CHAPTER 21

Physiology and Interpersonal Relationships

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During interpersonal interactions, a vast array of chemical, electrical, and mechanical activities are operating under each person’s skin at any moment. Most concerted activities remain out of individuals’ conscious awareness, but some “surface” and can be perceived by others. Psychophysicologists study these biological concomitants of social behaviors to better understand the social world; physiological indicators provide valuable information about cognitions, affect, and other internal states that individuals are either unwilling or unable to articulate in a self-report. Importantly, physiological responses also provide information about the stressful and emotional nature of social episodes or individuals’ circumstances. Not surprisingly, although personal relationships have the ability to enhance greatly one’s quality of life, they can also cause serious harm. The quarrelsome couple, the husband who must cope daily with the strains of caregiving for his chronically ill wife, the woman who ruminates about the disagreement she had with her boyfriend the day before, and the lonely exemplify those vulnerable to health-compromising physiological wear and tear from ongoing or repeated engagement with stressful circumstances. Conversely, individuals embedded within positive social network structures, such as good marriages or supportive friendships, fare better with regard to morbidity and mortality and are less physiologically vulnerable when faced with stressful events.

Overview and Scope of the Chapter

Our focus in this chapter is how relationships affect the body’s physiological systems (and vice versa). Although we do not focus on physical health outcomes per se (our attention is on how close relationships, including their characteristics, qualities, and dynamics, affect specific health-relevant physiological processes), we do note any links between physiological indicators and health outcomes when appropriate. We limit our review to adults and must neglect infant and child studies (Gunnar,
We begin with a summary of the most commonly utilized physiological indicators, with the goal of providing a general knowledge base so that even the most novice readers have a frame of reference from which to evaluate the findings reported throughout the chapter. Consequently, our introduction is dense and initially focuses exclusively on physiology rather than relationships; it is our hope that by providing an in-depth discussion of physiological processes and systems, we allow for some illumination of the bigger picture that may serve as a resource in its own right. We then focus on the physiological consequences of social isolation (or the opposite, social embedment), including the physiological effects of social support and loneliness. We next devote attention to one area of inquiry that has received considerable empirical attention: the psychophysiology of marital interaction. By and large, our review focuses on the ways in which specific psychological and behavioral characteristics of relationships affect physiology; however, we also review existing literature on the reciprocal influence of physiology on relationship processes. Finally, we briefly address more recent advances in the field, closing with a few suggestions for future directions as well as a general assessment of the current state of the field.

Physiological Responses in the Study of Personal Relationship: Emphasis on Stress

Contemporary interpersonal psychophysiological research has typically emphasized the impact of relationship and affiliation-related processes on the body's responses to various intra- and extra-dyadic stressors. Understanding how the body's systems respond during stress provides a basis for evaluating and integrating research addressing physiological influences on relationship and physical health.

The Autonomic and Endocrine Systems: Pathways of Physiological Influence

The autonomic nervous system is a system of sensory and motor nerves that innervate the body's organ systems to regulate their activity. It is composed of the sympathetic nervous system, the parasympathetic nervous system, and the enteric nervous system. The enteric branch is responsible for regulation of the digestive tract, but digestion is also controlled by the sympathetic and parasympathetic branches. The sympathetic nervous system, essential for energy mobilization, and the parasympathetic nervous system, responsible for energy conservation, work together to maintain the body's normal functioning by continually making adjustments in response to normal metabolic demands, such as when we stand up. The sympathetic nervous system is largely responsible for the fight-or-flight response during threat or danger. Its activities promote the transfer of blood to the brain and the muscles, an increase in sugar levels in the blood, and heightened heart rate and other organ activity in preparation for physical exertion. Conversely, the parasympathetic nervous system plays essential roles in reproduction and energy storage. This system opposes activity of the sympathetic nervous system.

The endocrine system regulates functioning through the release of hormones that travel through the bloodstream to target organs. These hormones originate from endocrine glands whose activity is under the influence of the brain's pituitary gland as well as the autonomic nervous system. Two endocrine pathways are integral during the stress response: the sympathetic adrenomedullary (SAM) pathway and the hypothalamic-pituitary-adrenocortical (HPA) pathway. Both the SAM and HPA pathways begin at the hypothalamus, the key structure in the coordination of autonomic and endocrine function, and end at the adrenal glands, located above the kidneys.

Through direct sympathetic innervation from the hypothalamus that characterizes
the SAM pathway, the adrenal medulla releases the catecholamines, epinephrine (adrenaline) and norepinephrine, into the bloodstream. Epinephrine acts on many tissues at one time and serves to coordinate many metabolic and behavioral responses during stress. Norepinephrine has minimal effects on the body when traveling though the bloodstream. However, when released via autonomic nerve pathways, norepinephrine increases general blood vessel constriction essential for blood pressure regulation. During activation of the SAM pathway, the HPA response also occurs, but effects are seen at a much slower rate. HPA release of adrenocorticotropin hormone (ACTH) into the bloodstream stimulates the adrenal cortex to secrete cortisol. Cortisol, a glucocorticoid hormone, is especially important for maintaining normal metabolic function but is also very important during the stress response; cortisol enhances the responses of the sympathetic nervous system and increases the release of glucose and stored fats for energy.

**Physiological Indicators of Autonomic and Endocrine Activity**

Numerous technologies are available to assess physiological function directly and indirectly, and our discussion provides information about some of the more common techniques currently in use. Those interested in pursuing additional measures and measurement techniques are encouraged to consult psychophysiological methods resources (e.g., Cacioppo, Tassinary, & Berntson, 2000; Stern, Ray, & Quigley, 2003).

