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Abstract

Affiliation with others is a basic human coping response for managing a broad array of stressful circumstances. Affiliating with others is both psychologically and biologically comforting, and biologically may depend upon oxytocin and brain opioid pathways. The origins of affiliative responses to stress include early life experiences, genetic factors, and epigenetic processes that interact with the availability of supportive others during times of stress. The beneficial consequences of affiliation for mental and physical health are strong and robust. Future research will continue to clarify the underlying biopsychosocial pathways that explicate why this is the case.

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Affiliation with others is one of human beings' most basic coping responses to threat. Whereas other animals have weapons, such as sharp teeth or claws, and defensive resources, such as speed or thick skin, primates, including human beings, depend critically on one another for survival. Correspondingly, social isolation or rejection from a social group are among the most distressing experiences people report (Eisenberger, Lieberman, & Williams, 2003), and social isolation is associated not only with risks to safety, but with long-term mental and physical health risks as well (Cacioppo & Hawkley, 2003). This chapter explores the conceptual basis for understanding the relation of affiliation to stress, the origins of affiliative responses to stress, psychological and biological mechanisms underlying these responses, and consequences of these responses for physical and mental health.

Affiliative Responses to Threat

Social relationships have long been known to sustain human beings in non-threatening as well as threatening times. In recent decades, convincing evidence that affiliation and its consequences also affect biological responses to stress and ultimately physical health has emerged. Thus, social relationships, especially in times of stress, have benefits at both the psychological and biological levels across the lifespan (Taylor, 2009).

Fight or Flight/Tend and Befriend

In the past, when scientists have characterized stress responses, they usually have done so in terms of fight or flight, a response pattern first characterized by Walter Cannon (1932). Fight or flight refers to the fact that in response to threat, an animal or person can become aggressive

and mount an antagonistic response to the threatening circumstances, or it can flee, either literally or metaphorically, from the stressor. Among the responses that stress researchers interpret as flight behavior are social withdrawal and substance use, especially drug and alcohol abuse. Fight and flight represent valuable individual responses for coping with stress, in that either fighting or fleeing has the potential to protect oneself from threats. However, humans are profoundly social and never more so than when the environment is threatening. Accordingly, it is important to characterize these affiliative responses to stress as well. To address the human tendency to affiliate under stress, we developed the term "tend and befriend" (Taylor, 2002; Taylor, Klein, Lewis, Gruenewald, Gurung, & Updegraff, 2000). In contrast to fight or flight, tending to offspring and affiliating with others represent social responses to stress.

The theory, tend and befriend, maintains that there is a biological signaling system that comes into play if one's affiliations fall below an adequate level, a condition that may occur in response to stress. The affiliative neurocircuitry then prompts affiliation in many animal species and in humans. As such, this system regulates social approach behavior and does so in much the same way as occurs for other appetitive needs. Once signaled, this appetitive need is met through purposeful social behaviors, such as affiliation and protecting offspring. As will be noted, oxytocin and endogenous opioid peptides appear to play a role in this system. As we will note later, the biological impetus to affiliate under stress, coupled with the psychological need for contact with others under stress, may represent redundant biobehavioral protective mechanisms that ensure affiliation and corresponding safety when the environment is threatening.

Tend and befriend has its origins in evolutionary theory, and as such tending and befriending may be somewhat more characteristic of women than men as responses to stress

(Taylor et al., 2000). During the time that human stress responses evolved, men and women faced somewhat different adaptive challenges due to the division of labor they assumed. Whereas men were primarily responsible for hunting and for group protection, women were typically responsible for childcare and foraging. Consequently, women's responses to stress are likely to have evolved so as to protect not only self but also offspring during times of stress. Consistent with this position, women are more likely than men to respond to stress by turning to others (Luckow, Reifman, McIntosh, 1998; Tamres, Janicki, & Helgeson, 2002). However, men, too, show social responses to stress, and the gender difference in affiliation in response to stress, although robust, is relatively modest in magnitude. Thus, affiliation in response to stress occurs among both men and women.

Functions of Affiliation

Affiliation serves several vital functions with respect to stress or threat. First, affiliating with others serves to calibrate or shape the biological stress systems that regulate responses to stress across the lifespan. As will be addressed, caregiving relationships, especially those early in life, help to serve this function. Beginning in the early environment, the quality of caregiving an infant receives can permanently affect that infant's biological, emotional, and social responses to stressful conditions. These effects can occur in the form of how genes are manifested in phenotypes and can exert permanent organizational effects on the regulatory systems that shape responses to stress, an issue addressed in more detail later in this article. Ultimately, these responses to stress also predict a broad array of chronic health disorders as well as longevity.

