Measuring the Pulse of an Organization: Integrating Physiological Measures into the Organizational Scholar's Toolbox

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This goal of this chapter is to build a bridge between psychophysiology and organizational behavior in an effort to extend organizational theories and enhance the precision of organizational research. The first section describes psychophysiological systems and theories that can inform organizational scholars' understanding of the biological bases of behavior in organizations. The second section discusses the advantages and challenges associated with incorporating psychophysiological measures into organizational research. The third section speculates on some possible domains where the use of psychophysiological measures may provide novel insights into key organizational phenomena. In sum, this chapter provides an opportunity for organizational scholars to think about how incorporating physiological measures and outcomes into organizational research can deepen theoretical insights and enrich our understanding of human behavior in organizations.

The study of human physiology may inform our understanding of organizational life in ways that cannot be discerned from the application of more commonly used measures. This chapter will therefore highlight theories and research that use peripheral psychophysiological measures. Applying these new methodological tools to organizational research may help to elucidate how psychophysiological processes can modulate and even mediate affective, cognitive, and motivational processes relevant to organizational settings.

Technological advances in physiological data collection have made physiological measures more widely available to organizational researchers in both laboratory and organizational settings. Innovations in ambulatory monitoring enable psychophysiological responses to be collected continually throughout an individual's work day, and such measures can be coordinated with experience sampling methodologies to capture an individual's emotional experiences. The possibilities of using both stationary and ambulatory monitoring in organizational settings are vast, constrained only by organizational researchers' finances, creativity, and knowledge.

This chapter focuses on the relevance of peripheral psychophysiological processes—embodied through the viscera, somatic, and endocrine systems—to organizational science. Examining psychophysiological processes allows us to understand how bodily responses are linked to centrally controlled affective, cognitive, and motivational processes that can influence behavior in organizations. Although intracranial processes that are embodied through the brain (i.e., typically measured with functional magnetic resonance imaging [fMRI] or electroencephalography [EEG]) are inextricably linked to the psychophysiological processes examined in this chapter, this vast topic which would require a chapter of its own is therefore excluded. Instead, stress, motivational, and emotional states that are detected in non-brain-based responses are examined. Specifically, the value of using autonomic nervous system (ANS) reactivity to explore constructs relevant to organizations, such as decision making, interpersonal trust, and creativity is explored.

This chapter begins with a description of the psychophysiological systems and two key social psychophysiological theories that can inform our understanding of the biological bases of behavior in organizations. The advantages of incorporating psychophysiological measures into the study of organizational behavior, as well as the challenges of using these measures in organizational research are then highlighted. This chapter concludes with an agenda for future research and speculates on promising domains that have not yet been examined in organizational studies.

PSYCHOPHYSIOLOGICAL SYSTEMS

This chapter focuses on the autonomic nervous system (ANS), which is part of the peripheral nervous system and which primarily serves a regulatory function by helping the body adapt to internal and environmental demands in order to maintain homeostasis. Changes in ANS activity can be assessed with a variety of measures. In this section, three broad, but related, categories: cardiovascular activity, electrodermal activity, and endocrine activity are briefly described and each measure, as well as what can be learned from examining each measure is discussed (see Table 1 for a summary of ANS indicators)

Table 1. Indicators of ANS Activity

Categories of ANS Activity	**Brief Description**	**What can be learned from examining this ANS activity**	**Key measures examined in psychophysiological research**
Cardiovascular	Consists of the heart and pathways through which oxygenated blood is delivered to the periphery and deoxygenated blood is returned to the heart.	• Affective states • Motivation • Attention • Vulnerabilities in physical and mental illness	• Systolic and Diastolic Blood Pressure • Heart Rate • Cardiac Efficiency (e.g., Cardiac Output, Ventricle Contractility, Total Peripheral Resistance) • Respiration
Neuroendocrine	Focuses on the interactions between the nervous system and the hormones of the endocrine system.	• Dispositional traits • Behavioral tendencies • Vulnerabilities in physical and mental illness • The quality of social relationships	• Cortisol • Testosterone • Dehydroepiandrosterone (DHEA) • Oxytocin
Electrodermal	Examines responses in the eccrine sweat glands, widely distributed in the hands and feet.	• Arousal • Attention • Intensity of emotion	• Skin conductance response • Skin conductance level

Cardiovascular (CV) Activity

In simplest terms, the cardiovascular (CV) system consists of the heart and pathways (vessels) through which oxygenated blood is delivered to the periphery and deoxygenated blood returns to the heart. Psychologically, this system is responsive to affective states, motivation, and attention. Additionally, CV responses have been commonly linked to vulnerabilities in physical and mental illness. This relationship between CV responses and psychological states dates back to research by the endocrinologist Hansle Selye, who identified bodily responses that co-occur with stress (Selye, 1956).

However, this work paid little attention to the mental states that were precursors to the physiological changes in response to stress. Subsequent theories such as Dienstbier's (1989) model of physiological toughness began to identify specific psychological antecedents that served as concomitants to CV responses to stress. This research forms the basis of our understanding of why certain CV responses can serve as indexes for motivation, emotion, and stress.

Distinct CV responses have been used to index discrete psychological states that occur when individuals are exposed to stressful experiences (Blascovich & Mendes, 2000; Blascovich & Tomaka; Tomaka, et al., 1993; cf. Wright & Kirby, 2003). Specifically, the biopsychosocial model of challenge and threat states that in situations that are: 1) active, 2) goal relevant, and 3) require instrumental cognitive responses, a combination of evaluations of situational demands (e.g., danger, uncertainty, and effort) and personal resources to cope (e.g., knowledge and abilities, disposition, and external support) produce distinct psychological states. Generally speaking, when the appraised demands of the situation are greater than an individual's perceived resources to cope, individuals experience a psychological state of threat. In contrast when the perceived resources are greater than the appraised demands, individuals experience a challenge state (see Lazarus & Folkman, 1991).

One of the more important distinctions between challenge and threat states can be seen in the patterns of cardiovascular (CV) reactivity associated with these states. Based on Dienstbier's (1989) research on psychological "toughness" patterns, challenge is associated with sympathetic adrenal medullary (SAM) activation, which enhances cardiac performance. Thus, challenge can be thought of as an adaptive physiological state. In contrast, threat can be thought of as a maladaptive physiological state as it is associated not only with activation of the SAM axis, but also with activation of the hypothalamic-pituitary-adrenal cortical (HPA) axis, which can result in higher systematic vascular resistance, which is considered to be less efficient CV reactivity (Blascovich & Tomaka, 1996). Thus, the challenge and threat theory can inform organizational scholars' understanding of how CV measures may serve as an index of

the affective and motivational states that occur in the context of stressful situations, which can in turn influence behavior in organizations.

Neuroendocrine Activity

The neuroendocrine system focuses on the interactions between the nervous system and the hormones of the endocrine system. Hormone levels are of particular interest to social scientists as they can index behavioral tendencies in response to stressors, as well as index dispositional traits. Four hormones frequently examined in psychophysiological research that may be of particular relevance to organizational scholars are cortisol, dehydroepiandrosterone (DHEAS), oxytocin, and testosterone.

Decades of neuroendocrine research have shown that physical and psychological stressors increase cortisol levels by activating specific cognitive and affective processes in individuals (Dickerson & Kemeny, 2004). Thus cortisol levels can serve as an indicator of the experience of stress, particularly in reaction to situations that are uncontrollable or characterized by social-evaluative threat. DHEAS is also often released during acute stress and is thought to confer protection from large increases in cortisol (Wolf et al.,1997), serving as an indicator of a more adaptive or healthy response to stress when measured in relation to cortisol.

While cortisol and DHEAS serve as indicators of the stress response, the hormone oxytocin has been used to index the tendency to seek affiliation during stressful situations. Oxytocin has been implicated in the "tend and befriend" response, which refers to the idea that under conditions of stress, tending to offspring and developing affiliative connections with others is as common a response to stress as fight-or-flight (see Taylor, 2006 for a review). Several studies have offered evidence that oxytocin is a critical part of the neurocircuitry that prompts affiliation, particularly in response to stress (Taylor, 2006; Turner et al., 1999). In addition, several research programs have found that oxytocin can mitigate stress, spurring individuals to seek social contact (Heinrichs, Baumgartner, Kirshbaum,&Ehlert, 2003; Light et al., 2000; Light, Grewen, & Amico, 2005). Given these properties, oxytocin is commonly

used to index the quality of social relationships (Seeman & McEwen, 1996) and trusting behaviors (Campbell, 2010; Taylor, 2006), as oxytocin levels can be responsive to trust signals.

Another hormone of interest to social scientists is testosterone, an anabolic hormone produced by both the testes and the adrenal cortex, which has been found to play a role in competitive situations. Studies of animals and humans have demonstrated that individuals who are high in baseline testosterone have a greater drive to gain and maintain status than individuals low in baseline testosterone (Mazur & Booth, 1998). In addition, high testosterone individuals are more sensitive to their status position in social and competitive situations. Testosterone levels have also been found to rise and fall in response to victory and defeat (Mehta & Josephs, 2006). Thus, testosterone is commonly used as an index of dominance or status-seeking behaviors.

Electrodermal activity (EDA)

Electrodermal activity (EDA), also known by its outdated name, galvanic skin responses (GSR), measures responses in the eccrine sweat glands, which are found widely distributed across the body, but are densely distributed in the hands and soles of the feet. EDA, specifically skin conductance responses, have been found to be highly sensitive to changes in emotion and attention. For instance, studies have shown that skin conductance levels can change when disclosing emotions (Pennebaker, Hughes, & O'Heeron, 1987) and can reveal emotional responses prior to the conscious awareness of that emotion (Bechara, Damasio, Tranel, & Damasio, 1997). EDA therefore serves as a fairly common ANS measure of general arousal or anxiety, attention, and intensity of emotion.

This brief overview of psychophysiological systems was intended to lay a foundation for exploring how organizational scholars can further incorporate physiological measures into organizational research. In the section that follows, the value of using these ANS indicators and drawing upon these psychophysiological theories to advance organizational research and theory is discussed.

Incorporating physiological measures into organizational research can offer new ways of understanding how the mind and body interact to influence behavior and decision making in organizations. There are several advantages to understanding the links between human physiology and organizational research. First, physiological measures allow for unobtrusive measurement free from the demand characteristics of traditional measures, such as self-reports. Additionally, obtaining data "on-line" allows for a dynamic analysis of moment-to-moment reactions that does not require introspective responses from participants. Finally, ANS responses can temporally precede conscious awareness, revealing emotional responses or preferences that individuals cannot yet report (Bechara, Damasio, Tranel, & Damasio, 1997). Next, these advantages are elaborated upon.