**General Sympathetic Activity Measurement**

Skin conductance or electrodermal response, one of the most widely measured physiological parameters (Stern, Ray, & Davis, 1980), is still commonly used today as an indicator of sympathetic nervous system activity (Dawson, Schell, & Filion, 2000). Electrodermal activity refers to the skin’s varying ability to conduct electricity; changes result from increased or decreased perspiration secretion by eccrine sweat glands. Although these glands cover most of the body, they are found in dense quantities on the palms and feet, and they are innervated by sympathetic nerve fibers. Sympathetic activation increases eccrine perspiration secretion, allowing an electrical signal to pass more readily between two electrodes placed on the eccrine glands.

**Cardiovascular Measures**

A large proportion of the psychophysiological research on personal relationships incorporates measurement of the cardiovascular system. Traditional cardiovascular parameters include heart rate and blood pressure, which are indirect indicators of autonomic activity (for example, blood pressure can rise because of norepinephrine activity at sympathetic nerve terminals), as well as sympathetically influenced endocrine activity (epinephrine released from the adrenal medulla can increase heart rate). Distinctions are often made between systolic (the maximum pressure in the arteries when the heart contracts) and diastolic blood pressure (pressure in the arteries when the heart is at rest). Heart rate can be assessed through measurement of the electrocardiogram (ECG) that reflects the natural electrical activity of the heart or more indirectly using methods that provide heart rate measures in addition to other parameters, such as automatic blood pressure assessment.

Cardiovascular indices not only provide inexpensive and reliable indicators of autonomic and endocrine system activity, but they characterize different motivational states (Tomaka, Blascovich, Kelsey & Leitten, 1993) and correlate with distinct coping opportunities (Hartley, Ginsburg, & Heffner, 1999). By assessing cardiac performance using impedance cardiography (a noninvasive technique to derive stroke volume and cardiac contractility measures) in conjunction with blood pressure measurement, more detailed information about substrates underlying cardiovascular changes is obtained. Measures of vascular resistance,
such as total peripheral resistance (TPR) or finger pulse volume (FPV), provide information about the extent to which blood vessels are constricted or dilated.

**ENDOCRINE MEASURES**

Although cardiovascular measures can be used to infer relative activation of HPA or SAM pathways, hormones produced through these channels can be more directly assessed. Cortisol, the major HPA-derived hormone, has been the focus of considerable research in light of its significant effects on metabolic activity during stress, as well as its regulatory influence on other body systems, including the immune system. Rises in circulating cortisol are observed some time after the onset of acute physical or psychological stress (anywhere from 10 to 20 minutes), but cortisol also follows a diurnal pattern: levels are highest in the morning hours after waking and continue to fall throughout the day. Deviations from this pattern can be indicative of pathology, but are also tied to chronic stress (Spiegel & Giese-Davis, 2003) and even relationship functioning (Adam & Gunnar, 2001). Cortisol can be measured from blood and urine samples, but even more beneficial for social scientists is the ability to sample cortisol levels from saliva, an inexpensive and unobtrusive method. In conjunction with cortisol measures, ACTH provides further information about HPA activation because cortisol release is dependent on ACTH travel from the pituitary to the adrenals. Currently, ACTH must be attained through blood samples.

SAM-activated endocrine output of epinephrine and norepinephrine can also be assessed through blood or urine sampling, but the methods to assay these catecholamines are much more costly than those to assess cortisol. However, because SAM activity occurs much more quickly than HPA activity, researchers may be interested, for instance, in sampling circulating epinephrine to better understand temporal changes in sympathetic adrenal activation during acute stress.

Of particular relevance to close relationships researchers interested in pair bond-
processes might indicate the situations and individual- or dyadic-level differences that potentially lead to immune-related health decrements.

Examining stress-associated immune modulation holds great promise for understanding the ways personal relationships impact health. The immune system is responsible for (a) distinguishing the “self,” the body’s normal cells, from the “nonself,” foreign invaders or transformed cells, and (b) destroying the latter. These processes are performed through cellular and humoral immune responses operating across two categories of the immune system termed innate and acquired immunity. Measuring the performance and condition of the immune system typically takes two forms. Functional assays provide information on the ability of immune system cells to perform their job, and enumerative assays provide information regarding actual counts or percentages of specific immune cells (for a description of specific measures, see Kiecolt-Glaser & Glaser, 1995a).

As with other indices of physiological reactivity, however, assessing immune function alone cannot illuminate the links between interpersonal stressors and health outcomes. What is required is empirical attention to biological mechanisms mediating stress and health links. Maladaptive physiological responses to stress, such as repeated over- or underresponsiveness to stressors, lack of habituation to recurrent, similar stressors, or inadequate recovery from stress have been suggested as pathways through which stress can damage the body over time, leading to poor health outcomes and advanced aging (Cacioppo et al., 1998; McEwen, 2002). There are a growing number of studies of associations among stress, associated physiological responses, and health outcomes (for example, see Cohen, Doyle, Turner, Alper, & Skoner, 2003; Kiecolt-Glaser & Glaser, 1995b). Such studies, with the addition of interpersonal factors as moderators of these associations, are necessary to understand fully how social relations influence morbidity and mortality.

