottle-feeding mothers, show lower blood pressure, lower vascular resistance level, and higher cardiac output both before and during stress (e.g., Altemus et al., 2001; Grewen & Light, 2006; Mezzacappa & Katkin, 2002). The level of calm reported by breastfeeding mothers is highly correlated with their plasma oxytocin levels (Uvnas-Möberg, 1996). Overall, the evidence that naturally elevated levels of oxytocin or exogenously-administrated oxytocin attenuate stress responses is strong in both animal and human studies.

Does Oxytocin Underpin Tend and Befriend?

Oxytocin appears to be importantly implicated in the dynamics of the tending and befriending response to stress. Oxytocin is at high levels following the birth of offspring and appears to promote bonding (Feldman, Weller, Zagoory-Sharon, & Levine, 2007). Also, oxytocin levels increase in response to physical social contacts such as touch and grooming (Stock & Uvnas-Möberg, 1988; Uvnas-Möberg, Bruzelius, Olster, & Lunderberg, 1993), and from massage-like stroking in both infant and adult mammals, including humans (Turner et al., 1999; Uvnas-Möberg, 2004). The physical contact that may result from affiliation may reduce anxiety and SNS and HPA axis responses to stress (e.g., Uvnas-Möberg, 1998b).

Is oxytocin implicated in befriending processes? Animal research suggests that it may be. In a study by Detillion, Craft, Glasper, Prendergast, and DeVries (2004), 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 (removal of the adrenal glands) eliminated the impact of the stressor on wound healing, thereby implicating the HPA axis in the healing process. Of particular interest, treating the isolated hamsters with oxytocin eliminated stress-induced increases in cortisol and facilitated wound healing; treating socially-housed hamsters with an oxytocin antagonist delayed wound healing. These data imply that, consistent with the tend and befriend perspective, social contacts can protect against the adverse effects of stress through a mechanism that implicates oxytocin-induced suppression of the HPA axis.

Opioid Mechanisms

Opioids are known for their rewarding, analgesic, and addictive properties. Numerous studies also suggest an important contribution of endogenous opioid peptides in the modulation and regulation of stress responses. Endogenous opioids are released in the brain during stress, and they are believed to be involved in the blunting and termination of cardiovascular and neuroendocrine stress responses (Drolet et al., 2001; McCubbin, 1993). Thus, the release of opioids during stress may serve as an inbuilt defense system that balances the response that stressors place on the organism against the potential detrimental effects that sustained stress responses may produce.

Opioids are also believed to influence affiliative and social responses to stress (see Taylor, Dickerson, & Klein, 2002 for a review) and have been found to play an important role in social attachment (Nelson & Panksepp, 1998). For instance, exogenous and endogenous opioids have been found to alleviate separation distress (as measured by isolation cries) in dogs, guinea pigs, chicks, rats, and primates (Panksepp, 1998; Panksepp, Herman, Vilberg, Bishop, & DeEskinazi, 1980). Behavioral quieting in response to social contact may also be opioid-based (Panksepp et al., 1980). In addition, opioid levels are elevated following bouts of allogrooming in monkeys (Keverne, Martensz, & Tuite, 1989), social contact can have analgesic effects at least partially mediated by opioid release in mice (D'Amato & Pavone, 1996), and social interaction with the mother can induce release of opioids in rats (Blass & Fitzgerald, 1988; Carden & Hofer, 1990). Thus, in terms of the tend-and-befriend framework, these findings suggest that opioids are involved in the benefits of "tending," as endogenous opioid release resulting from social contact may reduce the emotional and biological consequences of stress. In addition, opioids may play a role in "befriending," as they may mediate the rewarding properties of affiliative interactions, thus promoting subsequent social interactions.

Future Directions

Several issues regarding the relationship of oxytocin and opioid mechanisms to tending and befriending processes and to stress responses require additional research. First, if affiliative efforts are unrequited or negative, heightened stress responses may occur. In a study consistent with this point (Taylor et al., 2006), women participated in a socially threatening laboratory challenge task, and their responses were assessed. Those with low levels of plasma oxytocin showed an increase in cortisol in response to the social threat and a decrease during recovery. By contrast, women with initially high plasma oxytocin levels had significantly higher cortisol levels initially, which decreased early on in the laboratory procedures, but then again became elevated during the threat tasks. These findings suggest that women with high levels of oxytocin may be especially attuned to social features of the environment, and their levels of stress may be exacerbated by unsupportive social contacts. Thus, quality of social contacts during stressful times may be an important variable for understanding the relation of oxytocin to stress responses.

The fact that high levels of oxytocin can be associated both with relationship distress and with reduced stress responses also represents an issue on which further research is needed. One hypothesis is that bursts of oxytocin, as may occur in response to anticipated or actual social contact or exogenous administration of oxytocin, reduce stress responses, but levels of oxytocin in the plasma, which likely represent trace evidence of some preceding process, are associated with relationship distress (Turner et al., 1999; but see Grewen, Girdler, Amico, & Light, 2005). Turner and colleagues (1999) have also suggested that chronically elevated levels of basal oxytocin may be indicative of poor oxytocin regulation in response to social stimuli.