Social affiliation also affects the regulation of stress responses on an acute basis. During daily interactions, as a person copes with more or less stressful circumstances, affiliation influences the magnitude of stress responses. Contacts with others can increase tension and

exaggerate responses to stress, but more commonly, affiliation buffers an individual against the deleterious biological effects of stress. These proximal functions of affiliation in response to stress interact with the more distal calibration of stress systems just described, such that people's responses to stress depend both on the early development of their biological stress regulatory systems as shaped by early relationships, and also on current circumstances that moderate these biological responses to stress.

Affiliation serves practical functions with respect to stress. For example, other people transmit important knowledge about the environment in which stress occurs. This informational function may be direct, as when one person warns another about an impending stressor, or it may be indirect, such that how others respond to a threat provides useful information for the self. Other people can provide tangible aid and assistance that better enables the recipient to cope with stressful events. For example, in harsh economic times, a loan of money from relatives or the opportunity to share living spaces may provide badly-needed resources. Thus, social relationships can act as a barometer of how stressful an environment is and provide assistance for managing a stressful environment (Taylor & Gonzaga, 2006). Finally, affiliation in response to stress can reduce psychological distress. Those with whom one affiliates or from whom one seeks contact may be emotionally supportive and exert calming, soothing effects on the person seeking contact.

Origins of Affiliative Responses to Stress

Affiliation is vital to the survival of human beings. As such, there are likely to be biobehavioral mechanisms that are sensitive to social threat or to loss of social contact, resulting in social distress and efforts to remedy the situation. A large literature on separation distress attests to such processes in young animals and human infants. When the young are separated

from the mother, separation distress can result, especially during particular developmental periods. The experience of separation leads to distress vocalizations (e.g., crying in human infants) or active searching for the caregiver that may prompt the caregiver's return (Panksepp, 1998).

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 response to separation (Panksepp, 1998). There also appear to be genetic bases for these processes that likewise depend on opioid-based processes. For example, mice that lack the μ-opioid receptor gene emit few distress vocalizations when separated from their mothers, suggesting that endogenous opioid binding is a significant basis of infant attachment behavior (Moles, Kieffer, & D'Amato, 2004).

Oxytocin also appears to be implicated in infant bonding, separation, and reunification (Panksepp, 1998). For example, in an experimental study with rats, Nelson and Panksepp (1996), found that attraction to the mother was blocked in animals who had received an oxytocin antagonist, suggesting that oxytocin is implicated in the neurocircuitry that underlies separation and reunification. Oxytocin is also implicated in social distress in adults. Just as infants and young children experience gaps in their social relationships, so adults may experience an analogue of separation distress, which may implicate the same biological systems as in the young. Both animal (Grippo et al., 2007) and human studies support this conclusion. For example, a study from our laboratory found that women who experienced reduced contact with their mothers, with their best friends, with a pet, and with their social groups had especially high levels of oxytocin. Oxytocin levels were also elevated in response to the absence of positive relationships with a partner. Similar results have been found by Turner and colleagues (Turner,

Altimus, Enos, Cooper, & McGuiness, 1999). Grippo, Carter, and colleagues (Grippo et al., 2007) isolated female prairie voles and found that social isolation led to increases in oxytocin, thus confirming the directionality of the effect. Of note, in humans, the evidence to date suggests that oxytocin levels rise primarily in women in response to social stress.

If oxytocin and endogenous opioid peptides are related to social distress, then as part of the affiliative neurocircuitry, they may provide an impetus for social contact to ameliorate stress. Indeed, numerous studies attest to the fact that exogenously-administered oxytocin can act as an impetus to affiliation. Experimental studies with several animal species have found that the administration of oxytocin causes an increase in social contact and in grooming, among other prosocial activities (Argiolas & Gessa, 1991; Carter, De Vries, & Getz, 1995; Witt, Winslow, & Insel, 1992). For example, social contact is enhanced and aggression is diminished following central administration of oxytocin in estrogen-treated prairie voles (Witt, Carter, & Walton, 1990). Although human evidence for this point is more limited, Uvnas-Möberg (1996) found that women who were breastfeeding (and therefore very high in plasma OT concentration), rated themselves as more sociable than age-matched women not breastfeeding or pregnant.

Biological Effects of Affiliation

Biological Responses to Stress: Overview

Researchers have focused heavily on potential physiological, neuroendocrine, and immunologic pathways by which affiliation in response to stress may achieve beneficial effects on stress regulation. What are these pathways? During times of stress, the body releases the catecholamines epinephrine and norepinephrine with concomitant sympathetic nervous system arousal. Stress may also engage the HPA (hypothalamic-pituitary-adrenocortical) axis, involving the release of corticosteriods including cortisol. These responses have short-term protective

effects under stressful circumstances, because they mobilize the body to meet the demands of pressing situations.