Absence of Demand Characteristics

Physiological responses have the advantage of being immune from self-report biases. That is, a study participant could edit what she reports on a questionnaire, but would find it difficult, if not impossible, to control her physiological responses. This benefit is particularly relevant when studying sensitive contexts in which individuals might be unwilling to report their true feelings (Mendes, 2009), including collaborative situations, social interactions with individuals of diverse backgrounds, and team environments with embedded status and power differentials.

Several studies examining intergroup interactions have found that physiological and behavioral data can paint a different picture of an interaction than self-report data. For instance, using the challenge-and-threat model, Mendes, Blascovich, Lickel, and Hunter (2002) had White participants interact with a confederate who was either Black or White and of the same gender in a cooperative task. They hypothesized that when paired with a Black partner, the situational demands would outweigh the White participant's coping resources, resulting in threat physiological reactivity and impaired task performance. Participants interacting with Black confederates did indeed exhibit cardiovascular response patterns associated with threat and performed poorly on the cooperative task as compared to

participants interacting with White confederates who exhibited challenge cardiovascular patterns. Furthermore, participants' self-reported attitudes were inconsistent with their physiological and behavioral responses. Specifically, participants who interacted with Black confederates rated their partners more positively than did participants who interacted with White confederates. Participants rated Black confederate partners as more likable, independent, trustworthy, and hard working as compared to White confederate partners. These positive ratings extended to negatively valenced traits; Black confederates were rated as "less unintelligent" and "less unfriendly" than were White confederates.

These findings, which demonstrate that threat responses can ensue from interactions with racial outgroup members or stigmatized individuals, have been replicated using a variety of experimental paradigms (Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001; Mendes, Blascovich, Hunter, Lickel, & Jost, 2007). Moreover, many of these studies find that self-reported attitudes and perceptions of stigmatized partners were not related to cardiovascular responses. For example, some researchers find that White participants' responses on the Modern Racism Scale and Motivation to Control Prejudiced Reactions Scale do not typically correlate with the cardiovascular (CV) threat reactivity they experience when interacting with Black partners (Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001). These weak, often non-significant correlations among self-report and physiological responses, particularly during interactions with stigmatized individuals, suggest that physiological variables tend to be related to automatic or reflexive responses and that self-reports tend to be related to more deliberate or consciously controlled responses (Blascovich, Mendes, & Seery, 2002).

The inconsistency between self-report and physiological data offers promising avenues for organizational research and is especially relevant to the study of diversity in organizations. Since these inconsistencies are often seen in cross-race versus same-race interactions, using physiological measures in organizational studies of diversity may help resolve the critical question of when diversity is likely to

lead to positive or negative outcomes, a focus of organizational research for decades. Generally speaking, the negative consequences of diversity, broadly construed and including factors such as race, attitudes, experience, or expertise (Mannix & Neale, 2005; Moreland, Levine, & Wingert, 1996), have been found to include decreased group cohesion and morale (e.g., Cox, 1991; De Dreu & Weingart, 2003; McCain, O'Reilly, & Pfeifer, 1983; O'Reilly, Caldwell, & Barnett, 1989; Pelled & Adler, 1994). In contrast, the positive effects of diversity include increased creativity, information sharing, and flexibility (e.g., McLeod, Lobel, & Cox, 1996; Nemeth, 1995; Phillips, Mannix, Neale, & Gruenfeld, 2004; Phillips, Norcraft, & Neale, 1996; Triandis, Hall, & Ewen, 1965).

However, precisely when and why these divergent outcomes occur is not well understood. In a recent review chapter, van Knippenberg and Schippers (2007) note that extant studies on diversity in organizations tend to assume rather than assess the mediating processes that can lead to these positive or negative outcomes. Psychophysiological measures offer a means of assessing these mediating processes, and psychophysiological theories can help to shed light onto why a group's racial composition can lead to both functional and dysfunctional individual, group, and organizational outcomes. Just as the aforementioned studies have found that interactions with stigmatized individuals can result in threat CV response and impaired performance as compared to interactions with non-stigmatized individuals, these findings may to extend to group contexts. Would negative performance outcomes ensue if individuals within a diverse organizational context exhibit CV responses associated with threat in response to a stressor? Conversely, would positive performance outcomes ensue if individuals within a diverse context exhibit challenge CV responses to a stressor? In these contexts, where impression management concerns can influence self-report and deliberate behavioral responses, there is a clear benefit of using more covert psychophysiological measures. Furthermore, these measures are continuous and can be obtained without disrupting experience and without requiring introspective responses from participants.

Preceding Conscious Awareness and Predicting Behavior

Several studies have demonstrated that physiological reactions can reveal emotional responses or preferences that individuals cannot yet report (Bechara, Damasio & Damasio, 2000; Bechara, Damasio, Tranel, & Damasio, 1997). In a robust body of work, Bechara and colleagues examine skin conductance responses during decision-making tasks to show that thoughts and emotions can influence behavior, even when individuals are unable to consciously reflect on them. In one study (Bechara, Damasio, Tranel, & Damasio, 1997), participants engaged in the Iowa Gambling Task, which required them to blindly select the top card from one of four decks of face-down cards. Participants could win or lose large or small sums of money depending on the card turned over on each trial. The researchers varied the proportions of gain and loss cards in each deck; two decks provided small gains and small losses, while the other two decks provided big gains and big losses. Overall, the optimal choice in terms of financial gain was to select cards from the decks providing small gains and losses. By the 10th trial, skin conductance responses indicated participants' sensitivity to the biased nature of the decks. However, it was not until the 50th trial that participants revealed through self-reports their "hunches" that the decks were biased. Skin conductance responses indicated a premonition of an impending loss approximately 40 trials prior to participants' conscious awareness of the impending loss.

Not only do peripheral physiological responses offer insight into preferences outside of conscious awareness that can influence decision making, but these responses can also mediate affective, cognitive, and motivational processes. For instance, Kassam, Koslov, and Mendes (2009) demonstrated that patterns of CV markers predicted performance on an anchoring-and-adjustment task. In this study, participants were randomly assigned to social feedback conditions designed to engender challenge and threat states, as well as a control condition. Participants then completed an anchoring-and-adjustment questionnaire. Results indicated that those assigned to the challenge condition adjusted more from self-generated anchors than did those assigned to the threat condition.

In addition, CV responses mediated the relationship between condition and adjustment, such that as threat levels increased, adjustment decreased. This study demonstrates the importance of considering profiles of CV reactivity in organizational research, particularly when examining the influence of stress, emotion, and motivation on decision making.

Likewise, hormonal responses offer information beyond that provided by self-reports that can be predictive of behavior. A study of a group of male stock traders in London found that hormonal markers of stress, specifically cortisol and testosterone levels, were linked to their profits and losses (Coates & Herbert, 2008). Cortisol, a catabolic hormone produced by the adrenal cortex, has been found to be highly responsive to psychological stressors (see Dickerson & Kemeny, 2004). Since testosterone has been found to play a role in competitive situations and is highly responsive to wins and losses (Mehta, Jones, & Josephs, 2008), Coates and Herbert (2008) predicted that these hormones would respond to financial risk taking. To test this prediction, the investigators followed 17 stock traders for eight consecutive business days, collecting their hormone levels twice daily via saliva samples. High morning testosterone levels in traders predicted greater profitability for the remainder of the day. This finding is consistent with studies of animals and humans as acutely raised testosterone levels have been found to increase appetite for risk taking (Booth, Johnson,& Granger, 1999), search persistence (Andrews & Rogers, 1972), and fearlessness in response to novelty (Hermans, Putman, Baas, Koppeschaar, & Van Honk, 2006), all qualities the researchers suggest would enhance the performance of traders in a positive trading environment. In addition, cortisol levels responded to the volatility in traders' profits and losses, demonstrating that volatility could serve as a psychological stressor for traders. Specifically, traders experienced heightened cortisol levels in anticipation of higher market volatility, as measured by the implied volatility of options measured on the German Bund stock exchange. Coates & Herbert (2008) suggest that hormone feedback loops may help to explain why rational decision making is difficult during market bubbles and crashes. Because elevated cortisol is

associated with volatility and decreases in risk taking, cortisol levels are likely to rise during a market crash, increasing risk aversion and exaggerating the market decline. In contrast, since testosterone is associated with qualities that might augment performance, testosterone is likely to rise in a market bubble, increasing risk taking and emphasizing market inclines.

A New Set of Dispositional Characteristics

Neuroendocrinologists have long linked certain hormones to dispositional traits in both humans and animals. The hormone testosterone has been associated with dominance-related behaviors (Collias, Barfield, & Tarvyd, 2002; Mazur & Booth, 1998; Mullar & Wrangham, 2004), dehydroepiandrosterone (DHEA) with depression (Wolkowitz et al., 1997), and cortisol (or dysregulation of the HPA axis) has been commonly implicated in severe mood disorders (Heim & Nemeroff, 1999). Recently, researchers have begun to examine how the interaction between one's social situation and dispositional characteristics, as measured using biological products, can strongly predict behavioral outcomes.

For instance, using testosterone as an indicator of dominance- or status-seeking behaviors, Josephs and colleagues (2006) demonstrate that when baseline testosterone and a person's current status level are "mismatched," performance is hindered. In this set of studies, high- and low-testosterone individuals were placed into high- or low-status positions using a rigged competition. Individuals who were mismatched in testosterone and status (i.e., high in testosterone and low in status or low in testosterone and high in status) experienced impairments in cognitive functioning on subsequent tasks and increases in negative affect, as well as increases in heart rate and blood pressure. In contrast, when testosterone matched status levels (i.e., low in testosterone and low in status or high in testosterone and high in status), this host of negative physiological and psychological outcomes was not seen. These findings have been attributed to the discomfort experienced in mismatched roles; for instance, low-testosterone individuals may be ill at ease in high-status positions, as the implied dominance of their role may require engaging in status-maintenance behaviors. Similarly, high-

testosterone individuals may be ill at ease in low-status positions, in which the implied lack of dominance in their role may require them to engage in more submissive behaviors. This type of discomfort manifests itself psychologically in enhanced negative affect, physiologically in reduced cardiac efficiency, and cognitively in poorer performance due to cognitive preoccupation with the discrepancy between one's current social standing and one's desired social standing (Josephs, Newman, Brown, & Beer, 2003).