Not All Physiological Indicators Are Created Equal

The use of physiological indicators poses both methodological and interpretational challenges. For example, we noted earlier that catecholamines can only be assessed via blood or urine. This may prove difficult depending on the methodological design being employed (e.g., multiple assessments during a 30-minute conversation); however, utilization of a heparin well attached to a long polyethylene tube allows for repeated blood draws without frequent “sticks” (which also affect circulating hormone levels). In contrast, cortisol receives significant empirical attention both because of its function as a primary stress hormone, but also because it can be assessed relatively unobtrusively via saliva.

Consideration of the timing of biological samples and how they relate to the experimental procedure is also critical. Again, consider the catecholamines. Whereas cortisol and ACTH have a half life of 60–90 minutes and 10 minutes, respectively, the half-life for norepinephrine and epinephrine is significantly shorter—only 1 to 2 minutes (Baum & Grunberg, 1995; Rose, 1984). As a result, interpretation of change in physiological indicators that does not account for these differences in circulation life expectancy could be costly (e.g., inappropriately concluding that an intervention had no effect on norepinephrine because the blood or urine sample was collected too late to observe actual changes). Cardiovascular indices can also be difficult to interpret. For example, blood pressure can rise during stressful situations because of greater blood vessel constriction, a response that over time may have dire health consequences; however, blood pressure may also rise because the heart is pumping larger volumes of blood through the circulatory system, as is seen during healthful exercise. Impedance cardiography is useful for determining these sources of blood pressure changes, thus clarifying what implications such changes may have for individuals’ health.
Ultimately, and a point we reiterate at the chapter's end, this type of work truly benefits from collaboration (see Kiecolt-Glaser & Glaser, 1995a, for a discussion of the various issues faced when assessing immunological outcomes). Deciding what physiological indicator to utilize as well as how and when to assess it is best done through consultation with those who are best equipped to answer these questions, including endocrinologists, immunologists, and psychophysicologists.

Summary

Psychophysiological researchers have contributed a wealth of knowledge regarding associations among social, psychological, and physiological processes, but much remains to be done. Technological advances continue and will surely contribute to the study of biopsychosocial mechanisms. As discussed throughout this chapter, personal relationships play a central role in these mechanisms, contributing to our whole self, including our mental, emotional, and physical being. Examining autonomic, endocrine, and immune responses sheds light on the ways our close relationships produce or reduce stress in our lives and even set the stage for subsequent relationship functioning and health. Recent studies of physiological associations to disease and longevity suggest that cumulative biological mechanisms are important in predicting morbidity and mortality, and important for the study of personal relationships is early indication that positive cumulative relationships are tied to physiological function in the long term (Seeman, Singer, Ryff, Dienberg Love, & Levy-Storms, 2002), an issue we turn to next.

At the Heart of Relationships: A Fundamental Need for Affiliation

The need to belong "is a powerful, fundamental, and extremely pervasive motivation" (Baumeister & Leary, 1995). This proposition is impressively illustrated by longitudinal, prospective studies of various populations indicating increased mortality rates as a function of decreased social integration (Rutledge, Matthews, Lui, Stone, & Cauley, 2003), and myriad health and morbidity outcomes are associated with both the quality and quantity of an individual's social ties (Berkman, 1995). More recently, greater attention has been given to identifying potential mechanisms linking social relationships to health, with particular emphasis on social support. Whether in the context of marriage, family, or friendship, our affiliation with others (or a lack thereof) has powerful physiological consequences.

Being Socially Embedded: Physiological Correlates of Social Structures

Social integration is often operationalized based on various environmental characteristics proposed to reflect individuals' degree of social embedment, including their marital status, number of or degree of contact with relatives and friends, group affiliations, and the like (Berkman, Glass, Brissette, & Seeman, 2000). Importantly, recent research indicates an association between these structural indices of social network ties and physiological function and sheds light on mechanisms by which social integration may promote health. Seeman and her colleagues found decreases in urinary levels of epinephrine and norepinephrine for older men with greater social ties (Seeman, Berkman, Blazer, & Rowe, 1994), as well as reduced physiological activity across a range of indices in conjunction with increased social integration (Seeman et al., 2002). Older women evidenced weaker associations among social ties and physiological measures (Seeman et al., 1994), consistent with epidemiological reports of stronger relationships among social relationships and mortality for men (Kaplan et al., 1988).

Given the prevalence of coronary-associated diseases and deaths and their suggested association with social integration (Krantz & McCeney, 2002; Smith & Ruiz, 2002), much of the psychophysiological research on social ties has emphasized cardiovascular function, with specific attention...
PHYSIOLOGY AND INTERPERSONAL RELATIONSHIPS

The quality of social relationships is also important, and perhaps most important, in predicting physiological function. Ryff and Singer (1998) suggest that having quality relations with others is indeed the most universally agreed upon component of well-being. Even marriage, which provides mental and physical health protection and promotion (Kiecolt-Glaser & Newton, 2001), can have fewer health benefits and may even be detrimental to physical well-being when troubled or dissatisfying (Gallo, Matthews, Troxel, & Kuller, 2003).

