THE BIOPSYCHOSOCIAL MODEL OF AROUSAL REGULATION

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I. Introduction

Since the 1970s, the relationships between psychological activity and autonomic arousal have intrigued me (JB). This curiosity grew as my own perceptions of cardiac responses under varying but mundane situations concretely reinforced the notion of causal relationships between cognitive and physiological responses. For example, while gambling as a young adult, I can recall experiencing my heart pounding as I made (relatively) large bets at the blackjack table or in "friendly" poker games. Many years later, in ancitipation of major abdominal surgery, I experienced my heart pounding as I contemplated potential outcomes. Within both situations, I can remember sometimes associating my interoceptions with positive feelings and sometimes with negative feelings.

As a psychologist, I wanted to examine the relationships between mind and body empirically, mostly in the laboratory. In my case, this was easier said than done. It took several years for me to implement even a fairly simple, relevant experimental study (i.e., Blascovich, Nash, & Ginsburg, 1978), and many more years to become familiar enough with psychophysiological theory and methodology to establish a bona fide social psychophysiology laboratory. Along the way, I received expert tutelage in psychophysiology from such experts as John Cacioppo, Ed Katkin, Bob Kelsey, and Lou Tassinary.[1] Graduate students in my laboratory challenged and sharpened our thinking about arousal regulation. Karen Allen, John Ernst, Diane

[1] The first author benefited immensely as a National Science Foundation Fellow in the Program for Advanced Study and Research in Social Psychophysiology at The Ohio State

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Quinn, John Rousselle, Kristen Salomon, and Daryl Wansink all made important contributions. More than anything else, however, the collaboration between the authors of this chapter has brought this line of investigation into focus and fruition.

A. BACKGROUND ASSUMPTIONS

Over the years, like so many others, we have come to the explicit realization that many important behavioral domains are fundamentally related to physiological responses including emotion (at least at the superordinate levels), motivation, and health. More important, perhaps, we also have come to the conclusion that disciplinarily idiosyncratic approaches to the study of arousal regulation generally limit our understanding and restrict empirical investigations of arousal-related behaviors.

Consequently, we advocate in integrative, interdisciplinary approach because we believe that such an approach best represents the reality of arousal-regulation processes. We doubt, for example, that purely cognitive, biological, dispositional, or social psychological theories even begin to reflect the complex nature of arousal-related domains. However, we believe strongly that more integrated, multidisciplinary theoretical models can and do reflect such processes. Furthermore, we believe that theoretical dilemmas or ambiguities regarding arousal-related behaviors at a single subdisciplinary level of analysis can often be resolved by looking to other levels of analysis. Finally, we believe in the value, and perhaps the necessity, of powerful empirical models of arousal-relevant situations.

B. ILLUSTRATIVE DILEMMA

We can illustrate a major problem created by a unidimensional framework for arousal regulation by looking no further than our own past research. If we limit ourselves to a purely dispositional approach for explaining arousal-related behaviors, our arguments might take the form that certain types of individuals (based on dispositional categories) exhibit more or less autonomic arousal in psychologically relevant situations. We could

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University during the summer of 1989 under the expert tutelage of Gary Berntson, PhD, John T. Cacioppo, PhD, and Louis G. Tassinary, PhD. Both authors benefited from less structured, but equally important training in psychophysiology, from Edward S. Katkin, PhD, and Robert A. Kelsey, PhD. None of these individuals, however, bear any responsibility for any errors in our own theoretical or methodological psychophysiological thinking.

index such arousal by using subjective (i.e., self- or other report) or objective (i.e., physiological) measures.

1. Competitiveness

For example, we might hypothesize that highly competitive individuals exhibit more arousal in demanding performance situations because they are more motivated than noncompetitive individuals (cf. Brehm & Self, 1989; Wright & Dill, 1993). Self-report measures could provide a test of our hypothesis. However, we could also seek convergent, more "objective" dependent measures. Being true to our dispositionally idiosyncratic approach but naive psychophysiologically (not uncommon, in our opinion, in the dispositional arousal-regulation tradition), we might choose cardiovascular measures such as heart rate or blood pressure changes (i.e., reactivity) to index the arousal associated with motivation—the higher the heart rate or blood pressure, the more motivated and, presumably, the more successful the individual.