Another possible resolution stems from the fact that most studies documenting the stress-reducing qualities of oxytocin have not disentangled the effects of oxytocin from affiliation itself

or its anticipation. It may be that affiliation and its biological consequences produce some of the effects that have been attributed to oxytocin. A least some of the stress- reducing properties associated with affiliation appear to be mediated by a downstream opioid pathway. Whether unrequited social contact implicates this opioid pathway is unclear.

Much of the preceding discussion has focused on women's responses to stress, because there is considerable evidence that women both seek and provide more social support than men do under stressful conditions. Although these gender differences are very robust, they are relatively modest in magnitude, which means that men also typically affiliate in response to stress. Whether there are biological underpinnings of men's affiliative responses to stress has been largely unknown. One possibility is that oxytocin underlies affiliative tendencies in men just as it does in women. Exogenous administration of oxytocin has stress reducing properties in men just as it does in women (e.g., Heinrichs et al., 2003), and recent research has shown that exogenous administration of oxytocin can enhance feelings of trust and cooperative behavior in men (e.g., Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005). Nonetheless, because oxytocin is strongly regulated by estrogen and antagonized, at least in some species, by androgens, some researchers have speculated that oxytocin is a more potent influence on affiliative behavior in women than in men (Taylor et al., 2000).

A hormone very similar to oxytocin in molecular structure is vasopressin, and in certain respects, vasopressin may be a male counterpart to oxytocin in women (see Insel, 1997). Animal studies, for example, have found that vasopressin is related to mate guarding and other social activities in male prairie voles (Carter, 1998), and research implicates the vasopressin receptor gene in empathetic responses to others in men (Keverne & Curley, 2004). In summary, men clearly engage in affiliative activities of many kinds under stressful conditions, and although the

biological underpinnings of such behavior are not yet fully known, it appears that both oxytocin and vasopressin may be involved.

Clinical Implications

If the tend and befriend model represents a viable perspective on human responses to stress and to gender differences in these responses, then there should be predictable mental and physical health consequences. A first and obvious point is that if tending and befriending with others is an adaptive response to stress, then those who draw on affiliative contact to combat stress should experience better mental and physical health outcomes than those who do so less. The literature on social support makes precisely these points (see Taylor, 2007 for a review). In terms of clinical disorders, one would expect to see men somewhat overrepresented in disorders related to fight and flight, and this is also the case. For instance, men are more likely to die of homicide and suicide and of complications related to substance abuse than are women (Verbrugge, 1983). Although women are closing the gender mortality gap as their lifestyles have changed, the female propensity to use social support for dealing with stressful events as opposed to responses indicative of fight or flight may be reflected in women's consistently longer lifespan throughout the world.

Still, however, just as disorders related to fight-or-flight may be experienced disproportionately by men, might we expect to see that vulnerabilities related to the social network are experienced disproportionately by women? The answer appears to be yes. Women report more stressful events in their social networks than men do and report being more involved in them (see Taylor, 2002, for a review). Indeed, in a longitudinal study with adult opposite-sex twin pairs, it was found that women were more sensitive than men to the depressogenic effect of low levels of social support, suggesting that difficulties in social relationships may play a larger

role in the etiology of major depression in women than in men (Kendler, Myers, & Prescott, 2005). As noted earlier, women's caregiving activities often expose them to mental and physical health risks. Women also show a greater vulnerability to posttraumatic stress disorder (PTSD) than men do, which appears to be tied to the fact that their PTSD-related traumas are often social in nature, such as abuse and rape (Olff, Langeland, Draijer, & Gersons, 2007).

On a more positive clinical note, women may be especially benefited by social interventions to reduce stress. Women are more likely to participate in social support groups than men are. Indeed, one study found that women were more likely than men to use supportive social services of all kinds (Taylor, Falke, Shoptaw, & Lichtman, 1986). There are both good and lamentable aspects of this pattern. On the one hand, women appear to be served well by socially supportive services, but on the other hand, men may choose not to use such services. Women, though, are generous support providers, and the literature clearly indicates that men, children, and other women are benefited by women's propensity to give social support. Except for extreme examples such as caregiving noted earlier, women may profit both psychologically and biologically from their care giving as well as their care seeking.

Conclusions

Human being's basic mode of coping with stress and threatening circumstances is affiliation with others. Since early human prehistory, group living and banding together to combat joint threats have been the major ways that humans have ensured their survival. We have termed such affiliative responses "tend and befriend", referring to the fact that under stressful times human beings tend to their offspring to protect them from harm and affiliate with others for successful joint efforts against threats. The evidence suggests that women are more likely to tend and befriend in response to stress, whereas men may be more likely to engage in the fight or flight

response under stressful circumstances. Clinical implications of these hypothesized differences tend to support the existence of these gender patterns. However, the difference in magnitude in affiliative responses to stress between men and women is relatively small, and clearly men's survival has been beneficially affected by affiliative responses to threat, just as women's survival has.

Issues for future research include the fact that the biological underpinnings of affiliative responses to stress are still uncertain. There is evidence that oxytocin, vasopressin, endogenous opioid peptides, and the dopamine system may underlie affiliative activities and induce lower arousal to threatening circumstances as well. Progress on a biobehavioral model underlying social responses to stress can be expected within the next decades.

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