Josephs and colleagues also demonstrate that testosterone is a better predictor of behavior than self-report measures. Using the dominance subscale of the Personality Research Form (PRF; Helmes & Jackson, 1977) and the Social Dominance Orientation scale (SDO; Pratto, Sidanius, Stallworth, & Malle, 1994) as self-reported measures of dominance, Josephs et al. (2006) examined the relationship between testosterone and these self-report measures, in addition to comparing the predictive power of testosterone with that of the self-report measures on cognitive performance. Not only were the correlations between testosterone and PRF and between testosterone and SDO nonsignificant, but neither of the self-report measures by status interactions significantly predicted cognitive performance, whereas the testosterone by status interaction did (as highlighted above). These findings suggest that testosterone levels may capture different information than self-reports about individuals' status motives, perhaps because status motivations may exist outside of conscious awareness and therefore are more complicated to capture using self-report measures (cf. Schultheiss et al., 1999; 2003). Moreover, questionnaire measures often focus on traits that bear no relationship to behavior, whereas testosterone reactivity has been linked to behavior in certain situations – namely, those in which status is uncertain (Sapolsky, 1991). Thus, status motives may be situational and therefore not detected by self-report measures that ask about trait-like behavior.

Similarly, using hormones to measure vulnerability to experiencing negative affect, Akinola and Mendes (2008) offer support for the premise that hormones can be stronger predictors of behavior than

self-reports. Given that numerous highly creative individuals, including artists such as Vincent Van Gogh, poets such as Emily Dickinson, and musicians such as Robert Schumann, have been found to suffer from depression and other negative mood disorders, in this study an anabolic hormone, dehydroepiandrosterone-sulfate (DHEAS), was used to assess vulnerability to experiencing depression. Because DHEAS levels have been found to be lower in those being treated for depression, DHEAS was used to index "affective vulnerability," defined as having a heightened biological sensitivity to experiencing negative emotions. Drawing upon research suggesting that negative affect can enhance creativity (see Kaufman, 2003, for a review), it was predicted that negative emotions would bring about increased artistic creativity and that this effect would be exacerbated among those with lower levels of DHEAS.

To test this prediction, participants' baseline levels of DHEAS were collected via saliva. Mood was then manipulated by randomly assigning participants to receive social rejection or social approval in a nonsocial situation, after which participants completed artistic collages, which were later evaluated by artists. Results confirmed a person-by-situation interaction, such that participants who were lower in DHEAS and who received rejecting social feedback produced the most creative artistic products. The results showed no main effect of DHEAS, demonstrating that it is not just a susceptibility to depression that affects creativity, but rather that susceptibility coupled with situational factors, influence creative outcomes. It is important to note that the researchers examined participants' self-esteem levels as a proxy for self-reported vulnerability to experiencing negative affect and found no relationship between this measure and social feedback condition in predicting creativity. This work highlights the value of incorporating neuroendocrine products into organizational research, helping to elucidate the likely mechanisms through which creativity and other performance outcomes may be enhanced in organizational contexts.

In this section we have described how psychophysiological indexes can generate new insights into human behavior, since they are not susceptible to self-report biases, they allow for "on-line" data capture, they can reveal emotional responses outside of conscious awareness, and they open up a new set of dispositional traits for examination. Having highlighted the advantages of using physiological measures, it is now important to discuss some of the challenges associated with using these measures in organizational research.

IMPORTANT CONSIDERATIONS REGARDING THE USE OF PSYCHOPHYSIOLOGY IN ORGANIZATIONAL RESEARCH

As is always the case, there are both advantages and disadvantages to adopting new research technologies and methodologies. From an analytical standpoint, interpreting physiological data and establishing inferences between physiological responses and particular psychological states are two key challenges associated with using physiological measures in organizational research. Organizational researchers should also be mindful of important technical and ethical considerations when using these measures.

Interpretation of Contradictory Information

One clear challenge presented by the use of psychophysiological measures is the question of how to interpret contradictory information generated by physiological, self-report, and behavioral data. In Blascovich et al.'s (2001) aforementioned study of intergroup interactions, for example, one might have expected racial attitudes to be aligned with CV reactivity, such that greater scores on the Modern Racism Scale would be correlated with heightened CV threat reactivity for White participants interacting with Black confederates. However, this relationship was not seen. More broadly, if an individual's self-report indicates that she is not stressed, but she shows CV reactivity consistent with stress, how should these divergent responses be interpreted? Which response is more "accurate"? Rather than viewing

this divergence as a dilemma, these discrepancies can be viewed as opportunities for further exploration of the contexts under which one might expect convergence or divergence between self-report and physiological measures. As mentioned above, divergence is likely to be observed in environments in which impression management concerns are heightened or in which preferences are outside of conscious awareness, whereas convergence can be anticipated in environments where self-presentation is less of a concern and where there is conscious awareness of preferences.

Inconsistencies between self-report and physiological responses also create opportunities to explore the individual factors that can influence behavior. One question emerging from psychophysiological research in the domain of intergroup relations is whether there are particular moderators of physiological threat reactivity in response to stigmatized interactions. While several possible moderators have been tested in this research, the most robust moderator has been intergroup contact. For example, in a study by Blascovich and colleagues (2001), a self-report measure of intergroup contact with African Americans was found to moderate the threat effect, such that White participants who reported having high-quality intergroup contact with African Americans (e.g., had close friends who were African American) exhibited CV reactivity similar to that of participants who interacted with a same race partner. Furthermore, studies inducing intergroup contact have found that such contact can help to reduce anxiety (measured using cortisol responses) in intergroup relationships, particularly for individuals high in implicit prejudice (Page-Gould, Mendoza-Denton, & Tropp, 2008). This research suggests that psychological variables, such as implicit prejudice and intergroup contact, can dictate the extent to which convergence or divergence in self-report and physiological responses manifests itself.

Establishing Inference

It is also important to recognize that psychophysiological indexes can vary in terms of the strength of inference they offer. Specifically, inference refers to the extent to which an observed

physiological response or constellation of responses indicates that a particular psychological state is present, absent, or magnified. As psychophysiological indexes become more widely used and validated in physiological, social psychological, and organizational research, the level of inference they provide with regard to the psychological states they index will likely increase. However, to date, few measures can be considered invariants – that is, a psychophysiological index that has a one-to-one relationship with a social psychological construct (Cacioppo & Tassinary, 1990; Cacioppo, Tassinary, & Berntson, 2007). For instance, the startle reflex is considered to be one of the few physiological invariants associated with the psychological state of surprise in reaction to a specific stimulus. Instead, psychophysiological indexes can vary based on three dimensions: context, specificity, and sensitivity (Cacioppo & Tassinary, 1990; Cacioppo, Tassinary, & Berntson, 2007). However, to say that one physiological response, such as an increase in heart rate, is linked to a specific psychological state (e.g., happiness) in all cases would be overstepping the bounds of inference. As we know from personal experience, for example, emotions as diverse as fear and happiness can cause us to experience an increase in heart rate. A psychophysiological index may be context bound or even linked to many different psychological states. Thus, organizational scholars using physiological indexes should be sensitive to the strength of the inferences drawn from these indexes and should responsibly interpret the meaning of physiological responses, taking into consideration the dimensions on which psychophysiological indexes can vary.

Knowledge of Systems

Additionally, the value of receiving state-of-the-art training in psychophysiological measures and social psychology cannot be stressed enough in this research. Underlying the use of psychophysiology measures is the premise that three fundamental dimensions – subjective experience, behavior, and physiology – must be triangulated using multiple methods in order to holistically understand human behavior (Wastell & Newman, 1996). To attain this holistic perspective, organizational scholars must

become comfortable with a set of methods that few have used to date, especially in domains such as physiology, where rapid advancements in technology allow for dramatic improvements in data capture from month to month.

The time is ripe for organizational scholars to be truly interdisciplinary in our research by capitalizing on the richness of the academic environments in which we are immersed, leveraging the expertise of biologists, physiologists, and social psychologists. Collaborations with biologists can shed insight on how newly identified biological processes can influence individuals' behaviors, thoughts, and feelings. Discoveries by neuroendocrinologists that advance our understanding of how hormones affect the brain and behavior will become increasingly valuable. Furthermore, the technology and training needed to conduct psychophysiological research may actually require organizational scholars within business schools to engage in such collaborations. For instance, given that no reliable salivary measure has been developed for assaying oxytocin thus far (Horvat-Gordon, Granger, Schwartz, Nelson, & Kivlighan, 2005), organizational scholars who seek to determine how the hormone plays a role in generating trust in organizations may need to collaborate with medical schools or hospitals to measure oxytocin through blood. While this type of endeavor may seem daunting, such collaborations may prove fruitful in advancing organizational research and theory.

Ethical Considerations

Finally, the importance of using psychophysiological measures in a manner that will be helpful rather than harmful to organizations and their members must be underscored. Several studies have demonstrated that individual variability in physiological responses can differentially affect performance in organizations. As mentioned previously, individuals low in DHEAS were found to be more creative after receiving socially rejecting feedback (Akinola & Mendes, 2008) and stock traders with high levels of waking testosterone earned more money than those with lower waking testosterone levels (Coates & Herbert, 2008). Another study offers evidence that high-testosterone individuals are more

entrepreneurial than those low in testosterone (White, Thornhill, & Hampton, 2007). Such sensitive biological information could be used as criteria for hiring decisions or other organizational selection processes, initiatives that could be detrimental to organizations and their employees. Using these measures for employment screening assumes that they predict behavior with 100% accuracy, which we know is not the case; furthermore, there may be legal challenges to doing so. Instead, organizations should be encouraged to use these measures as a scientific tool and for educational purposes at the individual level. Ideally, employees' individual results would be revealed only to them and not to their employer. Employers could then receive aggregate results to improve their understanding of how factors such as stress play a role in the workplace. In sum, it becomes critical to advocate for the responsible use of psychophysiological measures in a way that furthers organizational scholarship that ultimately benefits employees rather than encouraging biased selection and unequal treatment.

AGENDA FOR FUTURE RESEARCH

Having discussed both the benefits and challenges of using psychophysiological measures in organizational research, some possible domains where the use of physiological measures may provide novel insights into key organizational phenomena are now speculated upon.

Affect in Organizations

There has been a rapid rise of research on affect in organizations. For instance, organizational researchers have explored how affect relates to creativity at work (Amabile, Barsade, Mueller, & Staw, 2005), the role of affect in supervisor–subordinate interactions (Glomb & Hulin, 1997), the ability of leaders to diagnose individual and collective group emotions (Sanchez-Burkes & Huy, 2008), and the impact of incidental emotion on decision making (Andrade & Ariely, 2009). At the heart of this research is the idea that organizational contexts can influence affect, which in turn can influence organizational outcomes. The majority of this research has focused on consciously processed affect, yet decades of social psychological research have demonstrated that affect can be nonconsciously processed (LeDoux,

1995; Murphy, 2001; Zajonc, 1980). In a recent review of the literature on implicit affect, Barsade, Ramarajan, and Westen (2009) begin a dialogue that encourages organizational scholars to integrate the construct of implicit affect into the field of organizational behavior. The researchers present a three-category framework of implicit affect that includes implicit sources of affect, implicit experiences of affect, and implicit regulation of affect, each of which they argue should be examined to further theoretical perspectives about various organizational phenomena. This section of the chapter extends this dialogue by discussing how psychophysiological measures can be used to capture nonconscious affect.