Indeed, we have found support for the hypothesized relationship. Specifically, we found that we could predict which male in a dyad would win a fair but competitive zero-sum game[2] on the basis of precompetition but postinstructional physiological arousal as indexed by heart rate (Blascovich et al., (1978). In this study, subjects came into our laboratory in same-gender pairs where experiments wired them for electrocardiogram (ECG) recording. Subsequently, the subjects, placed in separate "player rooms," rested while we obtained baseline physiological recordings. Next, they received instructions pertinent to the upcoming zero-sum experimental game and played a few practice trials. A postinstructional but pretask ECG recording was made, and finally the game commenced while the ECG recording continued for 50 trials. Each dyadic competition produced a winner and a loser (there were no ties). Examination of opposing players' respective significant differences in heart rate changes during the critical periods in the study revealed that male competitors with greater increases in heart rates just before commencement of the game prevailed (Figure 1). Indeed, this was true for 19 of 20 male pairs. Notably, we did not find that heart rate discriminated winners and losers in female dyads.

2. Stressfulness

Taking a dispositional approach, we might also argue that individuals prone to experience stress exhibit more arousal in demanding performance situations as a function of psychological threat. Again, being true to our

[2] Zero-sum games are ones in which the outcome expectancies across all competing players is zero (i.e., a friendly poker game).

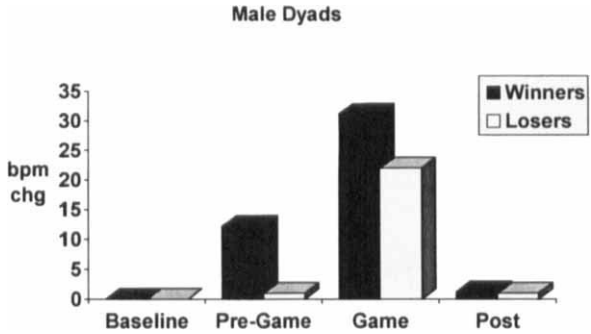

Fig. 1. Heart rate change data (Blascovich et al., 1978).

dispositional approach and naive psychophysiologically, we might choose a cardiovascular measure such as heart rate or blood pressure changes to index the arousal associated with stress—the higher the heart rate or blood pressure, the more stressed the individual.

We and many others (Blascovich & Katkin, 1993a; Matthews et al., 1986; Turner, Sherwood, & Light, 1993) have found data to support the predicted relationship. Indeed, in one study (reported in Blascovich & Katkin, 1993b), heart rate increased during the performance of a potentially stressful task, but also psychologically driven cardiovascular change itself predicted the extent of coronary artery disease, presumably a disease related to dispositional differences in stress responses (cf. Matthews et al., 1986;Turner et al., 1993).

Data collection took place in a study involving 30 patients undergoing diagnostic evaluation for coronary artery disease. All patients underwent exercise stress testing and "psychological stress testing" (performing a sensorimotor, signal detection task) in counterbalanced order in a clinical ECG laboratory at a large hospital. These patients then went on to coronary angiography, an invasive diagnostic technique used to determine the extent of coronary artery disease. Figure 2 illustrates the results of regression analyses revealing that the cardiovascular measures, including heart rate, recorded during psychological stress testing (entered into the regression model after the cardiovascular measures recorded during exercise stress testing) predicted significantly and substantially more variance in the degree of coronary occlusion in the three major coronary arteries than the traditional cardiological predictors recorded during exercise stress testing.

3. The Apparent Dilemma

Considered together, the separately hypothesized and empirically supported relationships among competitiveness, cardiovascular arousal, and

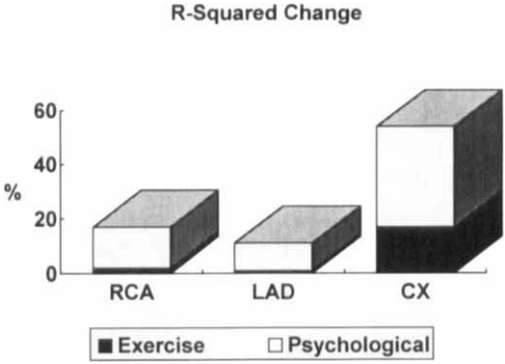

Fig. 2. Occlusion in three major coronary arteries: Right coronary artery (RCA), left anterior descending artery (LAD), and circumplex artery (CX) (Blascovich & Katkin, 1993).

