1

Introduction

The goal of this book is to provide methodological and technical information for social psychologists and other behavioral scientists who are considering using peripheral neurophysiological and endocrine measures of psychological constructs. This volume is neither exhaustive in terms of the entire range of candidate endocrine and peripheral neurophysiological systems nor even of the range of measures within the physiological systems described. Rather, it is meant to give investigators an informed basis for determining how to validly and valuably use endocrine and peripheral physiological indexes of social psychological constructs as measures in their empirical endeavors.

Advantages of Using Physiological Measures in Social Psychological Research

The major advantages of measuring endocrine and peripheral neurophysiological responses for social psychologists have been articulated in detail elsewhere (e.g., Blascovich, 2000) and include the ability to obtain responses continuously, covertly, and online. Assuming such measures or indexes are relatively strong inferentially (i.e., markers or invariants; see Figure 1.1), continuous measurement provides the temporal topology of a physiological response allowing for the recording of meaningful changes within experimental episodes. For example, the rise and fall slopes and times of a response may be more sensitive and, therefore, more meaningful than a simple means of a response. The fact that such measures are covert generally insures that research participants do not monitor and adjust their responses. This advantage enables researchers to index psychological states without either observing deliberative behaviors or asking participants to answer introspective questions about their feelings, intentions, and thoughts. Finally, the advantage that physiological measures are online means that researchers do not have to rely on inferences based on prospective or retrospective self-reports.

Adding to these advantages, physiological responses can be superior to explicit measures because they are generally more *sensitive*, *uncensored*, *prognostic*, and *mechanistic*. Such responses may provide more *sensitive* indicators of psychological states than explicit indicators, such as self-reports, for at least two reasons. The main one is that physiological responses typically occur below conscious awareness and can be sensitive to changes in mental states that individuals are *unable* to report. That is, participants are generally unaware of the shifts in their physiology, let alone patterns of processes that reflect mental processes and, thus, are unable to consciously report them. However, precise measurements of the responses themselves are sensitive to these processes and consequently mark them even when explicit indexes do not. For example, heart rate and ventricular contractility data can be used to assess task engagement on the part of participants in studies involving performance (see Chapter 2).

Although there is much to learn if one wants to successfully incorporate psychophysiology into the methodological toolbox of social psychology, the advantages make it worth it. Using physiological measures adds to the research enterprise including theory development, testing, and application. For example, the Biopsychosocial Model of Challenge and Threat (Blascovich & Tomaka, 1996) rests on neuroendocrine theory developed on the basis of animal studies (Dienstbier, 1989) and validated in humans (e.g., Tomaka, Blascovich, Kelsey & Leitten, 1993), used to test threat-based stigma theory (e.g., Blascovich, Mendes, Hunter, Lickel & Kowai-Bell, 2001), and applied to performance prediction (e.g., Blascovich, Seery, Mugridge, Weisbuch & Norris, 2004). Some monetary costs are accrued, both in terms of acquisition and maintenance of equipment, though nothing like the costs of acquiring and using brain imaging technologies. So, it is fitting here to discuss some of the benefits of using psychophysiological measures.

In terms of measurement, autonomic responses typically provide data at a ratio level of measurement, whereas explicit measures such as self-reports are often ordinal within small, circumscribed ranges. Unlike Likert-type self-report scales that force a ceiling or floor on measurements, changes in physiological responses, for example, autonomic nervous system (ANS) reactivity measures, cover broad ranges of values so that physiological values with known endpoints indicate meaningful and valid differences in psychological states and processes.

For example, patterned changes in ANS cardiovascular responses, indexing psychological states of *challenge* versus *threat*, are a better predictor of a decision-making heuristic – anchoring and adjustment – than self-reported ones (Kassam, Koslov, & Mendes, 2009). In this study, individuals were randomly assigned to either a "challenge" or "threat" state. Even though self-reports and physiology converged on participants' assessments of the randomly assigned challenge or threat state, only the ANS responses mediated the link between the manipulated experimental condition and subsequent decision-making processes. More specifically, explicit appraisals estimated less than one-quarter of the explanatory power that cardiovascular changes did in predicting decision-making processes. These data are important because they suggest that ANS responses can be more sensitive indicators of psychological processes than explicit self-reported states.