However, with chronic or recurrent activation, they can be associated with deleterious long-term implications for health (e.g., Seeman & McEwen, 1996; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). For example, excessive or repeated discharge of epinephrine or norepinephrine can lead to the suppression of cellular immune function, produce hemodynamic changes such as increases in blood pressure and heart rate, provoke abnormal heart rhythms such as ventricular arrhythmias, and produce neurochemical imbalances that may relate to psychiatric disorders (McEwen & Stellar, 1993). Intense, rapid, and/or long-lasting sympathetic responses to repeated stress or challenge have been implicated in the development of hypertension and coronary artery disease.

Stress can also suppress immune functioning in ways that leave a person vulnerable to opportunistic diseases and infections. Corticosteroids have immunosuppressive effects, and stress-related increases in cortisol have been tied to decreased lymphocyte responsivity to mitogenic stimulation and to decreased lymphocyte cytotoxicity. Such immunosuppressive changes may be associated with increased susceptibility to infectious disorders and to destruction of neurons in the hippocampus as well (McEwen & Sapolsky, 1995).

An immunosupression model does not explain how stress might influence diseases whose central feature is excessive inflammation (Miller, Cohen, & Ritchey, 2002); such diseases include allergic, autoimmune, rheumotologic, and cardiovascular disorders, among other disorders that are known to be exacerbated by stress. Miller and colleagues (2002) hypothesized that chronic stress may diminish the immune system's sensitivity to glucocorticoid hormones that normally terminate the inflammatory cascade that occurs during stress. They found a

buffering effect of social support on this process, such that among healthy individuals, glucocorticoid sensitivity bore no relation to social support; however, among parents of children with cancer (a population under extreme stress), those who reported receiving a high level of support from others had higher glucocorticoid sensitivity.

Extensive evidence suggests that these systems -- the HPA axis, the immune system and the sympathetic nervous system -- influence each other and thereby affect each other's functioning. For example, links between HPA axis activity and sympathetic nervous system activity suggest that chronic activation of the HPA axis could potentiate overactivation of sympathetic functioning (Chrousos & Gold, 1992). Proinflammatory cytokines, which are involved in the inflammatory processes just noted, can activate the HPA axis and may contribute not only to the deleterious effects that chronic activation of this system may cause, but also, potentially to depressive symptoms, which have previously been tied to HPA axis activation (Maier & Watkins, 1998; Capuron, Ravaud, & Dantzer, 2000). To the extent, then, that social contact can help keep sympathetic nervous system or HPA axis responses to stress low, it may have a beneficial impact on other systems as well (Seeman & McEwen, 1996; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). In turn, these benefits may affect health in a positive direction.

The Early Social Environment

Substantial evidence from both animal and human studies indicates that nurturant affiliative contacts in early life help to determine the parameters of these stress systems, and consequently not only have beneficial effects on responses to stress but also on mental and physical health across the lifespan.

Biological Consequences of Affiliative Contact in Early Life: Animal Studies

An early study by Harlow and Harlow (1962) found that monkeys who were raised with an artificial terrycloth mother and who were isolated from other monkeys during the first six months of life showed disruptions in their adult social contacts. They were less likely to engage in normal social behavior, such as grooming, their sexual responses were inappropriate, mothering among the females was deficient, and they often showed either highly fearful or abnormally aggressive behavior toward their peers, which, not surprisingly, led to social rejection. These findings suggest that social and emotional regulation skills may be critically engendered by nurturant contact in early life. Of interest, social deficiencies that result from deficient mothering appear to involve precisely the skills that would interfere with an adult offspring's ability to enlist social contact in adulthood.

Building on this work, Meaney and colleagues (Francis, Diorio, Liu, & Meaney, 1999; Liu et al., 1997) linked nurturant maternal contact to the development of stress responses in offspring and showed that these contacts affect emotional and neuroendocrine responses to stress throughout the animals' lives. 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 licking, grooming, and arched-back nursing, especially in species with a genetic predisposition to these behaviors. These contacts provide the pup with nurturant, soothing, immediate stimulation, and on the short-term, reduce 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 better regulation of somatic growth and neural development, especially hippocampal synaptic development. Rat pups exposed to highly nurturant mothering show less emotionality to novel circumstances and more normative social behavior including mothering in

adulthood, compared to recipients of normal mothering. These pups show more open field exploration, suggesting lower levels of fear as well (Francis, Diorio, Liu, & Meaney, 1999; Weaver et al., 2004).

This compelling animal model indicates that nurturant stimulation by the mother early in life modulates the physiological, neuroendocrine, and behavioral responses of offspring to stress in ways that have permanent effects on behavior and on the offspring's developing HPA axis. Studies with monkeys have shown similar effects. 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.