successful performance on the one hand, and among stressfulness, cardiovascular arousal, and coronary artery disease on the other hand, pose a theoretical and empirical dilemma for arousal-regulation research. How can data indicating that cardiovascular reactivity in potentially stressful performance situations positively indexes both adaptive processes (i.e., appetitive motivation, superior performance) and maladaptive processes (i.e., aversive motivation, stress, disease) be reconciled? In our view, the dilemma cannot be resolved satisfactorily using only a dipositional approach; instead, an interdisciplinary, multilevel approach is required.

C. OVERVIEW

In this chapter, we describe and discuss the results from a multidisciplinary, integrative approach to the study of arousal regulation, integrating not only dispositional but also cognitive, physiological, and social dimensions. In doing so, we move from discussion of the concept of *arousal* and the notion of *arousal regulation* to a description of our integrative *theoretical model,* the general *empirial model* we use in our work, and our major *research findings.* We also discuss *implications* of our work and chart *future directions* for empirical endeavors.

II. Arousal and Its Regulation

Arousal plays an important theoretical role in many categories of behavior. Intense emotional experiences and expressions such as terror, rage,

lust, and ecstasy easily come to mind. Many other behavioral domains amenable to an arousal-based explanation exist including stress and stress management; anxiety disorders such as panic, hypochondriasis, and obsessive-compulsive disorder (cf. Barlow, 1988); and addictions (cf. Cappell & Greeley, 1987). Furthermore, the outcomes of dysfunctional, arousal-based processes include not only the aforementioned psychopathologies, but also medical problems such as coronary heart disease (see Blascovich & Katkin, 1993c, for a review) and immunosuppression (see O'Leary, 1990, for a review).

A. CONCEPTUAL ISSUES

We have discussed the ubiquity of the arousal construct in psychology in considerable detail elsewhere (Blascovich, 1990; Blascovich & Katkin, 1982; Blascovich & Kelsey, 1990). Arousal has generally played the role of a motivational or "emotivational" construct in psychological theories at least since Hull (1943). In social psychology, arousal has been a major motivational construct since the late 1800s. Indeed, in the last half of the twentieth century, arousal-based theories were at the forefront of the subdiscipline for nearly 30 years, until the social cognition perspective became prominent.[3]

Festinger's (1957) work revolutionized the attitude literature by introducing arousal, albeit initially in semidisguised form (e.g., dissonance), as the driving force underlying attitude change. The resulting plethora of consistency theories (Abelson et al., 1969) did not question Festinger's arousal and arousal reduction notions as much as they specified an ever-increasing number of antecedents to arousal. Similarly, Schachter and Singer (1962) revolutionized the conceptual role of arousal in emotion, a role that persisted for at least a quarter of a century. Most critics of Schachter and Singer's approach did not question the arousal component of the neo-Jamesian perspective. Rather they argued against and refined the cognitive aspects of the theory (e.g., Marshall & Zimbardo, 1979; Maslach, 1979). Likewise, classic theories of prosocial (e.g., Piliavin, Piliavin, & Rodin, 1975) and antisocial (e.g., Zillmann, 1978) behavior; social justice (e.g., Walster, Walster, & Berscheid, 1978); interpersonal influence (e.g., Triplett, 1987; Zajonc, 1965); and interpersonal attraction (e.g., Schachter, 1959)

[3] One might speculate that the reliance of mainstream theories in social psychology on a fuzzy, affect-related construct such as arousal contributed in at least a small way to the abandonment by many of arousal-based theories in social psychology for the more "rational" cognitive approach.

incorporated arousal as their primary motivational component and generally remained unchallenged in doing so.

Ubiquity, of course, does not guarantee clarity, and arousal remains largely a fuzzy concept, especially in social psychology. Indeed, the fact that the common language definition of arousal, "being stirred up to activity, or excited" (cf. *Oxford English Dictionary,* 1989), appears to be as good as a general psychological definition, speaks volumes to the lack of attention on the part of many social psychological theorists to this central theoretical concept. However, the common language definition of arousal lacks precise scientific meaning. As we have argued previously (Blascovich, 1992), because definitional imprecision typifies the arousal construct in many theories, the scientific meaning of arousal within these theories from its empirical operationalization must be inferred, an often hopeless task.