By far the most compelling evidence of social relationship quality and its effects on bodily functioning comes from research on social support. In a seminal review of the social support and physiology literature, Uchino and colleagues (1996) concluded that there are strong associations between social support and the cardiovascular, endocrine, and immune systems. Most social support studies emphasize functional support, such as instrumental or emotional support, and the quality of support received rather than structural characteristics such as network size. In general, higher levels of social support are related to numerous physiological markers of health, including fewer age-related decrements in cardiovascular function at rest (Uchino, Cacioppo, Malarkey, Glaser, & Kiecolt-Glaser, 1995), lower levels of catecholamines and cortisol (Seeman et al., 1994), lower levels of cortisol in women with metastatic breast cancer (Turner-Cobb, Sephton, Koopman, Blake-Mortimer, & Spiegel, 2000), and better immune functioning, especially for individuals experiencing chronic stress (Esterling, Kiecolt-Glaser, Bodnar, & Glaser, 1994).

These correlational psychophysiological studies of integration and support represent an approach to the study of social relationships and health that emphasizes the broad, long-term impact personal relationships have on health-relevant biological mechanisms. The suggestion is that our relations with others can modify our regulatory bodily functions and set the stage for disease risk, for example, through bolstered immune function resulting from reduced anxiety and depression that good support affords during stress (Wills & Fegan, 2001). As such, an important contributor to our biological performance across time is our concurrent and recurring social emotional experience in key personal relationships (Ryff, Singer, Wing, & Love, 2001).

How might this long-term biological accumulation be borne out from our daily experience with relationships? One pathway by which health may be compromised is through the physiological wear and tear engendered by repeated physiological responses to stressors (McEwen, 1998). A psychophysiological account of the link between social support and health suggests attenuating effects of socially supportive others on acute physiological stress responses (DeVries, 2002). This buffering hypothesis has been investigated in laboratory studies by (a) relating measures of social support to stress reactivity and (b) manipulating the presence of others, as well as their specific supportive behaviors, during performance of stressful tasks. In light of the swift autonomic activation concurrent with acute stress, most of the research in this area has addressed cardiovascular reactivity. Recent advances in field methodologies, including ecological momentary assessment (Hufford, Shiffman, Paty, & Stone, 2001) and experience sampling (Csikszentmihalyi & Hunter, 2003) in conjunction with ambulatory physiological monitoring (Kamarck, Schwartz, Janicki, Shiffman, & Raynor, 2003), are fostering consideration
of social support's buffering effects on everyday stress and concurrent physiological function (Holt-Lunstad, Uchino, Smith, Olson-Cerny, & Nealey-Moore, 2003).

Higher levels of self-reported naturalistic social support are associated with healthier physiological responses to stressors, including faster cardiovascular recovery from stress (Roy, Steptoe, & Kirschbaum, 1998) and less age-related increases in blood pressure in response to a stressor (Uchino, Kiecolt-Glaser, & Cacioppo, 1992). Broadwell and Light (1999) reported lower vascular resistance during rest, conversation about the day's events, and a marital conflict discussion for spouses high in family support. Heffner, Kiecolt-Glaser, Loving, Glaser, and Malarkey (2004) found higher cortisol responses to a marital conflict for younger, newlywed wives and older, long-married husbands who reported less satisfaction with the support they receive from their spouses. These data suggest that the pathways linking shorter term physiological processes to long-term health may well differ for wives and husbands across the life span. To address social support's buffering effects of stress on immune function, psychoneuroimmunology researchers have examined associations among social support self-reports and immune measures in the context of relatively longer term stressors, such as medical exams (Glaser et al., 1992), coping with disease (Dixon et al., 2001), caregiving (Kiecolt-Glaser, Dura, Speicher, Trask, & Glaser, 1991), and bereavement (Esterling, Kiecolt-Glaser, Bodnar, & Glaser, 1994). Overall, higher levels of social support when coping with moderate to severe stress can reduce the impact of these stressors on immune function.

Findings from laboratory studies manipulating support through a friend’s or stranger’s presence or absence during stressful tasks have been mixed (Uchino et al., 1996), likely due to the varying degree of perceived social evaluation while performing the traditional, stressful cognitive lab tasks (Stoney & Finney, 2000). Studies controlling for evaluation are more apt to produce results consistent with the buffering hypothesis (Fontana, Diegman, Villeneuve, & Lepore, 1999), and interestingly, nonevaluative support from a pet may provide the most benefit by buffering responses even in the presence of evaluative support, such as a human friend or spouse (Allen, Blascovich, & Mendes, 2002).

Modifying supportive behaviors and source of support explicitly have yielded stronger and more consistent results. In general, supportive behaviors before and during stressful tasks attenuate cardiovascular responses. This is especially true when supportive behaviors are performed by friends rather than strangers (Christenfeld et al., 1997), and when the quality of the friendship is purely positive, rather than perceived as ambivalent (Uno, Uchino, & Smith, 2002). However, support from female confederates reduced cardiovascular responses during an impromptu speech, whereas male confederate support did not (Glenn, Christenfeld, & Gerin, 1999), suggesting support from women strangers can be beneficial. Few studies have addressed acute support effects on cortisol reactivity to stress, but existing evidence warrants future attention to these associations. Men who received social support from their romantic partners had smaller anticipatory cortisol responses compared with men without support or who received support from a stranger prior to a public speaking task; in contrast, women had increased cortisol responses when receiving support from their partners (Kirschbaum, Klauer, Filipp, & Hellhammer, 1995). Both men and women receiving video-relayed support by a same-sex confederate evidenced attenuated cortisol reactivity to a demanding computer task compared with a no support group (Thorsteinsson, James, & Gregg, 1998).