One way in which the implicit experience and regulation of affect can be measured in field settings is by using equipment incorporating ambulatory physiological monitoring with experience sampling methodology (ESM). This equipment, worn as a vest or on a belt in PDA format with sensors connected to the body, would measure an employee's CV reactivity throughout the work day. Using ESM technology, this equipment would require employees to respond to questions regarding their current context, their affective experience of the context, and situational factors, such as whether they are engaging in social interactions (e.g., with a subordinate, colleague, or superior), as well as the nature of the interaction (social, personal, work-related). Since it has been suggested that physiological variables tend to be related to nonconscious responses and that self-reports tend to be related to more consciously controlled responses (Blascovich, Mendes, & Seery, 2002), the rich data collected with this equipment could provide valuable insight into emotions outside of employees' conscious awareness. For instance, if self-reported emotions captured using ESM suggest positive affect, while CV responses indicate CV threat reactivity, which several studies have found to be associated with negative affect (Blascovich & Mendes, 2010), this inconsistency may signal unconscious negative affect. Triangulated with behavioral measures captured by coding facial expressions, tone, and body language, this

physiological data can enrich our understanding of how implicit affect influences cognition, motivation, and behavior in organizations.

In addition to improving our understanding of unconscious affect, these psychophysiological measures can also contribute to our understanding of conscious affect in organizations, including the processes that underlie the experience, perception, and communication of emotions in organizations. Through such measures, organizational researchers can address questions such as: What mechanisms are involved in employees' ability to read emotional and affective signals in their co-workers (a topic much discussed in the emotional intelligence literature)? How do high-arousal, "activating" mood states (i.e., anger, fear, happiness) versus deactivating mood states (i.e., calm, relaxed, sad, depressed) differentially affect organizational behaviors such as creativity and decision making? Is affective and physiological synchrony – that is, alignment between emotions and physiological reactivity – in supervisor-subordinate interactions predictive of beneficial performance outcomes?

Trust

Over the past decade, there has been a dramatic increase in studies examining trust in organizations, partially driven by growing evidence that trust can have myriad benefits within organizational systems. Since trust has been found to confer numerous economic, political, and social benefits (Knack & Keefer, 1997; Zak & Knack, 2001), the biological basis of trust in humans is a topic of growing interest to economists and social psychologists. Oxytocin has been identified by this research as being activated by trust signals as well as associated with trustworthy behavior (i.e., reciprocating trust). These studies corroborate behavioral literature on animals and psychophysiological theories of humans, such as tend and befriend, in which oxytocin has been found to facilitate various social behaviors and promote social attachment and affiliation (Campbell, 2010; Taylor, 2006).

In one such study, Zak, Kurzban, and Matzner (2005) measured participants' oxytocin levels during a trust game in order to test the prediction that oxytocin is related to trustworthiness in humans.

In this experiment, participants were each given $10 and were randomly assigned to be either player 1 or player 2 in a dyad, with player 1 deciding how much (if any) of his or her $10 to transfer to player 2. Both players were advised that whatever amount player 1 gave to player 2 would be tripled, after which player 2 then would decide how much (if any) of their combined funds they would send back to player 1. However, the researchers manipulated intentionality, such that half of the dyads played the game as just described (intention condition), while in the other half of dyads (random draw condition), player 1 publicly and randomly drew a ball numbered from 0-11 from an urn and transferred the amount of dollars indicated on the ball to player 2. Trustworthiness was measured as the amount of money transferred from player 2 to player 1, and participants' oxytocin levels were measured via blood after each player made his or her allocation decision.

The results indicated that both trustworthiness and oxytocin levels were higher for participants in the intention condition as compared to the random draw condition. Importantly, there was a significant relationship between oxytocin and trustworthiness for participants in the intention condition, such that as oxytocin levels increased, trustworthiness increased. This relationship was not seen in the random draw condition, suggesting that when the social signal of trust is eliminated, the oxytocin response is likewise extinguished. These findings offer evidence suggesting that perceptions of intentions of trust affect levels of circulating oxytocin. To highlight the critical role of oxytocin in trust, Kosfeld and colleagues (2005) exogenously administered oxytocin or a placebo to participants via an intranasal spray, after which participants engaged in a trust game. Consistent with the previous experiment, they found that trustworthiness was higher for participants receiving oxytocin as compared to the placebo (Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005). Overall, the results suggest that oxytocin plays a role in interpersonal processes surrounding trust.

One of the ongoing tensions in the organizational trust literature lies in the conceptualization of trust as either being social and relational or instrumental and calculative (Kramer, 1999). This

differentiation between cognition- and affect-based trust suggests two divergent systems of trusting that differ experientially and have distinct antecedents and consequences (Drolet & Morris, 2000; Kramer, 1999; McAllister, 1995). For instance, recent research has shown that cognition- and affect-based trust can lead to different outcomes (Levin & Cross, 2004; McAllister, 1995; Ng & Chua, 2006). Thus, the need for an integrative theory of organizational trust that bridges these two conceptions of trust is evident in the literature and requires research using multi-layered measures.

Given that oxytocin has been found to increase trust in humans (Kosfeld, Heinrichs, Zak, Fischbacher & Fehr, 2005) and is thought to be a critical part of the neurocircuitry that prompts affiliation (Taylor, 2006), an obvious future direction would be to examine whether oxytocin is more likely to be implicated in affect-based trust than in cognition-based trust. If cognition- and affect-based trust have indeed been found to lead to different outcomes, then might this relationship between trust and outcomes be mediated by different psychophysiological mechanisms? Specifically, given that cooperative behavior has been found to increase as oxytocin levels increase, and that affective-based trust has been found to generate more cooperative behavior than cognition-based trust (McAllister, 1995; Ng & Chua, 2006), then elevated oxytocin levels may be seen in individuals in contexts in which affect-based trust predominates as compared to contexts in which cognition-based trust predominates. This prediction could be tested using experimental design methodologies that manipulate cognition- and affect-based trust, such as those used by Ng and Chua (2006). Specifically, oxytocin levels would be measured while individuals engaged in a cooperative task requiring an economic exchange. Testosterone also would be measured, as studies have shown that testosterone decreases interpersonal trust, working in opposition to oxytocin (Bos, Terburg, & Van Honk, 2010), suggesting that the interplay of these two hormones could differentially influence trusting behaviors. Studies of this nature would enable researchers to build more precise theories connecting differing conceptions of trust in

organizations, further explicating the psychological, biological, and social factors that can influence the degree to which individuals engage in trusting behaviors.

Power, Dominance, and Competitive Situations

Competitive dynamics are a widely discussed topic within organizational scholarship, as competition is a critical and common means of determining power and status in organizations. There is a growing demand for research that addresses how power affects group dynamics, managerial decision making, and exchanges among individuals in organizations, as well as a need to further examine the cognitive and affective processes that undergird power relations. The majority of work in this domain relies either on self-reported measures of dominance to capture the dispositional tendency to seek power or on manipulating power positions in an effort to explore how differential power roles affect cognition and behavior. Psychophysiological measures of dominance, which can be better predictors of behavior than self-report measures (Josephs et al., 2006), may offer a unique means of understanding the factors that underlie status attainment, dominance-seeking behaviors, and performance in both individuals and groups within organizations. Given the links that have been established between hormones such as testosterone and status-seeking behaviors, the use of physiological indexes in this area of inquiry may be especially intriguing.

Drawing from literature on humans and numerous animal species, testosterone levels have been found to be positively associated with social rank and dominance-seeking behaviors (see Mazur & Booth, 1998 for a review). Specifically, under certain conditions, high baseline testosterone levels, as compared to low baseline levels, have been associated with a greater drive to gain and maintain status, and with greater responsiveness to information about status. In addition, the feedback loop between testosterone and cortisol reactivity in competitive situations is an evolving topic of inquiry. Cortisol is released by the hypothalamic–pituitary–adrenal (HPA) axis in response to physical exertion (Mastorakos, Pavlatou, Diamanti-Kandarakis, & Chrousos, 2005) and psychological stress (Dickerson & Kemeny, 2004).

In a variety of animal species, social defeat ensuing from competitive encounters has been associated with increases in cortisol levels (Keeney et al., 2006; Kramer, Hiemke, & Fuchs, 1999; Overli, Harris, & Winberg, 1999). Social psychologists and organizational scholars have begun to produce additional physiological evidence in humans linking baseline levels of testosterone and changes in testosterone and cortisol levels to competitive behavior and status preferences that can prove useful in understanding competitive dynamics in organizations.

In an effort to elucidate the hormonal and behavioral consequences of high and low status, Mehta, Jones, and Josephs (2008) examined basal testosterone levels and cortisol reactivity in men and women in competitive situations. Given that individuals high in basal testosterone are motivated to gain high status, the researchers explored whether basal testosterone would predict cortisol reactivity and behavior following changes in social status. Drawing upon studies showing that high-power individuals experience a rise in cortisol after defeat and a decline in cortisol after victory, while low-power individuals experience a rise in cortisol after victory and a decline in cortisol after defeat (Wirth, Welsh, & Schultheiss, 2006), Mehta and colleagues sought to test whether the interaction between basal testosterone and status would predict cortisol changes and behavior. In their first study, they collected saliva samples from male and female dog handlers in a dog agility competition. Saliva samples were collected prior to and following the competition and were later assayed for cortisol and testosterone levels. Consistent with prior research demonstrating that that low- and high-testosterone individuals differ in their affective, cognitive, and cardiovascular responses to low and high status (Josephs et al., 2003; 2006; Newman et al., 2005), high-testosterone men who lost the dog agility competition experienced a rise in cortisol, whereas high-testosterone men who won the competition experienced a drop in cortisol. Low-testosterone men's cortisol changes did not depend on whether they had won or lost.