Two types of arousal constructs pervade psychological theories. Some (cf. Averill, 1974; Harre, 1972) argue that the most common usage is purely hypothetical or symbolic. This type includes all uses and definitions of arousal constructs for which empirical operationalizations and, hence, direct empirical assessments are inherently impossible; for example, notions such as intrapsychic tension, imbalance, or dissonance where the arousal construct serves as a mere metaphor. Use of arousal constructs in a metaphoric sense is often found in psychological theories, such as many of the social psychological theories previously noted, which in the Hullian tradition posit arousal as the primary motivational factor. Prototypically, certain theoretically specified circumstances (e.g., oppositional cognitions, inequity, mere presence) cause increasing levels of arousal (e.g., dissonance, feelings associated with being under- or overbenefited, energization), which the individual is more or less automatically driven to reduce.

The second, but historically less common, usage can be labeled scientific (cf. Harre, 1972). This category includes all uses and definitions of arousal constructs for which empirical assessments are possible. We have argued that the basis for the use of arousal constructs in the scientific sense should necessarily rest on firm physiological theory pertinent to the domains within which the specified arousal construct plays a theoretical role (Blascovich & Kelsey, 1990). Consequently, the use of any sort of general arousal construct, however valuable metaphorically, is not scientific.

B. MEASUREMENT

Two major approaches to the assessment of arousal constructs have pervaded the psychological literature: self-report and physiological. Often, each approach has been used naively. In essence, naive measurement of

arousal, whether via self-report or physiological recording, results from the same fundamental problem—a lack of precise specification of the criteria for what constitutes an instance or episode of the arousal construct. The leap from hypothetical (metaphoric) usage of an arousal construct to measurement is always naive. Not surprisingly, an established self-report measure, or even a limited set of self-report measures, of general arousal has failed to take hold in the literature. Furthermore, without precise specification of the biological meaning of arousal, many researchers have used physiological measures, particularly autonomic measures, as though each were an independent and interchangeable measure of arousal.

Recently, theorists and researchers have taken a more precise and sophisticated view of arousal definition. This has resulted in more valid self-report and physiological measures. Notable, in regard to the former, are the efforts of Larsen, Diener, and Emmons (1986) and Shields (1989). The relative success of these more sophisticated self-report measures derives from the more precise specification of a narrower rather than a broader or more general arousal concept. Thus, the self-reported arousal in such theories is more limited and context specific.

Regarding physiological measures, Cacioppo and his colleagues (e.g., Berntson, Cacioppo, & Quigley, 1991; Cacioppo & Tassinary, 1990), as well as Blascovich and Kelsey (1990), have taken a strong position on precise specification of the arousal construct and the measurement of appropriate physiological responses. Hence,

> Valid physiological assessment of arousal requires the provision of a contextually relevant theoretical basis for the arousal construct and the measurement of a corresponding set of physiological responses over time (Blascovich & Kelsey, 1990; Cacioppo & Tassinary, 1990). Resulting patterns of physiological activity enable the investigator to determine the degree to which arousal of a theoretically specified type is present. (Blascovich et al., 1992, p. 165)

C. AROUSAL REGULATION DEFINED

How individuals become aroused and how they reduce, maintain, or enhance such arousal defines the domain of arousal-regulation theories. Such theories and research have appeared, not only within more biologically oriented subdisciplines of psychology such as psychophysiology (e.g., Fowles, 1988), but also within nonbiologically oriented subdisciplines such as personality (e.g., Eysenck, 1967; Stelmack, 1990) and social psychology (e.g., Carver & Scheier, 1990; Cioffi, 1991). Since the mid-1960s, arousal-regulation theories within each of these fields have advanced markedly,

reflecting increased theoretical and methodological sophistication. Yet, these advances have occurred relatively independently.

D. SUMMARY

We maintain that the well-worn concept of arousal, although valuable theoretically and symbolically, often fails empirically because without concrete definition the scientific measurement of arousal remains futile. For scientific purposes, we argue that the arousal concept must be specified within an appropriate external (i.e., environmental) and internal (i.e., biological) context. Furthermore, we argue that disciplinarily idiosyncratic approaches to the study of arousal-regulation processes have limited value. We believe that a multidisciplinary biopsychosocial approach represents a much more fruitful approach for understanding arousal regulation.