Loneliness

As we note, the availability of support is an important component for maintaining positive physiological outcomes and simple structural measures of integration predict favorable outcomes. One mechanism for this latter relationship might be the consequential experience of loneliness for
socially isolated persons. For example, coronary artery bypass surgery patients who endorsed the single item "I feel lonely" demonstrated significantly greater mortality rates 30 days and 5 years later relative to those who did not endorse the item (Herlitz et al., 1998).

Cacioppo and colleagues' studies of psychophysiological mechanisms associating loneliness to morbidity and mortality suggest a strong link between loneliness and autonomic activation (Cacioppo, Ernst, et al., 2000; Cacioppo, Hawkley, et al., 2002). Cacioppo, Hawkley, et al. (2002) had undergraduate participants complete four types of stress-inducing speeches as well as a mental arithmetic task. During all tasks, lonelier participants demonstrated lower heart rate levels and reactivity compared with nonlonely participants. Moreover, absolute blood pressure levels were similar across tasks for each group, although heart rate reactivity was lowest for lonely participants. This may seem counterintuitive; however, significant cardiovascular reactivity is expected in these types of situations, and an absence of such reactivity may be indicative of blunted or inadequate response by the system (McEwen, 1998). In an additional study, lonely individuals demonstrated higher total peripheral resistance and lower cardiac output than embedded (i.e., nonlonely) participants during a stressful task (Cacioppo, Hawkley, et al., 2002). Baseline systolic blood pressure and heart rate was also higher in older lonely participants versus younger lonely participants.

With regard to endocrine outcomes, much attention has been given to cortisol. Some work has reported increased cortisol levels in the lonely, but others have reported no differences (Cacioppo, Hawkley, et al., 2002; Kiecolt-Glaser, Ricker, et al., 1984). The type of loneliness assessed, as well as the timing of the cortisol measurement may warrant careful consideration. Trait loneliness was highly, positively correlated with undergraduates' salivary cortisol in the evenings, but not at any other time (Cacioppo, Ernst, et al., 2000). This might reflect the social context and timing of the sample; it is during the evenings that most social activity would occur for this undergraduate sample, a time when the discrepancy between desired and actual relationships would be most relevant and, thus, most likely to activate chronic loneliness (Cacioppo, Ernst, et al., 2000).

Feeling lonely also affects immune function. A series of studies on diverse samples have demonstrated immune system deficits in the lonely (Glaser, Kiecolt-Glaser, Speicher, & Holliday, 1985; Kiecolt-Glaser, Garner, et al., 1984; Kiecolt-Glaser, Speicher, Holliday, & Glaser, 1984), highlighting the health risks carried by this psychological state. Given the link between loneliness and depression (Russell, Peplau, & Cutrona, 1980), these results are not surprising (McGuire, Kiecolt-Glaser, & Glaser, 2002).

Summary

In sum, social integration is a key predictor of individuals' health outcomes, and the available evidence suggests a variety of physiological systems are involved. Both qualitative and quantitative indices of integration predict reduced cardiovascular arousal and more limited evidence suggests endocrine and immune benefits as well. Research into social support processes has offered the most explanations regarding a mechanism for these beneficial social integration effects, and work on loneliness suggests one mechanism whereby social isolation is detrimental (in addition to the lack of social support inherent in those circumstances). We now turn our attention to the physiological consequences produced by arguably our most important form of social integration: the romantic relationship.

From Pals to Pillow Talkers

In 1983, Levenson and Gottman (1983) reported an interesting result: In a sample of married couples, the more that one spouse's physiological arousal (e.g., heart rate, skin conductance, etc.) during a conflict discussion predicted the other spouse's physiological arousal, the lower the couples'
overall marital satisfaction. The degree of prediction obtained with this measure of "physiological linkage" was substantial: It accounted for 60% of the variance in marital satisfaction (Levenson & Gottman, 1983). Subsequently, the impact of romantic relationships on physiological function (and vice versa) has received widespread empirical attention. Put simply, heterosexual marital relationships impact a host of spouses' physiological parameters. We know considerably less about nonmarital romantic relationships. Naturalistic as well as laboratory studies have illuminated a number of processes by which intimate relationships influence spouses' physiology.

**Naturalistic Studies**

Recently, studying couples in their natural settings has garnered increased interest. Carels and colleagues (Carels, Sherwood, Szczepanski, & Blumenthal, 2000) assessed associations among wives' marital quality and their ambulatory blood pressure at work and home. Wives reporting higher marital distress had higher blood pressure at home versus at work. Lower marital cohesion predicted elevated nighttime blood pressure and 24-hour diastolic blood pressure in mildly hypertensive men and women (Baker et al., 1999). Gump, Polk, Kamarck, and Shiffman (2001) reported lower ambulatory blood pressure for individuals following social interaction with intimate partners relative to other persons or being alone. Interestingly, these effects were not moderated by relationship quality. Importantly, their sample consisted of married individuals as well as those living with a partner for more than three months. It is unclear whether relationship type might influence psychophysiological associations observed in naturalistic or even laboratory settings.

Clearly, investigating couples and couple members in their natural settings is ideal as it captures couples' ongoing, ordinary behavior without the constraints of experimenter observation, settings, and tasks. Technological advancements in ambulatory physiological monitoring, including the development of physiological equipment, and methods, such as salivary cortisol sampling, are contributing to the validity and reliability of naturalistic psychophysiological studies.