In study 2, Mehta and colleagues had women complete puzzles presented as a test of intelligence in a one-on-one experimental laboratory competition with a partner (another participant). Performance on the puzzles was manipulated such that participants were randomly assigned to be either winners or losers. Once again, testosterone moderated the effects of winning and losing on cortisol changes, such that high-testosterone women experienced a rise in cortisol after losing and a drop in cortisol after winning. Low-testosterone winners and low-testosterone losers showed minimal changes in cortisol. Study 2 also examined behaviors following winning and losing to test the prediction that approach-avoidance behaviors are moderated by basal testosterone, as demonstrated in prior research (Mehta & Josephs, 2006). This prediction was supported; high-testosterone winners chose to repeat the competitive task, whereas high-testosterone losers chose to avoid it. Conversely, low-testosterone winners and losers did not differ in their task preferences. Taken together, these results suggest that basal testosterone moderates the effects of winning and losing on subsequent cortisol changes and behavior. Furthermore, these studies offer evidence of basal testosterone as a means of measuring status motivation and show how this motivation can be predictive of physiological and behavioral responses to social competition.

Extending this research on testosterone, organizational scholars have begun to test the effects of testosterone in team environments. For instance, following Josephs and colleagues' (2006) work on the "mismatch effect" (referenced earlier in this chapter), Zyphur, Narayanan, Koh, & Koh (2009) examined whether a mismatch of the relationship between testosterone and status in groups would influence the group's collective efficacy, defined as the group's perception of its ability to succeed (Bandura, 1986). Specifically, they hypothesized that the effect of testosterone on status within a group would predict collective efficacy in a positive direction, such that as the relationship between testosterone and status becomes more positive, collective efficacy will increase. In this study, students in an introductory organizational behavior course were randomly assigned to 92 groups ranging in size

from 4 to 7. Groups met twice weekly for 12 weeks to produce a professional management-training video. During the sixth week, testosterone was assayed via saliva, and participants rated the status of each group member. Six weeks after saliva and status data collection, participants rated the collective efficacy of their group. The results indicated that as testosterone and status became more negatively related (i.e., as testosterone and status became more "mismatched"), group collective efficacy decreased. In other words, when low-testosterone group members assumed positions of status (i.e., a mismatch), the group's collective efficacy decreased. In contrast, when high-testosterone individuals held positions of status (i.e., a match), the group's collective efficacy increased. This research suggests that the mismatch between an individual's status position and their basal testosterone levels (be they high or low) could help account for a dysfunction commonly seen in groups in organizational and other settings.

Additional research is needed to examine the mismatch effect within organizations, where there are clear power distinctions to discover how the interaction of individual factors (i.e., testosterone levels) and role (i.e., positional power) can dramatically affect cognitive functioning, affect, and social behavior. In the context of power dynamics, individuals, especially power holders, may be particularly vulnerable to self-presentation concerns, making psychophysiological measures highly valuable. Moreover, there is a paucity of research examining how the powerful interact with the powerless when they feel their power is threatened, which can be the case in periods of organizational or financial market instability. Animal research suggests that situational volatility can influence physiological functioning. In a study of baboons, for example, Sapolsky and Ray (1989) discovered that in stable hierarchies, high-ranking males had distinct patterns of hormonal reactivity that were markers of dominance. In stable social periods, dominant baboons consistently had low basal concentrations of cortisol and, during periods of stress, exhibited faster rises in cortisol and more elevated testosterone levels than subordinates. However, when social status was threatened, high-ranking male baboons

experienced elevated basal cortisol and suppressed cortisol reactivity to stress, and they no longer exhibited elevated testosterone during stress. The researchers concluded that the psychological and physiological advantages associated with social status and power in stable times are lost to baboons when stability is threatened. While there is evidence that high power individuals have a tendency to exert their control precisely when there is a great deal of uncertainty and instability (Maner & Mead, 2010), animal literature suggests that this behavior in the face of situational volatility could be mediated by physiological functioning. Further research using physiological measurements might explore how conditions such as organizational or financial market instability can contribute to these potentially important interpersonal power dynamics.

Conflict and Negotiations

The dynamic nature of negotiations, coupled with the need for additional theoretical perspectives on the underlying mechanisms responsible for actions and outcomes in the context of negotiation settings, makes the field one that can fully capitalize on the use of physiological measurements. First, the "online" nature of physiological measurements allows moment-to-moment reactions to be captured in negotiation settings without disrupting the negotiation itself. Additionally, since the majority of negotiations are not one-time events, but rather entail multiple interactions where issues of learning, reputation, and relationship all become relevant (e.g., Mannix, Tinsley, & Bazerman, 1995), being able to capture parties' unexpurgated thoughts and feelings is paramount. One key question that arises is the extent to which the experience of conflict is embodied in the negotiation. That is, would diverging physiological reactivity be seen initially between individuals experiencing conflict in a negotiation context (i.e., one party exhibits threat CV reactivity while the other exhibits challenge CV responses), but more convergent physiological reactivity as the conflict is resolved (i.e., both parties exhibit challenge CV responses)? This question focuses on the rhythm of negotiations and

the degree to which synchrony between parties can affect outcomes, which can be captured by triangulating between physiological, behavioral, and self-report measures.

Second, the use of psychophysiological theory can be beneficial for conflict scholars who are interested in understanding how different types of conflict can affect performance, particularly in group settings. Research first conducted by Jehn, Northcraft, and Neale (1999) linking types of diversity to specific types of conflict, expounded upon by numerous conflict researchers, has indicated that higher levels of informational diversity increase task conflict, which can be beneficial to performance (see De Dreu & Weingart, 2003 for a review). In contrast, higher levels of social category diversity can enhance emotional conflict, which can be detrimental to performance. Given our prior discussion of the physiological correlates of intergroup interactions, these findings should come as no surprise. Several studies have provided evidence that CV threat responses can ensue when individuals who do not share social category membership interact with each other, whereas challenge CV responses can occur when individuals share social category membership (Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001; Mendes, Blascovich, Hunter, Lickel, & Jost, 2007). Furthermore, in these studies, threat responses predicted performance, such that individuals working with outgroup members performed worse on cooperative tasks than did those working with ingroup members. The intersection of these two literatures suggests that social category diversity can both enhance emotional conflict and trigger threat CV reactivity, thereby impairing performance. If this is the case, then perhaps informational diversity triggers challenge CV reactivity, spurring task conflict that can be beneficial to performance. Yet, the prediction that physiological mechanisms may serve as mediators between types of conflict and task performance has not yet been empirical tested.

Finally, some conflict settings are highly competitive, such as auctions, which, like negotiations, are dynamic in nature and can entail multiple interactions between bidders. Thus, the online benefits of physiological measurements are also important in this domain. In fact, using the example of the auction

of life-sized fiberglass cows from a 1999 public art exhibit in Chicago, Ku, Malhotra, and Murnighan (2005) offer evidence for a model of decision-making that they refer to as "competitive arousal," which focuses on how diverse factors such as rivalry, social facilitation, time pressure, and/or the uniqueness of being first can fuel arousal, which can impair decision-making. In two studies, they offer support for the competitive arousal model of decision making by demonstrating that bidders were more likely to exceed their reservation prices, and by greater amounts, when few rather than many other bidders remained in the bidding process (i.e., creating rivalry), particularly at the end of an auction (i.e., creating time pressure). Ku and colleagues imply that this arousal is physiological in nature, but the specific type of arousal engendered by "auction fever" remains to be tested. Since the authors mention social facilitation as one factor that can intensify arousal in auction settings, prior work on social facilitation that incorporates the biopsychosocial model of challenge and threat (Blascovich, Mendes, Hunter, & Salomon, 1999) can be drawn upon to offer a theoretical explanation of how competitive arousal may have resulted in overbidding. The presence of others, coupled with the uncertainty inherent in a bidding process, can engender the threat pattern of CV reactivity, resulting in impaired performance (i.e., exceeding one's reservation price and overbidding). This link, which remains to be tested, is one promising avenue for future research extending the competitive arousal model of decision making.

Diversity in Organizations

Earlier in this chapter, the value of using psychophysiological measures in diversity research was discussed, as these measures are less susceptible to the impression management concerns that can influence self-report and behavioral responses for individuals in diverse contexts. This discussion focused primarily on research highlighting the experience of majority members during interactions with minority or outgroup members. However, it would be equally valuable to understand how minority members experience interactions with majority members and, more important, how the nature of these

interactions influences individual performance and well-being, particularly for minorities in organizations.

A large body of research has shown that minorities face significant barriers to career progression in organizations. In diverse organizations, informal coalitions develop around shared category membership (e.g., race and gender), and as a result, critical information bypasses formal networks of reporting relationships in favor of informal networks based on functions or social categories (Schneider & Northcraft, 1999). Individuals left out of these informal networks have difficulty succeeding in organizations (Brass, 1985; Ibarra, 1993; Kanter, 1977; Lincoln & Miller, 1979). Research has indicated that minorities are often excluded from informal majority social networks, impeding their ability to succeed (Bartol, 1978; Ibarra, 1993; Kanter, 1977; Lincoln & Miller, 1979; Morrison & Von Glinow, 1990; Northcraft & Gutek, 1993). And, exclusion from informal networks limits the mentoring received by minorities, which can hinder career progression. Minorities not only have fewer mentoring relationships, but also have an increased likelihood of failed cross-race mentoring relationships, which can have negative repercussions for career development (Thomas, 1993, 2001).

In a recent review of the literature on physiology in organizational research, Heaphy and Dutton (2008) note that social interactions at work, whether brief connections or enduring relationships, have physiological correlates and effects. In this chapter, it is suggested that the use of physiological measures during real-time social interactions between individuals who do not share social category membership may help to explain why interracial work-centered dynamics, such as cross-race mentoring, may negatively influence individual performance and well-being for minorities in organizations. Social psychophysiological research on discrimination can inform our understanding of the mediating processes that can lead to these negative outcomes for minorities, suggesting new research on cross-race dynamics in organizations.

Both perceiving and experiencing discrimination have been found to engender physiological responses that have negative health consequences (Clark, et al., 1999). Several studies have demonstrated that experiences with discrimination can lead minorities to believe that threat is pervasive in their environments, heightening their vigilance to signs of prejudice and discrimination (Allport, 1954, Barrett & Swim, 1998). This perspective can foster an expectation of social rejection in interactions with majority group members and can lead minorities to interpret negative or unclear social evaluations as discriminatory (Frable, Blackstone, & Scherbaum, 1990; Major, Quinton, & McCoy, 2002).