An early nurturant environment can also induce lasting changes in the function of genes, which is an additional mechanism by which early affiliative experience can induce long-term alterations in behavior. Specifically, the long-term behavioral effects of early life maternal care appear to result at least in part from epigenetic structural alterations (methylation) to the glucocorticoid receptor gene that occur in the first week after birth and affect its expression throughout the lifespan (Meaney & Szyf, 2005). Mothers expressing high levels of nurturant behavior exhibited greater increases in oxytocin receptors during pregnancy, which is thought to trigger maternal responsivity (Meaney, 2001), and have higher levels of dopamine release when caring for their pups (Champagne, Chretien, Stevenson, Zhang, Gratton, & Meaney, 2004). The nurturant mothering that results triggers greater increases in serotonin turnover in the pup, which initiates a cascade, leading to altered glucocorticoid receptor expression that beneficially affects adult reactivity to stress (Meaney & Szyf, 2005).

Biological Consequences of Affiliative Contact in Early Life: Human Studies

Similar processes and mechanisms have been identified in humans. Warm, nurturant, supportive contact with a caregiver early in life affects physiological and neuroendocrine stress responses in human infants and children (see Repetti, Taylor, & Seeman, 2002, for a review). Early research on orphans, analogous to the Harlow monkey studies, found 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 attention of caregivers, infants may fail to thrive and many die (Carlson & Earls, 1997).

Similarly, 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, cold non-nurturant behavior, or neglect 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 and/or chronic stress unabated by supportive family contacts may produce repeated or chronic SNS activation in children, which in turn may lead to wear and tear on the cardiovascular system. Over time, such alterations may lead to pathogenic changes in sympathetic or parasympathetic functioning or both. These changes may contribute to adult chronic health disorders such as hypertension and coronary heart disease.

Recurrent or chronic engagement of the HPA axis in response to stress can compromise the efficient functioning of this biological stress regulatory system as well. Specifically, in response to the stress of a harsh early childhood environment, functioning of the HPA axis may

be compromised in any of several ways. Daily cortisol patterns may be altered. Normally, cortisol levels are high upon waking in the morning, but decrease across the day (although peaking following lunch) until they flatten out at low levels in the afternoon. People under chronic stress, however, can show elevated cortisol levels long into the afternoon or evening (Powell et al., 2002), or a general flattening of the diurnal rhythm. In response to acute stress, an elevated flat response to stress (Taylor, Lerner, Sage, Lehman, & Seeman, 2004), an exaggerated cortisol response, a protracted cortisol response, or poor recovery may be seen (McEwen, 1998). Any of these patterns is suggestive of compromises in the ability of the HPA axis to respond to and recover from stress (McEwen, 1998; Pruessner, Hellhammer, Pruessner, & Lupien, 2003).

Attachment is implicated in these processes. Specifically, securely attached infants are less likely to show elevated cortisol responses to normal stress than insecurely attached offspring (Gunnar, Brodersen, Krueger, & Rigatuso, 1996; See also, Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996). The protective effects of secure attachment are especially significant for socially fearful or inhibited children, temperamental characteristics that have a genetic basis.

Early nurturant and supportive contacts are also important for the development of social and emotional regulation skills, especially those involving responses to stress or threat. A broad array of evidence supports the point that children from harsh families are less likely than those from non-nurturant families to develop effective emotion regulation skills and social competencies (Repetti et al., 2002).

Is the calibration and regulation of stress responses confined to early environment? Just as evidence increasingly points to the important role that maternal nurturance plays in the biological stress responses of offspring, some research is beginning to uncover the ways in which adults' affiliative contacts may influence each other's biology as well. An early study

(McClintock, 1971) found that roommates' menstrual cycles become synchronized over time, probably because of olfactory cues (McClintock, 2002). Research examining physiological concordance between clients and clinical psychologists suggests that such concordance is tied to ratings of therapist empathy (Marci, Ham, Moran, & Orr, 2007). These processes may be especially significant in close relationships, and, to a degree, partners may co-regulate or synchronize their physiological and affective states (Diamond, 2001; Sbarra & Hazan, 2008; Pietromonaco, Barrett, & Powers, 2006). Substantial evidence indicates reciprocity of negative affective processes and concomitant physiological arousal in marital couples (e.g., Levenson & Gottman, 1983; Gottman, Coan, Carrere, & Swanson, 1998); that is, one partner's hostility is likely to arouse the other's. In happier marriages, arousal in conflict situations is more often not in synchrony, possibly because one partner may be attempting to calm the more agitated partner (Saxbe, 2009). Hofer (1984) suggested that cohabiting partners influence each other's regulatory symptoms and routine so much that some of the consequences of bereavement, such as disturbed sleep, reduced appetite and social withdrawal, might result from the loss of this biological regulatory influence. Until recently, physiological underpinnings of these processes had not been addressed. There is now some evidence that couples' HPA axis activity may be coordinated (Berg & Wynne-Edwards, 2002; Schreiber et al., 2006). Overall, however, negative emotional states may be more "contagious" than positive ones, suggesting the possibility of the exacerbation of stress within close relationships rather than its amelioration. Such effects may depend on whether both members of a couple are facing a particular stressor or whether only one person is.