Physiological responses generally provide an *uncensored* view of people's mental states because they can reveal psychological states that individuals may be *unwilling* to report. For social psychologists, attention to physiological changes has some parallels with law enforcement agencies' use of ANS responses for "lie detection" purposes – criminals often confess to a crime if they believe someone has insight into their "true" thoughts as revealed via ANS measures (though there is little evidence supporting their validity; Feinberg & Stern, 2003). The *bogus pipeline* (Jones & Sigall, 1971), for example, was introduced specifically for the purposes of coaxing individuals to self-report their *true* thoughts and feelings because such individuals were led to believe that their bodies would betray them by producing signals that they could not control. Although the bogus pipeline did not involve actual physiological measures, participants thought it did. Like so-called lie detection, the same effect on veridicality of self-reported responses obviously can accrue to research actually involving physiological responses.

There are also domains in which individuals might be unwilling to explicitly report their thoughts and feelings because of self-presentational issues. For example, in the last 10 to 15 years, the number of studies examining intergroup interactions using psychophysiological techniques has surged (e.g., Amodio, Harmon-Jones & Devine, 2003; Blascovich, Mendes, Hunter, Lickel & Kowai-Bell, 2001; Mendes, Blascovich, Lickel & Hunter, 2002; Mendes, Blascovich, Hunter, Lickel & Jost, 2007; Scheepers, 2009). This increase is likely due to the possibility of demand characteristics inherent in intergroup interaction studies. In most Western contexts, overtly discriminating against someone because of their race/ethnicity carries social and legal costs. However, it is unlikely that racism, xenophobia, and fear of "different or exotic others" simply vanished when cultural sanctions against these biases were set in place. Instead it is likely that for some people the lingering effects of racism remain, but are masked by conscious actions and explicit statements. What remains are the uncontrollable responses that may be manifested via physiological signals.

There is no question that self-reported shifts in attitudes towards minorities have become increasingly egalitarian over the past half century – in 1958, for example, 38% of voters reported that they would vote for a qualified African American for president; by 2003 the number was 92% (Gallup, 2004, see Keeter & Samaranayake, 2007). But self-reported attitudes represent one facet of an individual's belief structure the component they are willing to share with others. Because they cannot be explicitly controlled, except in rare circumstances, physiological responses may reveal reactions to target others or taboo stimuli that indicate a different mental state than the one that individuals are willing to self-report. For example, Blascovich, Mendes, and Seery (2002) report that while participants' explicit ratings of experimentally facially birthmarked others were significantly more positive on variables such as attractiveness, intelligence, etc. than the same targets without birthmarks, they exhibited a threat response physiologically to the former but not the latter.

Changes in physiological responses indexing a specific mental state may precede conscious awareness of that state and thus may be *prognostic*. Such changes may be detectable prior to explicit reportable mental states. Strong evidence for this idea comes from Demasio and Bechara's study examining decision-making using a gain/loss card game (Bechara, Damasio, Tranel, & Damasio, 1997). In this study, skin conductance level was measured while participants made choices of which of four decks of face-down playing cards from which to turn over a card. Cards turned over from two of the decks produced larger overall losses than gains when the participant's goal was to optimize gains. When asked explicitly which decks were the better decks, normal (non-brain damaged) participants guessed correctly by approximately the 40th trial. However, skin conductance levels increased prior to participants choosing from loss decks by approximately the 10th trial, suggesting that bodily responses indicating loss preceded conscious awareness of that loss.

Finally, physiological responses might provide information about *how* mental states influence behavior (or vice versa). That is, physiological responses might be the causal explanation and be thought of as *mechanistic*. This argument can be seen in a variety of research programs. In medical research and health psychology studies of stress, ANS and/or endocrine responses are often regarded as the mediator via which individual or group differences are linked to end-point physical health outcomes, like essential hypertension or coronary artery disease (see Blascovich & Katkin, 1993). For example, researchers examining the influence of personality factors on cardiac diseases have suggested that individuals higher in dispositional hostility have exaggerated increases in blood pressure responses (Chesney & Rosenman, 1985) or cardiac activity (Matthews, 1988) during mildly stressful tasks, and this acute reactivity is implicated as part of the etiology of vascular and cardiac diseases.