This worldview may be exacerbated in organizational settings, as minorities are underrepresented in U.S. organizations (Catalyst, 2002; Fortune, 2007). This underrepresentation has been attributed to a variety of factors that can heighten the perception and experience of discrimination for minorities in organizations. For example, the preponderance of stereotypes surrounding the intelligence of minorities makes minorities in organizational environments particularly susceptible to identity threats, such as the threat of being misjudged as less intelligent than their white counterparts due to their group membership (Foley, Kidder, & Powell, 2002; Kirschenman & Neckerman, 1991; Sanchez & Brock, 1996). These stereotypes, often unconsciously held by nonminorities, can result in selection biases that favor white over minority workers and hinder minority career advancement. These findings are consistent with social identity theory, which suggests that nonminorities are likely to use salient social categories as an indicator of similarity and thus are likely to prefer individuals with whom they share category membership (Kanter, 1977; Tajfel & Turner, 1979). In concert, these factors contribute to the perception and experience of discrimination by minorities in organizations.

The key question stemming from this research is, how does the perception and experience of discrimination influence affective, cognitive, and physiological responses? One commonly held assumption is that discrimination might reduce the self-esteem of minorities. However, attributional ambiguity theory (Crocker & Major, 1989) posits that making external attributions (rather than internal

attributions) for negative feedback can protect minorities' self-esteem. For example, if an African American who is turned down for a promotion attributes his supervisor's decision to racial bias rather than to his own capabilities at work, his self-esteem is not negatively affected by the lack of promotion. The employee may still suffer a host of negative emotions, but these would likely be anger and frustration rather than sadness and despair.

To examine the physiological consequences of discrimination and how attributional ambiguity might shape responses, Mendes, Major, McCoy, and Blascovich (2008) examined the CV reactivity of both Black and White individuals who interacted either with same race (White-White; Black-Black) or different race (White-Black) partners. In this study, confederates were used as interaction partners and provided unambiguously negative or positive social feedback right after the participant completed a speech. The researchers found that participants who received negative feedback from an outgroup member were more likely to attribute this feedback to racial discrimination than when they received the same feedback from an ingroup member. Additionally, in a subsequent interaction with the partner, participants who received negative feedback from an outgroup partner exhibited anger and strong cardiac reactions consistent with approach motivation. White and Black participants showed similar responses to discrimination, but receiving positive feedback from an outgroup member produced a more nuanced picture. When White participants received positive feedback from Black partners, they experienced an increase in self-reported positive emotion and exhibited benign physiological responses. In contrast, when Black participants received positive feedback from White partners, they showed behavioral signs of vigilance and exhibited threat responses.

Furthermore, in the same study, an examination of performance on a subsequent cooperative word-finding task indicated that, consistent with the notion that threat responses impair cognitive performance, the greater the CV threat pattern, the fewer the words pairs of participants found. Black participants who had received positive feedback on their speeches from their partners performed better

when paired with Black partners as compared to White partners. Among White participants who had received positive feedback from their partners, there was no effect of partner race. Furthermore, results revealed that Black participants paired with White partners performed worse than White participants paired with Black partners.

This research has clear implications for the study of cross-race supervisory and mentoring relationships in organizations. Several studies of mentor relationships have found that the content of the communication between mentors and protégés can have a significant effect on the type of relationship that later develops. That positive and negative feedback can have a dramatic influence on physiological reactivity and performance outcomes depending on the race of the giver and receiver of feedback in cross-race mentoring relationships is an avenue worthy of further exploration. Organizational scholarship on diversity has not fully explored the different strategies that might be used in cross-race mentoring relationships to increase the likelihood that positive outcomes will ensue. Specifically, how can differences be leveraged to produce high-quality cross-race relationships and how do such dynamics affect the development of future cross-race relationships?

Such questions can be addressed by capitalizing on ambulatory physiological measures. Same-race and cross-race mentor-protégé or supervisor-subordinate pairs in organizations could be studied longitudinally, and their emotional and physiological responses tracked during their interactions; objective performance measures also could be captured. One prediction would be that among pairs experiencing maladaptive physiological reactivity (i.e., threat), poorer performance is expected as compared to pairs experiencing benign physiological reactivity (i.e., challenge). Furthermore, strategies for fostering high-quality cross-race mentoring and supervisory relationships could be tested. Since intergroup contact has been found to moderate physiological threat reactivity in cross-race contexts, interventions using this moderator can be examined (Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001). For instance content, quality, and frequency of communication can be manipulated in

preexisting mentoring and supervisory relationships to see if these interventions can attenuate the stress of cross-race interactions, promoting more effective work outcomes.

Health Implications

Although the link between patterns of ANS response and mental and physical health vulnerabilities has not been focused on in this chapter, it is important to note that incorporating physiological measures into organizational research could shed light on how organizational settings may contribute to disease etiology and progression. For over three decades, physiological markers have been used as outcomes in job stress research (Caplan, Cobb, French, Harrison, & Pinneau, 1975). These measures primarily have been used to obtain biological markers of an individual's responses to working conditions presumed to be stressful. Theoretically, biological markers have been thought to be useful mediating variables for the effects of working conditions on well-being. Yet this research has been deemed less relevant in organizational contexts; psychophysiological measures proved to be fruitful in examining short-term reactions to social stressors, but less valuable in assessing chronic job stress and its relationship with mental and physical well-being.

However, researchers have now begun to use neuroendocrine responses, such as cortisol reactivity, to model patterns of hormonal reactivity associated with various trigger events in the daily lives of employees to examine which patterns are the most predictive of health outcomes. For example, Ganster, Fox, and Dwyer (2001) found that high job demands combined with low job control for full-time nurses predicted their cortisol production both during the work day and during a rest period several hours after work. It was only the after-work cortisol production that predicted the accumulated healthcare costs of these nurses over the subsequent five years. Specifically, healthcare costs were higher for nurses when their workload was demanding and they had little personal control over their workload than when they had a demanding workload that they could control. In addition, the higher an employee's after-work cortisol levels, the greater that employee's healthcare costs over time. This

finding suggests that the residual effect of cortisol activation after work has ended, rather than the amount of cortisol produced while confronting work stressors, may be more predictive of employees' long-term well-being.

What remains to be explored are questions related to how stress in organizations influences individual health and well-being in the long term. Most studies assess physiological reactivity in the short term by examining individuals' responses to acute stressors that are situationally specific, such as receiving feedback, giving a presentation, or performing a difficult task. In these contexts, physiological measurements are typically assessed before and after the individual experiences the stressor and are used to examine the impact of physiological reactivity on the performance variable of interest. Few studies have looked at how repeated acute stressors can more generally affect performance and well-being over a longer period of time, such as a year or more. Thus, longitudinal studies using ambulatory physiological measures with repeated daily assessments of neuroendocrine and CV responses may shed further light on how chronic stress can affect long-term health and well-being for organizational employees.

CONCLUSIONS

The goal of this chapter was to articulate and illustrate the ways in which psychophysiological measures could be used to advance theory, research, and practice in the study of organizational behavior. To this end, examples of research using psychophysiological indexes have been provided that address conceptual puzzles in the organizational literature, and in so doing help to improve organizational theories.

In addition, from a practice standpoint, although past organizational research using physiological measures focused primarily on physiological responses as an indicator of job stress and strain (Cooper, Dewe, & O'Driscoll, 2001; Karasek & Theorell, 1990), this chapter has demonstrated that these measures can be used more broadly to examine shifts in emotion, motivation, attention, and

preferences for organizational members. This broadened perspective can offer additional insight into the organizational conditions that can have beneficial or harmful effects on employee health and well-being.

Finally, from a research perspective, we have demonstrated how incorporating psychophysiological indexes into organizational studies can provide novel observations that could not have been obtained using the less technically demanding methods that organizational scholars have come to know and love. While some of the studies presented in this chapter were conducted by organizational scholars and published in organizational journals, the paucity of this research in organizational settings offers evidence of an untapped potential to deepen theoretical insights about individual, dyadic, and organizational phenomena by tapping into the neuropsychological processes at play at each of these levels of analysis. In fact, at the time of this writing, several business schools have begun to build behavioral labs outfitted with physiological equipment and to purchase ambulatory physiological equipment as a means of incorporating psychophysiological measures into laboratory and field research. The hope is that this chapter has provided organizational scholars with some motivation, if not inspiration, to capitalize on these unique measures and boldly begin to incorporate bodily responses into the study of human behavior in 21st-century organizations.

References

Akinola, M. & Mendes, W. B. (2008). The dark side of creativity: Biological vulnerability and negative mood leads to greater artistic creativity. *Personality and Social Psychology Bulletin*, *34*, 1677-1686.

Allport, G. (1954). *The nature of prejudice*, Reading, MA: Addison-Wesley.

Amabile, T. M., Barsade, S. G., Mueller, J. S., & Staw, B. M. (2005). Affect and creativity at work. *Administrative Science Quarterly, 50,* 367-403.

Andrade, E. B., and Ariely, D. (2008). The enduring impact of transient emotions on decision making. *Organizational Behavior and Human Decision Processes*, *109,* 1-8.

Andrew, R. J. & Rogers, L. J. (1972). Testosterone, search behaviour and persistence. *Nature, 237,* 343-346.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

Barrett, L. F., & Swim, J. (1998). Appraisals of prejudice: A signal detection framework. In J. Swim & C. Stangor (Eds.), *Prejudice: The target's perspective* (pp. 11-36). Academic Press.

Barsade, S., Ramarajan, L., & Westen, D. (2009). Implicit affect in organizations. *Research in Organizational Behavior, 29,* 135-162.

Bartol, K. M. (1978). The sex structuring of organizations: A search for possible causes. *Academy of Management Review, 3,* 805-815

Bechara A, Damasio H, Damasio AR. (2000). Emotion, decision making and the orbitofrontal cortex. *Cerebral Cortex, 10,* 295–307.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science, 275,* 1293–1295.

Blascovich, J. & Mendes, W. B., (2000). Challenge and threat appraisals: The role of affective cues. In: Forgas, J.P. (Ed.), *Feeling and thinking: The role of affect in social cognition* (pp. 59–82). Paris, FR: Cambridge University Press.

Blascovich, J. & Mendes, W. B. (2010). Social psychophysiology and embodiment. In: S. T. Fiske, Gilbert, D. T., Lindzey, G. (Eds.). *The Handbook of Social Psychology (5th edition; pp. 194-227)*. New York: Wiley.

Blascovich, J., Mendes, W. B., Hunter, S., Lickel, B., & Kowai-Bell, N. (2001). Perceiver threat in social interactions with stigmatized others. *Journal of Personality and Social Psychology, 80,* 253-267.

Blascovich, J., Mendes, W. B., Hunter, S. B., & Salomon, K. (1999). Social "facilitation" as challenge and threat. *Journal of Personality and Social Psychology, 76,* 68–77.