**Laboratory Studies Utilizing the Problem-Solving Paradigm**

Many laboratory marital interaction studies have followed similar experimental paradigms. Couples are asked to sit in silence, facing each other, for some period of time (e.g., 5 minutes). With a researcher, couples then identify two or more areas of marital disagreement based on partners' self-report ratings (Gottman, Markman, & Notarius, 1977); more recent work has taken care to identify and counterbalance "husband" and "wife" issues so that the topic initiator is taken into account (Caughlin & Vangelisti, 1999; Heavey, Layne, & Christensen, 1993). Couples are next instructed to work on resolving one or more identified issues as if they were at home. Interaction periods last from 10 to 30 minutes or more. From the beginning of the baseline session until, in many cases, a recovery period following the interaction, a range of physiological data are collected (e.g., cardiovascular measures, blood samples for purposes of endocrine and immune assays).

**NOT BEING NASTY MATTERS MORE THAN BEING NICE**

By and large, the physiological effects of these observed marital discussions are influenced by the presence or absence of negative behaviors (Ewart, 1993). This finding is best summarized by Ewart and colleagues 1991 article titled "High Blood Pressure and Marital Discord: Not Being Nasty Matters More Than Being Nice" (Ewart, Taylor, Krase, & Agras, 1991). In their sample of 43 hypertensive adults, hostile behaviors during a 10-minute discussion increased wives' blood pressure; positive and neutral behaviors had no impact. Husbands' blood pressure changes were only related to their speech rate.

This conclusion is not unique to cardiovascular reactivity. In a sample of 90 newlywed couples participating in an
overnight study that included a 30-minute problem-solving discussion, Kiecolt-Glaser and colleagues demonstrated that (a) spouses’ escalation of negative behaviors (e.g., criticizing, interrupting) accounted for large amounts of variance in change in wives’, but not husbands’, hormone levels (Kiecolt-Glaser et al., 1997); (b) spouses classified as low versus high immune responders were in marriages characterized by a greater frequency of negative behaviors (Kiecolt-Glaser et al., 1997); (c) spouses displaying more negative or hostile behaviors showed greater decrements on four functional immune measures and larger increases in blood pressure, with effects greater for wives than husbands and no effects for positive behaviors (Kiecolt-Glaser et al., 1993); and (d) wives’ composite (average across the day) norepinephrine and cortisol levels were greater to the extent that their husbands’ withdrew during the marital conflict following their negative behaviors, but no effects were found for husbands’ endocrine responses (Kiecolt-Glaser et al., 1996).

Similar patterns are evidenced in other samples. In a sample of older adults, wives’ (but not husbands’) cortisol, ACTH, and norepinephrine increased when negative behaviors escalated, and spouses who displayed more negative conflict behaviors demonstrated weaker immune responses (Kiecolt-Glaser et al., 1993). In a sample of German couples, wives demonstrated greater cortisol responses to a conflict discussion than did husbands (Fehm-Wolfsdorf, Groth, Kaiser, & Hahlweg, 1999). Finally, in a study employing an extensive assortment of immune system indicators, two different measures of immune system function increased in spouses during a 15-minute conflict discussion (Dopp, Miller, Myers, & Fahey, 2000).

NOT BEING NASTY MATTERS MORE THAN BEING NICE . . . FOR WIVES?

A majority of the studies reviewed above as well as others have documented the differential impact of conflict discussions on wives relative to husbands (Dopp et al., 2000; Mayne, O’Leary, McCrady, Contrada, & Labovivie, 1997). In their comprehensive review on the health impact of marriage, Kiecolt-Glaser and Newton (2001) concluded, “A . . . key theme among the interaction studies is the relatively greater physiological change shown in women; gender disparities were most obvious in relation to negative behavior” (p. 16). This summary is inconsistent with Gottman and Levenson’s (1988) psychophysiological model of marital interaction, which suggests that men withdraw from conflict because of their greater conflict-associated physiological arousal relative to wives. The validity of Gottman and Levenson’s model has been addressed elsewhere (Kiecolt-Glaser & Newton, 2001; Kiecolt-Glaser et al., 1996), and due to space limitations we do not revisit the issue here; however, a recent study (Denton, Burleson, Hobbs, Von Stein, & Rodriguez, 2001) testing the escape-avoidance model is worth mentioning in detail because it provides new insight into the demand-withdrawal communication pattern and highlights the importance of the interdependent dynamic between spouses rather than a focus on gender per se.

Denton et al. (2001) classified spouses as initiators (i.e., demand) or avoiders (i.e., withdraw) with respect to their general marital communication patterns. Consistent with past work (Heavey et al., 1993), husbands were more likely to be classified as avoiders and wives were more likely to be classified as initiators; however, during a structured interview, spouses classified as avoiders, regardless of gender, demonstrated greater increases in systolic blood pressure than did initiators. Furthermore, avoidant wives demonstrated greater systolic blood pressure reactivity than did initiator wives, and husbands demonstrated greater physiological arousal when they interacted with an avoidant wife (versus an initiator wife), especially when the husband was himself classified as an initiator. Denton et al. (2001) concluded that rather than a sole focus on gender, “our results suggest that physiological reactivity during confrontative interactions is a complex, joint function of one’s own dispositions as well as the dispositions of
one’s spouse” (p. 416). These data highlight the need for further work exploring individual and couple-level predictors of the classic demand–withdrawal interaction sequence.