III. Theory: The Biopsychosocial Model

A. GENERAL COMMENTS

A very primitive version of our arousal-regulation model appeared in the early 1980s (Blascovich & Katkin, 1982), an expanded version (Blascovich, 1990) and a revised version in the early 1990s (Blascovich, 1992), and herein the most recent version. Obviously, theoretical model building is a dynamic enterprise and scientists should expect to continuously expand and refine models over time. We believe the dynamics of our biopsychosocial modeling process provides a constantly advancing conceptual framework for explaining and testing arousal-regulation processes.

Importantly, although we apply the biopsychosocial model within a specific limited context, the model itself is general and does not necessarily depend on any particular concrete specification of arousal and associated arousal measurement strategy. Rather, the model can frame various specific arousal constructs and measurement strategies. For example, the model can frame affect (as a specific arousal construct) regulation exhibited and measured somatically via the facial musculature. It also can frame stress (as a specific arousal construct) regulation exhibited and measured autonomically via the electrodermal and cardiovascular system.

We believe that empirical research derived from our biopsychosocial model of arousal regulation has facilitated understanding of interactions among many of the intrapersonal, interpersonal, and physiological factors

involved in arousal-regulation processes. These discoveries have led us to a theoretical account that resolves the apparent dilemma—arousal as beneficial versus arousal as pathological—described earlier.

Because arousal-regulation processes are undoubtedly multiply determined (cf. Cacioppo & Berntson, 1992; Dienstbier, 1989), integration of multiple levels of analysis (e.g., physiological, dispositional, cognitive, social) and methods has the potential to advance our understanding of arousal-regulation processes rapidly. Thus, arousal regulation, as a multiply determined process in the simplest case and as a set of multiply determined processes in the most complex case, requires an interdisciplinary approach. The biopsychosocial framework guiding our research is such an approach.

B. PRIMARY PROCESS

1. Situation-Arousal Component

According to the biopsychosocial (BPS) model (Figure 3), the major or primary arousal-regulation process (illustrated by the black, descending arrows) begins with the perception and subsequent cognitive appraisal of a goal-relevant situation which leads, in turn, to a pattern of physiological arousal associated with situational demands and appraisal outcome. A goal-relevant situation has perceived (real or imagined) consequences for the well-being (psychological or physical) of the individual (Lazarus, 1991). Individuals experience both metabolically demanding (e.g., track and field events) and nonmetabolically demanding (e.g., delivering a lecture, writing a memo) goal-relevant situations throughout their lives. Goal relevancy defines the general domain of the BPS model. Relatively nonmetabolically demanding, goal-relevant situations specify the domain within which we have, for the most part, concentrated our theoretical and empirical efforts.[4]

Nonmetabolically demanding, goal-relevant situations can occur in relatively passive form, such as the presentation of emotionally evocative photographs or news magazine accounts of the economy, attracting the individual's attention but requiring or demanding little or no immediate overt or cognitive action. Similar to Obrist (1981), we label this type of situation a *passive situation.* However, goal-relevant situations may occur in relatively interactive form, such as an academic examination, a speech, or a specific job duty, attracting not only the individual's attention, but also requiring

[4] Nonmetabolically demanding performance situations simply do not require the energy requirements of metabolically demanding ones. The latter, involving large muscle movement, represent quite a different domain for the BPS model. Undoubtedly, different patterns of cardiovascular response result from benign and malignant overall appraisals in metabolically demanding situations versus nondemanding situations.