Whether adults can influence each other's biology on a chronic basis in the same ways as occur in the mother-infant relationship is unknown, but the answer may be not to the same

degree. Maternal influences occur at the time that biological stress regulatory systems are just developing, and so their effects may be more profound and long-lasting than is true in adult biological co-regulation. Nonetheless, the idea that chronic cohabitation exerts ongoing effects on the biological functioning of both parties, resulting, in some cases, in biological synchrony merits additional attention.

Affiliation and Genetic Pathways

Socioemotional skills that underpin affiliation may have an epigenetic basis in humans as well. This research is in its infancy, and so there is much still to be discovered, but to date, genes involved in the regulation of MAOA, serotonin, and dopamine appear to be implicated. Monoamine oxidase-A (MAOA) is an enzyme that breaks down neurochemicals such as serotonin and dopamine (Shih, Chen, & Ridd, 1999). The MAOA gene that regulates the enzyme has been implicated in antisocial behavior (e.g., Eisenberger, Way, Taylor, Welch, & Lieberman, 2007). For example, in epidemiological studies, men with the low expressing alleles of the MAOA-uVNTR are more likely to engage in aggressive and antisocial activity than men with high expressing alleles; of interest, these effects appear to be especially likely when those with the genetic risk have also been exposed to maltreatment in childhood (Caspi et al., 2002; Kim-Cohen et al., 2006).

The harshness or nurturance of the early family environment also influences the expression of the serotonin transporter gene (5-HTTLPR). People with two copies of the 5-HTTLPR short allele (short/short) 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), although these effects do not always replicate (Risch et al., 2009). A study from our

laboratory (Taylor, Way, Welch, Hilmert, Lehman, & Eisenberger, 2006), which may help to explain these inconsistencies, indicates that the short allele may not function as a risk allele for depression in the face of an adverse environment, but as a general sensitivity allele, providing protection from symptoms of depression when the environment is nurturant. We found a significant gene-by-environment interaction, such that 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 supportive early environment. Notably, the adverse early family environments studied were fairly mild, consisting of some conflict, moderate household chaos, and/or cold, unaffectionate, and distant behaviors, rather than explicit maltreatment in the form of physical or sexual abuse. Thus, nurturant, affiliative contacts in early life can shape the expression of genes in ways that can have lifelong effects on social behavior (such as aggression) and on susceptibility to stress in the social environment.

Certain genes in the dopamine system may show a similar pattern. Researchers have found that, when exposed to non-nurturant parenting, people with the long allele of the polymorphism DRD4 are at higher risk for externalizing behaviors than individuals with other alleles (e.g., Bakermans-Kranenburg & van IJzendoorn, 2006). However, recent evidence indicates that the long allele may increase sensitivity to positive as well as negative parental influences. In one study, when the environment was nurturant, individuals with the long DRD4 allele had low levels of externalizing behavior, but when the environment was harsh, individuals with the same allele had high levels of externalizing behavior. The behavior of individuals with the other alleles was less responsive to parenting quality (Bakermans-Kranenburg & van IJzendoorn, 2007). Bakermans-Kranenburg and colleagues (2008) also found that toddlers with

the long allele of DRD4 were more responsive to a parental educational program designed to reduce externalizing behavior through increasing the attentiveness of parenting, than those with other alleles. Findings such as these offer significant evidence that the social environment early in life can powerfully shape expression of genes related to social behavior across the lifespan.

Affiliative Responses to Acute Stress

A variety of empirical studies have shown that affiliative contact can be protective against the psychological and biological effects of acute stress as well. For example, experimental studies demonstrate that the presence of a supportive person when one is going through a stressful task can reduce cardiovascular and HPA axis responses to stress; these benefits can be experienced whether the supportive person is a partner, a friend, or a stranger (e.g., Christenfeld et al., 1997; Gerin, Pieper, Levy, & Pickering, 1992; Gerin, Milner, Chawla, & Pickering, 1995; Kamark, Manuck, & Jennings, 1990; Kors, Linden, & Gerin, 1997; Lepore, Allen, & Evans, 1993; Sheffield & Carroll, 1994; see Lepore, 1998 for a review).