Blascovich, J., Mendes, W. B., & Seery, M. D. (2002). Intergroup encounters and threat: A multi-method approach. In D. M. Mackie & E. R. Smith (Eds.), *From prejudice to intergroup emotions: Differentiated reactions to social groups* (pp. 89-109). New York: Psychology Press.

Blascovich, J. & Tomaka, J. (1996). The biopsychosocial model of arousal regulation. In M. Zanna (Ed.), *Advances in experimental social psychology*, Vol. 28, (pp. 1-51). New York: Academic Press.

Booth, A. Johnson, D. R. Granger, D. A. Crouter, A. C., & McHale, S. (2003). Testosterone and child and adolescent adjustment: The moderating role of parent-child relationships*. Developmental Psychology, 39 (1),* 85-98.

Bos, P.A., Terburg, D., van Honk, J. (2010). Testosterone decreases trust in socially naive humans. *Proceedings of the National Academy of Sciences, 107(22),* 9991-9995.

Brass, D. J. (1985). Men's and women's networks: A study of interaction patterns and influence in an organization. *Academy of Management Journal, 28,* 518-539.

Cacioppo, J. T., & Tassinary, L. G. (1990). *Principles of psychophysiology: Physical, social, and inferential elements.* New York: Cambridge University Press.

Cacioppo, J. T., Tassinary, L. G. & Berntson, G. G. (2007). Psychophysiological science: Interdisciplinary approaches to classic questions about the mind. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of psychophysiology (3rd edition; pp. 1-16).* Cambridge, UK: Cambridge University Press.

Campbell, A. (2010). Oxytocin and human social behavior. Personality and Social Psychology Review, 14, 281-295.

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Caplan, R. D., Cobb, S., French, J. R. P., Jr., Van Harrison R., & Pinneau, S. R. (1975). *Job demands and worker health: Main effects and occupational differences.* Washington, D.C.: U.S. Government Printing Office.

Catalyst. 2002. *The 2002 Catalyst census of women corporate officers and top earners*. New York: Catalyst.

Clark, R., Anderson, N. B., Clark, V. R., Williams, D.R. (1999). Racism as a stressor for African Americans: A biopsychosocial model. *American Psychologist, 54 (10),* 805-816.

Coates, J. M., & Herbert, J. (2008). Endogenous steroids and financial risk taking on a London trading floor. *Proceedings of the National Academy of Sciences*, *105,* 6167–6172.

Collias, N.E., Barfield, R.J., Tarvyd, E.S. (2002). Testosterone versus psychological castration in the expression of dominance, territoriality and breeding behavior by male village weavers (Ploceus cucullatus). *Behaviour, 139,* 801–824.

Cooper, C. L., Dewe, P. J., & O'Driscoll, M. P. (2001). *Organizational stress: A review and critique of theory, research, and applications.* Thousand Oaks, CA: Sage.

Cox, T. 1991. The multicultural organization. *Administrative Science Quarterly, 40*, 423-443.

Crocker, J. & Major, B. (1989). Social stigma and self- esteem: The self-protective properties of stigma. *Psychological Review, 96(4)*, 608-630.

De Dreu, C. K. W. & Weingart, L. R. (2003). Task versus relationship conflict and team effectiveness: A meta-analysis. *Journal of Applied Psychology, 88,* 741-749.

Dickerson, S. S. & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin, 130(3),* 355-391.

Dienstbier, R. A. (1989). Arousal and physiological toughness: Implications for mental and physical health. *Psychological Review, 96*, 84-100.

Drolet, A. & Morris, M. W. (2000), Rapport in conflict resolution: accounting for how nonverbal exchange fosters coordination on mutually beneficial settlements to mixed motive conflicts. *Journal of Experimental Social Psychology, 36 (1),* 26-50.

Foley, S., Kidder D. L., & Powell, G. N. (2002). The perceived glass ceiling: Antecedents and consequences for hispanic law associates. *Journal of Management, 28(4),* 471-496.

Fortune. 2007. *The 2007 Fortune 500*. New York: Time Inc.

Frable, D.E., Blackstone, T., & Scherbaum, C. (1990). Marginal and mindful: Deviants in social interactions. *Journal of Personality and Social Psychology, 59,* 140–149.

Ganster, D. C., Fox, M. L., & Dwyer, D. J. (2001). Explaining employees' health care costs: a prospective examination of stressful job demands, personal control, and physiological reactivity. *Journal of Applied Psychology, 86*, 954-964.

Glomb, T. M., Hulin, C. L. (1997). Anger and gender effects in observed supervisor-subordinate dyadic interactions. *Organizational Behavior & Human Decision Processes, 72(3),* 281-307.

Heaphy, E., & Dutton, J. (2006). Positive social interactions and the human body at work: Linking organizations and physiology. *Academy of Management Review, 33(1), 137-162.*

Heim, C., & Nemeroff, C.B. (1999). The impact of early adverse experiences on brain systems involved in the pathophysiology of anxiety and affective disorders. *Biological Psychiatry, 46,* 1509–1522.

Heinrichs, M., Baumgartner, T., Kirshbaum, C., & Ehlert, U. (2003). Social support and oxytocin interact to suppress cortisol and subjective responses to psychological stress. *Biological Psychiatry, 54*, 1389–1398.

Helmes, E. & Jackson, D. N. (1977). The item factor structure of the Personality Research Form. *Applied Psychological Measurement, 1*, 185-194.

Hermans, E. J., Putman, P., Baas, J. M. P., Koppeschaar, H., & Van Honk, J. (2006). A single administration of testosterone reduces fear potentiated startle in humans. *Biological Psychiatry, 59,* 872-874.

Horvat-Gordon, M., Granger, D. A., Schwartz, E. B., Nelson, V. J., & Kivlighan, K. T. (2005). Oxytocin is not a valid biomarker when measured in saliva by immunoassay. *Physiology and Behavior, 84(3),* 445-448.

Ibarra, H. (1993). Personal networks of women and minorities in management: A conceptual framework. *Academy of Management Review*, *18,* 56-87.

Jehn, K. A., Northcraft, G. B., & Neale, M. A. (1999). Why differences make a difference: a field study of diversity, conflict, and performance in workgroups. *Administrative Science Quarterly, 44 (4),* 741-763.

Josephs, R. A., Newman, M. L., Brown, R. P., & Beer, J. M. (2003). Status, testosterone, and human intellectual performance: stereotype threat as status concern. *Psychological Science, 14 (2),* 158–163.

Josephs, R.A., Sellers, J. G., Newman, M. L., & Mehta, P. H. (2006). The mismatch effect: when testosterone and status are at odds. *Journal of Personality and Social Psychology, 90 (6),* 999–1013.

Kanter, R. (1977). *Men and women of the corporation*. New York: Basic Books.

Karasek, R., & Theorell, T. (1990). *Healthy work: stress, productivity, and the reconstruction of working life.* New York, NY: Basic Books.

Kassam, K. S., Koslov, K., & Mendes, W. B. (2009). Decisions under distress: Stress profiles influence anchoring and adjustment. *Psychological Science, 20,* 1394-1399.

Kaufmann, G. (2003). Expanding the mood–creativity equation. *Creativity Research Journal, 15*, 131-135.

Keeney, A., Jessop, D. S., Harbuz, M. S., Marsden, C. A., Hogg, S., & Blackburn-Munro, R. E. (2006). Differential effects of acute and chronic social defeat stress on hypothalamic–pituitary–adrenal axis function and hippocampal serotonin release in mice. *Journal of Neuroendocrinology, 18*, 330–338.

Kirschenman, J., & Neckerman, K. (1991). We'd love to hire them but. In Jencks, C. & Peterson, P. (Eds.), *The urban underclass (pp. 203-232)*. Washington DC: The Brookings Institution.

Knack, S. and Keefer, P. (1997a). Does inequality harm growth only in democracies? *American Journal of Political Science, 41,* 323–331.

Knack, S. & Keefer, P. (1997b). Does social capital have an economic payoff? A cross-country investigation. *Quarterly Journal of Economics, 112,* 1251–1288.

Kosfeld, M., Heinrichs, M., Zak, P. J., Fischbacher, U., Fehr, E. (2005). Oxytocin increases trust in humans. *Nature, 435(7042),* 673-676.

Kramer, R. M. (1999). Trust and distrust in organizations: Emerging perspectives, enduring questions. *American Psychological Review, 50,* 569-598.

Kramer, R. M., Hiemke, C., & Fuchs, E. (1999). Chronic psychological stress and antidepressant treatment in tree shrews: time dependent behavioral and endocrine effects. *Neuroscience and Behavioral Reviews, 23(7),* 937-947.

Ku, G., Malhotra, D., & Murnighan J. K. (2005). Towards a competitive arousal model of decision-making: A study of auction fever in live and Internet auctions. *Organizational Behavior and Human Decision Processes, 96,* 89-103.

Lazarus, R., & Folkman, S. (1991). The concept of coping. In A. Monat & R. S. Lazarus (Eds.), *Stress and coping: An anthology* (3rd ed., pp. 189-206). New York: Columbia University Press.

LeDoux, J. E. (1995). Emotions: Clues from the brain. *Annual Review of Psychology, 46,* 209-235.

Levin, D. Z., & Cross, R. (2004). The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer*. Management Science, 50,* 1477-1490.

Light, K., Grewen, K., & Amico, J. (2005).More frequent partner hugs and higher oxytocin levels are linked to lower blood pressure and heart rate in premenopausal women. *Biological Psychiatry, 69*, 5–21.

Light, K.C., Smith, T.E., Johns, J.M., Brownley, K.A., Hofheimer, J.A., & Amico, J.A. (2000). Oxytocin responsivity in mothers of infants: A preliminary study of relationships with blood pressure during laboratory stress and normal ambulatory activity. *Health Psychology, 19*, 560–567.

Lincoln, J. R., & Miller, J. (1979). Work and friendship ties in organizations: A comparative analysis of relational networks. *Administrative Science Quarterly*, *24,* 181 – 199.

Major, B., Quinton, W. J., & McCoy, S. K. (2002). Antecedents and consequences of attributions to discrimination: Theoretical and empirical advances. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 34, pp. 251-330). San Diego: Academic Press.

Maner, J.K., & Mead, N. L. (2010).The essential tension between leadership and power: When leaders sacrifice group goals for the sake of self-interest. *Journal of Personality and Social Psychology, 99 (3),* 482–497.

Mannix, E., & Neale, M. (2005). What differences make a difference? The promise and reality of diverse teams in organizations. *Psychology in the Public Interest, 6(2),* 31-55.

Mannix, E. A., Tinsley, C., & Bazerman, M. H. (1995). Negotiating over time: Impediments to integrative solutions. *Organizational Behavior and Human Decision Processes, 62*, 241-251.