Moderators of Spouses’ Physiological Reactivity During Discussions

The Denton et al. (2001) study highlights one moderator of discussion-induced physiological reactivity: the interdependent dynamic between spouses. Discussion-task characteristics as well as individuals’ characteristics also influence physiological response patterns. Smith, Gallo, Goble, Ngu, and Stark (1998) asked spouses to discuss a number of topics (e.g., rent controls for campus-area housing) and randomly assigned them to same or opposing sides of the arguments. When forced to disagree during the discussions (labeled a communion stressor), wives, but not husbands, demonstrated elevated cardiovascular reactivity. When led to believe their part of the interaction would be critically evaluated (labeled an agency stressor), husbands, but not wives, displayed elevated reactivity. In an additional study, husbands given an incentive to influence their wives during a nonmarital topic discussion demonstrated larger systolic blood pressure increases than did those not given an incentive. Wives’ blood pressure did not increase (Brown & Smith, 1992). In further analyses, husbands’ level of cynical hostility was associated with greater husbands’ heart rate reactivity regardless of incentive, but only with increased systolic blood pressure when an incentive was present. Husbands’ cynical hostility increased wives systolic blood pressure reactivity, but wives’ cynical hostility had no effect on their own or husbands’ cardiovascular reactivity (Smith & Brown, 1991). Less dominant spouses, based on spouses’ ratings of dominance and submissiveness, displayed heightened blood pressure reactivity during discussion, except at very high levels of spouse dominance (Brown, Smith, & Benjamin, 1998). Interestingly the incentive condition tended to reduce the attenuation seen at high levels of spouse domination.

Similarly, Loving, Heffner, Kiecolt- Glaser, Glaser, and Malarkey (2004) demonstrated that relative levels of emotional involvement impacted spouses’ ACTH and cortisol responses to marital conflict. Utilizing a principle of least interest approach (Waller & Hill, 1951) to delineating marital power, they compared spouses’ reports of dependent power for one another. Less powerful spouses (i.e., spouses relatively more emotionally involved) displayed elevated ACTH responses to a conflict discussion, while shared power appeared to have a beneficial effect on wives’ but not husbands’ ACTH responses. Spouses’ cortisol levels declined over time except for wives who were less powerful and for husbands who shared power with their wives. These data suggest that the particular dynamics couple members have already developed prior to their participation in marital interaction studies can significantly impact couple’s physiological responses.

Recalling and Viewing Conflicts

Recalling or viewing marital conflict discussions can also have physiological consequences. For example, wives in distressed marriages demonstrate higher blood pressure than wives in nondistressed marriages when recalling a marital conflict (Carels, Szczepanski, Blumenthal, & Sherwood, 1998). Notably, it is not necessary to recall or view one’s own problem discussion to invoke physiological responses. In a related vein, when individuals are asked to view the conflicts of other couples, married individuals best at rating the self-reported affect of other spouses who had engaged in the discussion (i.e., other perception; Kenny, 1994) demonstrated patterns of physiological arousal while making the affect ratings that were similar to the physiological responses of the spouse who had actually engaged in the discussion (Levenson & Rues, 1992).

Relationships in Context: Unique Psychophysiological Processes?

In this section, we have primarily focused on studies involving samples of married
couples in light of the paucity of research with the nonmarried. We have mentioned two studies that utilized nonmarried samples (Gump et al., 2001; Kirschbaum et al., 1995). To our knowledge, with the exception of research on immune outcomes in HIV-Positive individuals following the loss of a partner (Kemeny et al., 1995; Leserman et al., 2000), no studies have investigated the psychophysiological processes involved in sexual-minority relationships. Thus, our understanding of these processes is really limited to the heterosexually married, with one exception: work on adult attachment utilizing heterosexual dating samples.

Adult attachment researchers have investigated how attachment processes might influence physiological responses to stressful situations within the context of dating relationships. These studies build on the social support literature reviewed earlier in which (typically) participants were asked to bring friends to serve as support provider (vs. a confederate). In a study of college women involved in a serious dating relationship, participants were led to believe that they would engage in an unspecified stressful task. Avoidant and anxious participants demonstrated greater anticipatory physiological arousal (heart rate and systolic blood pressure) when their partner was present versus when he was absent (Carpenter & Kirkpatrick, 1996). In another study (Feeney & Kirkpatrick, 1996), dating women performed a serial subtraction task, once in the presence of their male partner and once alone. Their partner was placed in sight, but prevented from being able to evaluate their partner during the task. Anxious and avoidant women displayed heightened physiological arousal in all conditions when they were first separated from their partner; the results were strongest for heart rate.

Few additional studies have investigated the physiology-attachment link in adults (or undergraduate samples; for an exception, see Scheidt et al., 2000). Given the hypothesized physiological underpinnings of attachment mechanisms (Diamond, 2001) as well as the significant role attachment plays in social support processes (Mikulincer & Florian, 1997), further empirical attention is certainly warranted. Diamond (2001) recently called for greater psychophysiological exploration of the attachment system, with a focus on the HPA and the parasympathetic branch of the autonomic nervous system. She also noted the important role that might be played by oxytocin (Diamond, 2001; Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003).

Summary

Marital interaction research is particularly important for understanding the physiological consequences of relationship processes (e.g., behaviors, affect, marital dynamics, individual dispositions) and how such intimate affiliations may lead to morbid outcomes through their effects on the autonomic, endocrine, and immune systems. We now explore the reciprocal relationship: Can physiology affect the “health” of relationships?