Oxytocin may play a role in these processes. In response to stress, animals and humans experience a cascade of hormonal responses that begins, at least under some stressful conditions, with the rapid release of oxytocin. Consistent evidence suggests that oxytocin is released in response to stress and that oxytocin is associated with reduced SNS and HPA axis responses to stress (see Taylor, Dickerson, & Klein, 2002). For example, oxytocin is associated with parasympathetic (vagal) functioning that plays a counterregulatory role in fear responses to stress (e.g., Dreifuss, Dubois-Dauphin, Widmer, & Raggenbass, 1992; McCarthy, 1995; Sawchenko & Swanson, 1982; Swanson & Sawchenko, 1980). In experimental studies, oxytocin enhances sedation and relaxation, reduces anxiety, and decreases sympathetic activity (Altemus, Deuster, Galliven, Carter, & Gold, 1995; Uvnas-Moberg, 1997). Exogenous administration of oxytocin in

rats results in decreases in blood pressure, pain sensitivity and corticosteriod levels, among other findings indicative of a reduced stress response (Uvnas-Moberg, 1997). Oxytocin appears to inhibit the secretion of adrenocorticotropin (ACTH) hormone and cortisol in humans as well (Chiodera & Legros, 1981; Legros, Chiodera, & Demy-Ponsart, 1982).

Oxytocin may be implicated in the clinical benefits of affiliation as well. A study by Detillion and colleagues (Detillion, Craft, Glasper, Prendergast, & DeVries, 2004) reported a role for oxytocin in wound healing. In this study, Siberian hamsters received cutaneous wounds and were then exposed to immobilization stress. The stressor increased cortisol concentrations and impaired wound healing. However, these effects occurred only in socially isolated and not in socially housed animals. Thus, social housing acted as a stress buffer. The studies went further to tie down the mechanism underpinning this effect. The researchers found that eliminating 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 for the role of oxytocin in the wound healing process, 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, however, delayed wound healing. This evidence strongly implies that affiliation can be protective against adverse effects of stress through a mechanism that implicates oxytocin-induced suppression of the HPA axis. Moreover, it confirms a role for oxytocin in a clinically significant health-related outcome (wound healing).

The potential roles of oxytocin in the downregulation of SNS and HPA axis responses to stress, in the tendency to turn to others, and in health-related outcomes, at present, are hypotheses with animal evidence to support them, but less evidence from human studies. Consequently, these issues currently represents a direction for research, rather than an

established biological pathway by which social contact may exert protective effects on health. Moreover, there may be roles for other hormones both in promoting social support initially and in regulating its biological effects, which include vasopressin, norepinephrine, serotonin, and prolactin (Nelson & Panksepp, 1998; Taylor, Dickerson, & Klein, 2002).

Research has also focused on the neural mechanisms whereby social contact affects physiological processes which, in turn, affect health outcomes. A three-part investigation (Eisenberger, Taylor, Gable, Hilmert, & Lieberman, 2007) had participants 1) complete a daily diary that recorded the supportiveness of social interactions, 2) used fMRI to scan reactions to a social exclusion manipulation, and 3) recorded physiological and HPA axis reactivity to laboratory-induced social stressors. The results indicated that people who interacted regularly with supportive people on a day-to-day basis showed diminished cortisol reactivity to a social stressor. Moreover, both greater social support and a diminished cortisol response were associated with lower reactivity during the social exclusion task in two brain regions that have been previously tied to distress induced by social separation, namely the dorsal anterior cingulate cortex (dACC) and Brodmann Area 8 (BA 8). Mediational analyses revealed that individual differences in dACC and BA 8 reactivity mediated the relationship between high daily social support and low cortisol reactivity to social stress; that is, those people experiencing greater social support showed reduced neurocognitive reactivity to social exclusion which, in turn, was tied to reduced neuroendocrine stress responses to laboratory challenges. This study, then, helps to document the neural mechanisms underpinning the relationship between social support and health-relevant outcomes and suggests a mechanism by which social support may benefit health, namely by diminishing neural and physiological reactivity to stress.

Physical and Mental Health Consequences of Affiliation Under Stress

In response to their affiliative efforts, people 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.

Mapping onto the functions of affiliation more generally, 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 request support from others is often comforting in its own right.

The beneficial effects of affiliation and social support on mental and physical health are well established. 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), cancer (Penninx, van Tilburg, Boeke, Deeg, Kriegsman, & van Eijk, 1998; Stone, Mezzacappa, Donatone, & Gonder, 1999), rheumatoid arthritis (Goodenow, Reisine, & Grady, 1990), kidney disease (Dimond, 1979), childhood

leukemia (Magni, Silvestro, Tamiello, Zanesco, & Carl, 1988), and stroke (Robertson & Suinn, 1968), among other disorders.

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), better compliance and 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 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).

Social support contributes to longevity (e.g., Rutledge et al., 2004). In a classic study that documented this point, epidemiologists Lisa Berkman and Leonard Syme (1979) followed nearly seven thousand California residents over a nine-year period to identify factors that contributed to their longevity or early death. They found that people who lacked social and community ties 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). Of particular significance is the fact that the positive impact of social ties on health is as powerful, and in some cases, 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). In prospective studies controlling for baseline health status, people with a higher quantity and quality of social relationships have consistently been shown to be at lower risk of early death (Herbst-Damm & Kulik, 2005; Seeman, 1996), and in studies of both humans and animals, social isolation has been found to be a major risk factor for early mortality (House, Landis, & Umberson, 1988).