To be sure, statistical mediation does not necessarily identify the casual *mechanism* for how individual differences lead to physical health outcomes. For example, blood pressure responses, like most ANS responses, are imperfect measures and are often end-points of complex physiological processes that are difficult to measure directly – for example, blood pressure is determined by overall vascular resistance and cardiac outflow. So, although pointing to physiological responses as statistical mediators between a personality trait on one hand and end-points of health or behavior on the other hand, is a potentially fruitful avenue of study, one needs to be careful to not over-state mechanism claims.

Physiological Indexes of Psychological States

Scholars have intuited relationships between bodily states and mental constructs for millennia. Nevertheless, scholars in Western cultures eschewed physiological measures well into the twentieth century due in large part to the lingering metaphysical assumption of the Cartesian notion of mind–body substance dualism. However, beginning in the middle of and lasting to the end of the twentieth century, social psychological researchers began taking seriously the notion of mind–body relationships.

These early attempts remained generally in the form “A difference in physiological response X occurs when independent psychological variable Y is manipulated.” For example, on the basis of an observation that a person’s heart rate increased when he or she viewed photographs of another person as opposed to a non-sentient object might have led an investigator to conclude that such heart rate increases measured passion or even love (e.g., Valins, 1967). The physiological rationale underlying such conclusions was that the human psyche is somehow tied closely to the autonomic nervous system, particularly to its sympathetic branch that was thought to be activated during periods of some sort of psychic arousal or disequilibrium. Hence, many autonomic measures, particularly sympathetic ones, were regarded as redundant and interchangeable.

The validity problems with this approach were at least twofold: it relied on a relatively naive physiological assumption; and, researchers fell into the logical “reverse inference” or “affirmation of the consequent” trap. The former was somewhat excusable as the assumptions of parallel sympathetic anabolic processes (i.e., activation of one process indicated activation of all) and catabolic tension between sympathetic and parasympathetic processes (i.e., the latter tending to diminish the former) were regarded more as fact than hypothetical. However, “affirmation of the consequent” is inexcusable as the presence of a supposed physiological response (i.e., consequence) does not guarantee the presence of a psychological phenomenon except in very limited and special circumstances.

The nature of relationships between any measures or indexes, whether physiological, behavioral, or subjective in nature, of psychological states and processes and the states and processes themselves always bear scrutiny. Problems of reverse inference or affirmation of the consequent are not distinctive to physiological indexes as we know; for example, from methodological concerns about social desirability problems with paper and pencil measures. However, it is important to remember that there is no validational shortcut just because indexes may be physiological.

Cacioppo and colleagues have clarified (Cacioppo & Tassinary, 1990) and re-clarified (Cacioppo, Tassinary & Berntson, 2007) the taxonomy of relationships between psychological and physiological variables assuming the identity thesis; that is, that all psychological processes are somehow embodied. Blascovich (2000) summarized their arguments as “... the more one limits the social psychological construct, and expands the set of physiological measures indexing it, the closer the construct and index can come to an invariant relationship;” that is, one cannot occur without the other.

Cacioppo et al. (2007) specified that an investigator can determine the strength of the relationships between psychological variables and physiological responses