Physiological Indicators As Predictors of Relationship Health

The notion that what happens inside couple members can affect couple functioning was first advanced by Levenson and Gottman (Gottman, 1993; Levenson & Gottman, 1983). The basic rationale behind their studies can be stated as follows: Individuals’ physiological responses to interaction with, or the presence of, their partner might provide insights into some underlying currents within the relationship.

As noted at the outset of the section on marital interaction, Levenson and Gottman (1983) were able to explain 60% of the variance in spouses’ average marital satisfaction scores from spouses’ levels of physiological linkage during a conflict discussion. Subsequently, in 19 of the original 30 couples, greater overall arousal, but not physiological linkage, at Time 1 predicted declines in marital satisfaction over a 3-year period (Levenson & Gottman, 1985). What was most noteworthy about these latter findings is that their measure of physiological reactivity predicted changes in marital
satisfaction much better than the use of observational data (accounting for over 80% of the variance in changes in marital satisfaction); however, the small sample size necessitates further replication of this result. More recently, husbands' physiological reactivity during an eyes-closed baseline preceding a discussion significantly predicted divorce (Gottman, 1993); on average, husbands who did divorce evidenced an 11-beat-per-minute greater heart rate than husbands who did not eventually divorce.

Hormone levels also relate to relationship outcomes (Kiecolt-Glaser, Bane, Glaser, & Malarkey, 2003). In a follow-up study of the newlywed couples mentioned earlier, stress hormones related to marital satisfaction and divorce 10 years after initial study participation. Spouses' epinephrine was 34% higher during the conflict discussion 10 years earlier for divorced versus intact couples, and divorced wives also had higher nighttime norepinephrine levels during the initial study. Among spouses not divorced, norepinephrine levels 10 years earlier distinguished satisfied from dissatisfied couples at the 10-year follow-up. In addition, wives' ACTH levels at the beginning of conflict were higher among those wives who were dissatisfied at follow-up. Furthermore, Cohan, Booth, and Granger (2003) demonstrated that concordance versus discordance of spouses' testosterone levels affects spouses' behaviors during conflict and social support discussions (Bradbury & Pasch, 1991). They argued that testosterone is a key variable in the marital behavior equation given its role in assertiveness and dominance. When husbands and wives were concordant for high testosterone levels, husbands were more positive and less negative during a conflict discussion. When wives were high and husbands were low on testosterone, husbands were more negative. During a social support interaction, husbands were more positive support providers when they and their wife had low levels of testosterone, but husbands were less positive when their testosterone levels were higher than their wives (Cohan et al., 2003).

Recent Developments

The field broadly construed as the psychophysiology of adult relationships extends beyond the primary physiological outcomes (and predictors) that we have focused on thus far. Oxytocin has been the subject of increasing interest in its role as a stress hormone and a promoter of bonding and attachment processes (Diamond, 2001; Taylor et al., 2000). What is particularly exciting about this work is that it incorporates aspects of mainstream relationships research (i.e., attachment theory) with psychophysiological mechanisms.

Research into the effects of steroidal chemosignals offers promise for increasing our understanding of, for example, attraction in relationships (Thornhill & Gangestad, 1999). McClintock and colleagues (Jacob, Kinnunen, Metz, Cooper, & McClintock, 2001; McClintock & Herdt, 1996), demonstrated that exposure to the chemosignal androstadienone affects a variety of brain areas, participant mood states, as well as other physiological indices (e.g., skin conductance and temperature). One unique study showed that positron emission tomography (PET) was able to identify brain areas activated by the hormone (Jacob et al., 2001). Magnetic resonance imaging is another methodology gaining favor with relationships researchers (Fisher, Aron, Mashek, Li, & Brown, 2002), and will likely become increasingly popular as researchers further explore the biology of close relationships.

Conclusion

Fifteen years ago, House, Landis, and Umberson (1988) commented: "The mechanisms through which social relationships affect health and the factors that promote or inhibit the development and maintenance of social relationships remain to be explored" (p. 540). Much has since been learned about the mechanisms responsible for the link between social relationships and health, and the underlying mechanisms (e.g., marital
quality, dominance, behavior) are becoming clearer. However, in a recent editorial, House (2001) still noted similar inadequacies in the literature, particularly in our understanding of "the extent to which support or any other attribute or correlate of relationships can account for the robust and substantial impact of social relationships on health" (p. 273).

We encourage relationships researchers to take these comments to heart as they have the knowledge and tools about close relationships necessary to begin unraveling the processes and dynamics at play. Applications of attachment (Diamond, 2001), intimacy (Reis, 1990), and interdependence theory (Kelley & Thibaut, 1978), just to name a few, hold great promise for further understanding of why and how close relationships get under our skin. Advances in close-relationship methodologies may also be useful. For example, experimental social support studies rely heavily on trained confederates, and for good reason: "Natural" support providers (i.e., close friends or partners) bring a complex history with them to the laboratory making it difficult to control for extraneous effects; however, what if researchers wanted to investigate the effects of, for example, relationship closeness on social support provision and effects on physiological reactivity? The experimental induction of closeness paradigm seems perfectly suited for this inquiry (Aron et al., 1997). With this method, researchers can actually manipulate feelings of closeness between support recipient and provider and determine how this affects support seeking, provision, and physiological responses.

In sum, the complex set of dynamics that define close (and not so close) personal relationships hold profound implications for individuals' physiological functioning. With the advancement of new methods and technologies, and an intersection with psychophysiological and close relationships principles and theories, we can expect increasing resources devoted to a complete understanding of the role of close relationships in the mind–body equation.

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