When Affiliation is not Experienced as Supportive

Not all research shows beneficial effects of affiliation in challenging circumstances, however. Sometimes the presence of a friend or stranger actually increases sympathetic reactivity among those undergoing stress (e.g., Allen, Blascovich, Tomaka, & Kelsey, 1991; Mullen, Bryant, & Driskell, 1997). Whereas the presence of a partner typically reduces stress-related physiological and neuroendocrine reactivity among men, the presence of a male partner often enhances reactivity among women (Kiecolt-Glaser & Newton, 2001). The presence of a friend or partner may increase evaluation apprehension over whether important others' perceptions of the self may decline, and so this apprehension may eliminate any beneficial effect of support (Lepore, 1998).

Sometimes efforts to provide social support are experienced as intrusive, or would-be support providers may give poor advice or fail to provide the right kind of social support, thereby reducing the effectiveness of the effort (Bolger, Foster, Vinokur, & Ng, 1996; Burg & Seeman,

1994; Dakof & Taylor, 1990). Social support efforts may also be perceived as controlling or directive by the recipient. For example, chronically ill patients sometimes report that a spouse's efforts to co-manage the disorder can lead to conflict in the couple (e.g., Fisher, La Greca, Greco, Arfken, & Schneiderman, 1997). Social support may reinforce symptom experiences if it becomes contingent on a person's expression of psychological or physical distress (Itkowitz, Kerns, & Otis, 2003).

When people are under threat, they are especially vulnerable to perceived or actual threats to the self. That is, although people are often receptive to negative or threatening information when they are in a positive state of mind (see Fiske & Taylor, 2008, for a review), under threat, people typically need to shore up a sense of self. As such, having to ask for help or solace or receiving obvious forms of assistance may be perceived as threats to the self. Consistent with this argument, Bolger and colleagues have suggested that the most effective kinds of social support are those that are invisible to the recipient. In a series of studies with couples, they showed that supportive efforts identified by a partner but not perceived by the recipient had greater effects on the recipient's emotional well-being than support efforts experienced by both the supportive person and the recipient as intended (Bolger & Amarel, 2007; Bolger, Zuckerman, & Kessler, 2000). Visible acts of social support can raise a sense of obligation or indebtedness and lower self-esteem, particularly when the recipient is under stress.

Other factors may compromise the efficacy of socially supportive efforts as well. In their "matching hypothesis", Cohen and McKay (1984) suggest that to be supportive, the actions of a support provider must meet the specific needs of the recipient. For example, if a person needs emotional support but receives advice instead, the misfired effort at support may actually increase psychological distress (Thoits, 1986). Consistent with this perspective, Helgeson and

Cohen (1996) examined the impact of social contact on adjustment to cancer and found that emotional support was most desired by patients and appeared to have the greatest beneficial effects on adjustment. However, when that support was provided in a peer group setting, it did not, for the most part, have benefits; rather, educational groups that provided information were perceived more positively. It may be that emotional support is best provided by people close to the patient such as family and friends (Dakof & Taylor, 1990), and that educational needs are better satisfied by educational interventions (Helgeson & Cohen, 1996).

Recent research suggests that certain adverse effects of social support may be more acutely experienced by East Asians than by European Americans. Although social support appears to be universally beneficial for mental and physical health, there are cultural influences on how it is experienced. East Asians and Asian Americans are more reluctant to explicitly ask for social support from close others than European Americans, because they are more concerned about the potential negative relational consequences of such behaviors (Taylor, Sherman, Kim, Jarcho, Takagi, & Dunagan, 2004). Instead, they are more likely to use and benefit from forms of social support that do not involve explicit disclosure of personal stressful events and disclosure of distress.

Accordingly, one may distinguish between implicit and explicit social support (Taylor, Welch, Kim, & Sherman, 2007). Explicit social support involves the specific recruitment and use of a social network in response to specific stressful events and involves the elicitation of advice, instrumental aid, or emotional comfort. Implicit social support, by contrast, involves the emotional comfort that one can obtain from social networks without necessarily disclosing or discussing one's problems vis-à-vis specific stressful events. Implicit support may take the form

of reminding oneself of close others, affiliating with close others without discussing problems, or simply perceiving social support to be available without actually making use of it.