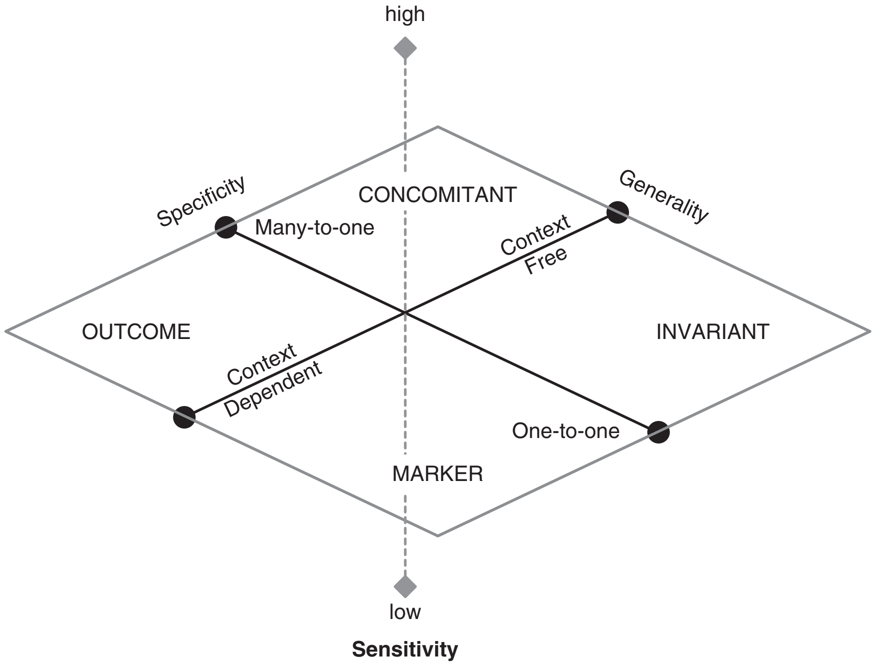

Figure 1.1 Cacioppo et al. Taxonomy of Psychophysiological Inference

by considering three dimensions or axes. These include *generality*, *specificity*, and *sensitivity*. Plotting these as orthogonal to each other produces a three-dimensional model with four segments varying in sensitivity (see Figure 1.1).

Generality refers to a contextual continuum on which indexes vary from limited or "context-dependent" to unlimited or "context-free." The latter are more desirable because the physiological indexes are generalizable across all situations (i.e., contexts). However, the latter are also relatively and even extremely difficult to achieve. Nonetheless, even context-dependent indexes can be valuable if the theoretical domain is similarly limited though still important or valuable.

Specificity involves the relationship between the index and construct. Perfect specificity means that there is a one-to-one relationship between a construct and its index. When the construct is activated, the index is activated and vice versa. When the construct is inactive, the index is not active and vice versa. In Cacioppo et al.'s (2007) nomenclature, specificity varies from "one-to-one" to "many-to-one." The latter means that any of several constructs can lead to the same index, and therefore cannot be distinguished form each other via that index. It is important to note, however, that "one-to-one" does not necessarily imply that a single physiological measure such as heart rate, cortisol level, or specific muscle response is necessary for an index to have a one-to-one relationship with a psychological construct. Importantly, a “single” physiological index can be defined as a pattern of multiple physiological measures at a point in time or even a pattern of physiological measures over time (i.e., topological pattern).

Sensitivity in the typology of Cacioppo et al. (2007) is the degree to which a physiological index corresponds to the putative underlying psychological state or process. Sensitivity provides information about the degree to which changes in the physiological index reflect the changes in the underlying psychological state or process.

Using the 2 2 2 typology based on generality, specificity and sensitivity, four segments are possible. That measures falling into the various segments vary in their logical strength as indexes does not mean that any segment is valueless. However, investigators must be aware of the limitations in terms of generality, specificity, and sensitivity of their own created or adopted physiological measures or indexes of psychological constructs.

For example, the validity claims of Blascovich and colleagues (e.g., Blascovich & Tomaka, 1996; Blascovich & Mendes, 2000; Blascovich, 2008) regarding their multivariable-based physiological indexes of challenge and threat motivation are limited to active coping or “motivated performance situations;” that is, ones requiring task engagement and instrumental cognitive responses such as exams, speeches, games, interviews, etc. and not necessarily to passive coping situations such as watching scary movies, witnessing crimes, etc. Yet, these markers have proven highly sensitive to motivational levels across a variety of social psychological processes (e.g., Blascovich, 2008), and they are important to the extent that motivated performance situations pervade human and social lives.