Mastorakos, G., Pavlatou, M., Diamanti-Kandarakis, E., Chrousos, G. P. (2005). Exercise and the stress system. *Hormones, 4(2),* 73-89.

Mazur, A. & Booth, A. (1998). Testosterone and dominance in men. *Behavioral and Brain Sciences, 21,* 353 – 397.

McAllister, D. J. (1995). Affect and cognition-based trust as foundations for interpersonal cooperation in organizations. *Academy of Management Journal, 38 (1),* 24-59.

McCain, B. R., O'Reilly, C. A., & Pfeifer, J. (1983). The effects of departmental demography on turnover. *Academy of Management Journal, 26,* 26–641.

McLeod, P. L., Sharon A. L., & Taylor H. C. (1996). Ethnic diversity and creativity in small groups. *Small group research, 27,* 248-264.

Mehta, P. H., & Josephs, R. A. (2006). Testosterone change after losing predicts the decision to compete again. *Hormones and Behavior, 50,* 684–692.

Mehta, P. H., Jones, A. C., Josephs, R. A. (2008). The social endocrinology of dominance: basal testosterone predicts cortisol changes and behavior following victory and defeat*. Journal of Personality and Social Psychology, 94 (6*), 1078–1093.

Mendes, W. B. (2009). Assessing the autonomic nervous system. In E. Harmon-Jones and J. Beer (Eds.) *Methods in Social Neuroscience (pp. 118–147)*. Guilford Press.

Mendes, W. B., Blascovich, J., Hunter, S., Lickel, B., & Jost, J. (2007). Threatened by the unexpected: Challenge and threat during inter-ethnic interactions. *Journal of Personality and Social Psychology,* April, 698-716.

Mendes, W. B., Blascovich, J., Lickel, B., & Hunter, S. (2002). Challenge and threat during social interactions with white and black men. *Personality and Social Psychology Bulletin, 28*, 939–952.

Mendes, W. B., Major, B., McCoy, S., & Blascovich, J. (2008). How attributional ambiguity shapes physiological and emotional responses to social rejection and acceptance. *Journal of Personality and Social Psychology*, *94,* 278-291.

Moreland, R. L., Levine, J. M., & Wingert, M. L. (1996). Creating the ideal group: Composition effects at work. In E. H. Witte & J. H. Davis (Eds.), *Understanding group behavior: Small group processes and interpersonal relations (pp. 11–35)*. Mahwah, NJ: Erlbaum.

Morrison, A. M., & Von Glinow, M. (1990). Women and minorities in management. *American Psychologist, 45(2*), 200-208.

Muller, M. N., & Wrangham, R. W. (2004). Dominance, cortisol, and stress in wild chimpanzees (Pan troglodytes schweinfurthii). *Behavioral Ecology and Sociobiology, 55,* 332–340.

Murphy, S. T. (2001). The nonconscious discrimination of emotion: Evidence for a theoretical distinction between affect and emotion. *Polish Psychological Bulletin*, *32*, 9-15.

Nemeth, C. J. (1995). Dissent as driving cognition, attitudes, and judgments. *Social Cognition, 13,* 73-291.

Newman, M. L., Sellers, J. G., Josephs, R. A. (2005). Testosterone, cognition, and social status. *Hormones and Behavior, 47 (2),* 205–211.

Northcraft, G. B., & Gutek, B. A. (1993). Discrimination against women in management: Going, going, gone, or going but never gone? In E. Fagenson (Ed.), *Women in management: trends, issues, and challenges* (pp. 219-245). Newbury Park: Sage Publications.

Ng, K. Y., & Chua, R. Y. J. (2006). Do I contribute more when I trust more? Differential effects of cognition- and affect-based trust. *Management and Organization Review, 2(1),* 43-66.

O'Reilly, C. A., Caldwell, D., & Barnett, W. (1989). Work group demography, social integration, and turnover. *Administrative Science Quarterly, 34*, 21-37.

Overli, O., Harris C. A., & Winberg, S. (1999). Short-term effects of fights for social dominance and the establishment of dominant-subordinate relationships on brain monoamines and cortisol in rainbow trout. *Brain, Behavior and Evolution, 54(5*), 263-75.

Page-Gould, E., Mendoza-Denton, R., & Tropp, L. R. (2008). With a little help from my cross-group friend: Reducing anxiety in intergroup contexts through cross-group friendship. *Journal of Personality and Social Psychology, 95,* 1080 - 1094.

Pelled, L. H. & Adler, P. S. 1994. Antecedents of intergroup conflict in multifunctional product development teams: A conceptual model. *IEEE Transactions on Engineering Management, 41(1)*, 21-28.

Pennebaker, J. W., Hughes, C. F., & O'Heeron, R. C. (1987). The psychophysiology of confession: Linking inhibitory and psychosomatic processes. *Journal of Personality and Social Psychology, 52(4),* 781-793.

Phillips, K. W., Mannix, E., Neale, M., & Gruenfeld, D. H. (2004). Diverse groups and information sharing: The effects of congruent ties. *Journal of Experimental Social Psychology, 40,* 497-510.

Phillips, K. W., Norcraft, G. B., & Neale, M. A. (2006). Surface-level diversity and decision-making in groups: When does deep-level similarity help? *Group Processes and Intergroup Relations, 9,* 467-82.

Pratto, F., Sidanius, J., Stallworth, L. M., & Malle, B. F. (1994). Social dominance orientation: A personality variable predicting social and political attitudes. *Journal of Personality and Social Psychology, 67,* 741-763.

Sanchez, J. L., & Brock, P. (1996). Outcomes of perceived discrimination among Hispanic employees: Is diversity management a luxury or a necessity? *Academy of Management Journal, 39,* 704-719.

Sanchez-Burks, J., & Huy, Q. (2008). Emotional Aperture: The Accurate Recognition of Collective Emotions. *Organization Science*, 1-13.

Sapolsky, R. M. (1991). Testicular function, social rank and personality among wild baboons. *Psychoneuroendocrinology, 16*, 281–293.

Sapolsky R. M., & Ray J. (1989). Styles of dominance and their physiological correlates among wild baboons. *American Journal of Primatology, 18,* 1–13.

Schneider, S. K. & Northcraft, G. B. (1999). Three social dilemmas of workforce diversity in organizations: A social identity perspective. *Human Relations, 52(11),* 1445-1467.

Schultheiss, O.C., Dargel, A., & Rohde, W. (2003). Implicit motives and gonadal steroid hormones: effects of menstrual cycle phase, oral contraceptive use, and relationship status. *Hormones and Behavior, 43,* 293–301.

Schultheiss, O. C., Campbell, K. L., and McClelland, D. C. (1999). Implicit power motivation moderates men's testosterone responses to imagined and real dominance success. *Hormones and Behavior, 36(3),* 234–241.

Seeman T.E., & McEwen B. S. (1996) Impact of social environment characteristics on neuroendocrine regulation. *Psychosomatic Medicine, 58(5)*, 459-71.

Selye, H. (1956). *The stress of life*. New York: McGraw - Hill.

Tajfel, H., & Turner, J. C. (1979). An integrative theory of intergroup conflict. In W. G. Austin & S. Worchel (Eds.), *The social psychology of intergroup relations (pp.33-47).*. Monterey, CA: Brooks-Cole .

Taylor, S. E. (2006). Tend and befriend: Biobehavioral bases of affiliation under stress. *Current Directions in Psychological Science, 15,* 273-277.

Thomas, D. A. (1993). The dynamics of managing racial diversity in developmental relationships. *Administrative Science Quarterly, 38,* 169.

Thomas, D. A. (2001). The truth about mentoring minorities: Race matters. *Harvard Business Review, 79(4),* 98-107.

Tomaka, J., Blascovich, J., Kelsey, R. M., & Leitten, C. L. (1993). Subjective, physiological, and behavioral effects of threat and challenge appraisal. *Journal of Personality and Social Psychology, 65,* 248–260.

Triandis, H., Hall, E., & Ewen, R. (1965). Member heterogeneity and dyadic creativity. *Human relations, 18,* 33-55.

Turner, R. A., Altemus, M., Enos, T., Cooper, B., & McGuinness, T. (1999). Preliminary research on plasma oxytocin in healthy, normal cycling women investigating emotion and interpersonal distress. *Psychiatry,62*, 97-113.

van Knippenberg, D., & Schippers, M. C. (2007). Work group diversity. In M. I. Posner & M. K. Rothbart (Eds.), *Annual review of psychology 58,* (pp. 515– 541). Palo Alto, CA: Annual Reviews.

Wastell, D.; Newman, M.(1996)., "Stress, Control and Computer System Design: A Psychophysiological Field Study", *Behaviour and Information Technology, 15,* 183-192.

White, R. E., Thornhill, S., & Hampton, E. (2007). A biosocial model of entrepreneurship: The effect of testosterone and family business background. *Journal of Organizational Behavior*, *28*, 451-466.

Wirth, M. M., Welsh, K. M., & Schultheiss, O. C. (2006). Salivary cortisol changes in humans after winning or losing a dominance contest depend on implicit power motivation. *Hormones and Behavior, 49,* 346-52.

Wolf, O.T., Neumann, O., Hellhammer, D.H., Geiben, A.C., Strasburger, C.J., Dressendo¨rfer, R.A., et al. (1997). Effects of a two-week physiological dehydroepiandrosterone substitution on cognitive performance and well-being in healthy elderly women and men. *Journal of Clinical Endocrinology and Metabolism, 82,* 2363–2367.

Wolkowitz, O. M., Reus, V. I., Roberts, E., Manfredi, F., Chan, T., Raum, W. J., et al. (1997). Dehydroepiandrosterone (dhea) treatment of depression. *Biological Psychiatry, 41*, 311-318.

Wright, R.A. & Kirby, L.D. (2003). Cardiovascular correlates of challenge and threat appraisals: A critical examination of the biopsychosocial analysis. *Personality and Social Psychology Review, 7(3)*, 216–233.

Zak, P. J. & Knack, S. (2001). Trust and growth. *Economic Journal, 111,* 295–321.

Zak, P. J., Kurzban, R., & Matzner, W. T. (2005). Oxytocin is associated with human trustworthiness. *Hormones and Behavior*, *48,* 522-527.

Zajonc, R. B. (1980). *Social psychology: An experimental approach*. California: Brooks/Cole.

Zyphur, M. J., , Narayanan, J., Koh, G., & Koh, D. (2009). Testosterone–status mismatch lowers collective efficacy in groups: Evidence from a slope-as-predictor multilevel structural equation model. *Organizational Behavior and Human Decision Processes, 110,* 70-79.

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