In a series of studies (Kim, Sherman, & Taylor, 2008; Taylor, Sherman, et al., 2004; Taylor et al., 2007), we found that Asians and Asian Americans sought less social support than European Americans, and when they were put in a position of needing to ask for social support, experienced more psychological distress and stronger arousal. They were, however, psychologically and biologically buffered by the process of merely thinking about their close relationships. European Americans, in contrast, were more comfortable with seeking explicit social support, namely asking others for help, but were not benefitted by merely thinking about their social relationships. On the surface, these findings regarding European Americans would appear to contradict the findings on invisible support by Bolger's research group; however, it may be that European Americans are comfortable with asking for social support on their own terms, but that unsolicited social support from close others in times of threat creates a sense of indebtedness or a threat to self-esteem.

As the research on unintended negative effects of social support efforts suggests, there is a disjunction between findings concerning the benefits of affiliation and those attesting to the risks of socially-supportive efforts. Research consistently finds that strong social networks have a positive effect on mental and physical health in both stressful and non-stressful times (Thoits, 1995). Research on actual support transactions, however, suggests that under many conditions, efforts at support misfire for a host of reasons. Although the difference between the two types of studies may depend on the particular type of evidence gathered and paradigms used, to the extent that it reflects a reality about social contact, it implies that mere social contact and the ability to affiliate with others under stress may be more beneficial than extracting social support from

others. If you think back to an occasion when you were ill, you may remember that it was comforting just to leave the bedroom door open so you could hear other people moving about in the house. Similarly, spouses may experience much of the benefit of their contact with each other simply by knowing that the other is around and available and not through the specific social interactions that occur. Carrying this argument one step further, what scientists construe as social support may be a basic biopsychosocial process that depends heavily on proximity and/or awareness of others' availability more than on the explicit social support transactions that have been so widely studied.

Future Directions

Substantial empirical progress has been made in understanding the biopsychosocial underpinnings of affiliation in response to stress. In the near future, we can expect to see additional insights regarding the roles of oxytocin, vasopressin, and the opioid system in eliciting and responding to affiliative contact. We may also see additional clarity regarding genetic bases of social support needs and perceptions. On the social psychological side, the benefits of giving as well as receiving social support will become increasingly understood (e.g., Brown, Nesse, Vinokur, & Smith, 2003).

Our current conceptualization of the role of affiliation in protection against stress may require some rethinking. Human biological systems are marked by substantial redundancy. That is, activities that are vital to survival are often maintained by more than one biological process. There are, for example, five different ways by which the stomach can produce hydrochloric acid for the digestion of food. Other more obvious examples of redundancy include the fact that people have two eyes, two hands, two lungs, two kidneys, and so on. This is not to say that all vital biological systems are backed up through redundancy, the heart being an obvious

counterexample. Nonetheless, it may be useful to think about psychological processes as implicated in this redundancy. That is, vital processes may be backed up not only through multiple biological mechanisms, but through a combination of psychological and biological mechanisms as well. In this viewpoint, the human impetus toward group living as well as human beings' tendencies to affiliate with others in stressful times may have multiple psychological and biological origins. Affiliation is psychologically satisfying, and during times of stress, human beings experience a psychological need, as well as a biological impetus, toward affiliating with others. It is possible that the psychological architecture that leads people toward comforting social relationships represents redundancy within the biopsychosocial system, whereby either the psychological impetus toward others or the biological impetus or both ensure that affiliative efforts are undertaken in times of threat. Future research will clarify whether this conceptualization is theoretically and empirically useful.

Conclusions

The tendency to affiliate with others under stressful conditions is one of the most basic responses that human beings have for coping with a broad array of stressful and threatening circumstances. Unlike the fight or flight response that has typically guided research, tend and befriend characterizes the fact that humans come together for mutual protection and solace and to protect offspring. These affiliative responses to stress have both biological and psychological origins and effects. Affiliating with others is inherently comforting under most conditions, and so people often choose to affiliate with others when times are stressful so as to gain emotional comfort, information about a stressor, tangible assistance, and reduced physiological reactivity. Biologically, these effects may depend upon oxytocin and brain opioid pathways that provides a signal to the organism that the social environment is lacking and that provides an impetus to

seeking social contact. Part and parcel of this response is the fact that social isolation is experienced as aversive, and rising endogenous oxytocin levels in response to isolation may prompt affiliative behavior.

The biological benefits of affiliation are clear. Studies of early life experience provide unequivocal evidence that nurturant mothering helps to shape biological stress regulatory systems as well as craft socioemotional skills that aid in the creation of social networks and the seeking of social support across the lifespan. Genetic factors and epigenetic processes are also implicated in these pathways. The interplay of these early influences with the availability of supportive others during times of acute stress leads reliably to ameliorative effects on both psychological distress and biological responses to acute stressors.

The consequences of affiliation under stress for mental and physical health are very well established. Although there are circumstances under which efforts at social support backfire and may actually worsen the situation, social support nonetheless has effects on health on par with smoking, lipids, and other well-established biological risk factors. On the whole, the perception that one has social support available appears to have as many mental and physical health benefits as the reality, and under some circumstances, may suffice for protecting against the ravages of stress.

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