Inferring Psychological Constructs from Physiological Responses

The logic of developing and inferring properties is important, but it is also important to consider what can be done to maximize those properties. Blascovich and Seery (2007) proposed a set of principles for increasing the strength of inferences made from physiological measures or indexes of social psychological constructs.

Principle 1: Specify the nature of the construct

Because social psychological constructs are often labeled with common language terms (e.g., attitude, self-esteem, risk taking, ego depletion, threat, stress, liking, prejudice) sometimes researchers assume that everyone agrees on what a construct means. Indeed, it can be argued that the reverse is true. Because social psychological constructs are often labeled in common language terms, their meaning is often left implicit or fuzzy or both. Science demands precision not only in terms of methods and measurement but also in terms of definitions of terms and constructs (Blascovich & Ginsburg, 1978). Common language connotations or even "dictionary definitions" of constructs are not enough. One must be as specific as possible regarding what one means by scientific constructs. This does not imply universal agreement, which though desirable is not absolutely necessary, only that the investigator is clear to other researchers and consumers about what he or she means by the construct.

Principle 2: Specification of physiological indexes

At the present time, the control of physiological processes has been assumed to be largely a central nervous system process (i.e., the brain and its projections to the cranial endocrine organ – the pituitary). It is also the case that peripheral embodiments themselves (Blascovich & Mendes, 2010) have a role to play on moderating and perhaps even mediating such control through various hormonal and afferent neural influences. These systems clearly interact cybernetically.

Nevertheless, we are concerned here with peripheral physiological and endocrine processes as candidate indexes for social psychological constructs. Such indexes have several advantages. First, arguably most if not all of the results of central nervous system and endocrine processing are expressed peripherally, which are orders of magnitude less complex than their central nervous system antecedents. Second, the costs of peripheral measures for investigators is currently much less than the costs of central measures, especially ones based on brain scanning. Third, they are less intrusive. Fourth, participant embodiments (i.e., movements) are less restricted. Fifth, the predicted peripheral physiological indexes of social psychological constructs can be measured more precisely than putative underlying central nervous system and endocrine ones.

Principle 3: Specification of theoretical physiological linkages

Because neither the first nor second principles above are sufficient to postulate causal linkages between social psychological processes or constructs and candidate peripheral physiological linkages, researchers must specify theoretical mechanisms and processes for linking the two. In many ways, the power of the physiological index rests on the validity of the underlying theoretical rationale. Because of the importance of establishing one-to-one relationships between physiological indexes and psychological constructs, and because very few if any peripheral physiological responses are not mediated or moderated by a cascade of other physiological factors, it is very likely that worthwhile indexes can only increase in specificity and sensitivity if they include multiple responses and, often, are measured over time.

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Going Forward with this Book

The critical take-away points from this discussion are that researchers should approach measurement and interpretation of neurophysiological indicators carefully, soberly, and somewhat skeptically. Autonomic responses neither provide a royal road to the truth nor are self-report or behavioral data lacking in value. Ideally, all three measurement categories should be part of a multi-method approach. Also, there are occasions when physiological responses are expected to correlate with self-report responses and occasions when they are expected not to correlate. The advantages described above describe a possible road map to begin to make speculations about relationships across physiological and non-physiological methods.

The rest of this book focuses on three types or categories of physiological response measures worthy of researchers' interest. Each category comprises a chapter that was designed to stand on its own. The fact that each of the three chapters corresponds closely to the work of at least one of the authors of this book is no accident. Indeed, it would be impossible to single-author a work such as this because specialized and practical knowledge in each area is so important. Yet, it is also important to realize the commonalities across various categories of physiological measures.

A final caveat is that this is not a "cook book." Rather, it is a distillation of knowledge and experience that the authors have found has promoted and defined their own use of social psychophysiological approaches. The book was written to educate readers in both a general and a specific way. However, there are many other sources available to help researchers include endocrine and peripheral neurophysiological measures in their research. Not the least of these are the many guidelines for specific physiological measures published by the Society for Psychophysiological Research in its journal *Psychophysiology*.