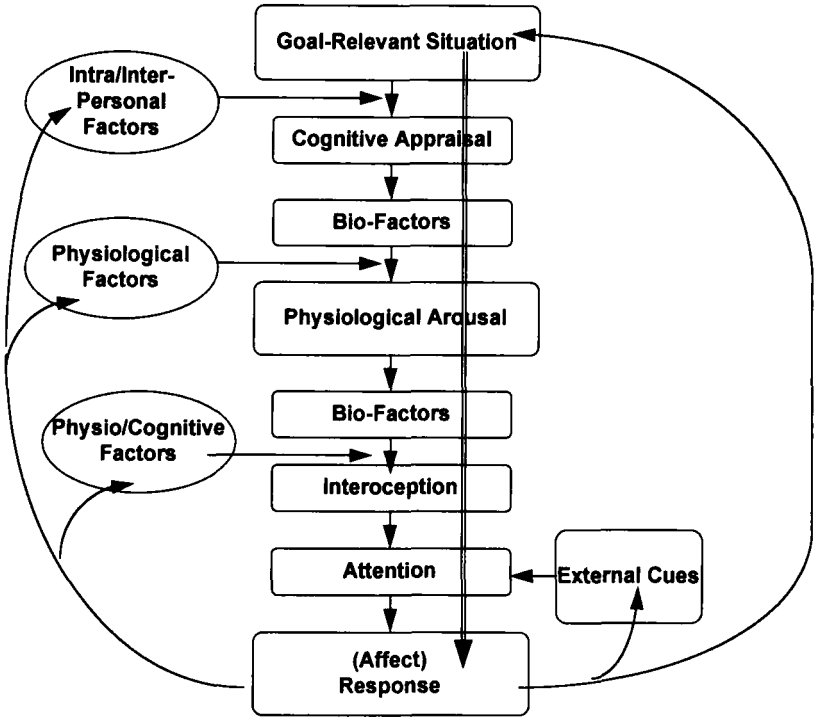

Fig. 3. The biopsychosocial model.

or demanding immediate overt or cognitive action that can be evaluated by the individual and observers. We call the latter type of situation a *motivated performance situation.* Because both types of goal-relevant situations pervade our lives, both deserve study. However, because goal-relevant passive and motivated performance situations differ fundamentally in behavioral and cognitive demands for action, the type of goal-relevant situation, as it is hoped the reader sees from our data, must not be overlooked when making predictions about and conducting empirical studies of arousal-regulation processes. We mostly focus empirically on the motivated performance or active-coping (cf. Obrist, 1981) type of situation but also have data relevant to more passive kinds of situations.

The BPS model specifies *cognitive appraisal* as the initial mediator in the goal relevant situation-arousal component of the BPS model (see Figure 3). We specify a fairly simple cognitive appraisal process based on the phenomenological comparison of two component appraisals: primary and

secondary. *Primary appraisal* refers to the degree of demand, uncertainty, and/or danger in the situation. *Secondary appraisal* refers to the degree of perceived resources or abilities that one brings to bear on the situation. If comparative primary and secondary appraisals result in a perception of demand that cannot be overcome by perceived resources, then *threat* becomes the overall resultant appraisal. If comparative primary and secondary appraisals result in a perception of resources that can overcome the perceived demand, then *challenge* becomes the overall resultant appraisal.

In our view, primary and secondary appraisals drive the resultant overall cognitive appraisals relatively equally in motivated performance situations. In passive situations, however, primary appraisals explain more of the variance in the resultant overall appraisals. Our arguments for this distinction are based on the following rationale. As previously discussed, we assume the goal relevance of both passive and motivated performance situations such that individuals are motivated to remain in and adapt to both types of situations as well as they can. Primary appraisals in both types of situations can vary considerably within individuals. However, the repertoire of resources that can be brought to bear on the two types of situations differs categorically within individuals. Resources appropriate to goal-relevant passive situations are likely to be limited to emotional stamina or endurance, or what Lazarus and Folkman (1984) termed "emotion-focused coping resources." Resources appropriate to goal-relevant motivated performance situations include not only emotion-based abilities but also cognitive and behavioral abilities, with Lazarus and Folkman (1984) termed "problem-focused coping resources." In essence, passive situations limit the range and relevance of secondary appraisals.

Although our notions of cognitive appraisal take root in Lazarus and Folkman's theoretical efforts (Lazarus, 1991; Lazrus & Folkman, 1984), important differences between their conceptions and our conceptions exist. First, the Lazarian concept of primary appraisal is much more inclusive than ours. For example, Lazarus includes goal relevance within the notion of primary appraisal, whereas we do not. Second, his notions of secondary appraisal are less situation specific than ours, as he does not emphasize the distinction that we (and others such as Obrist [1981]) do between passive and active (i.e., motivated performance) kinds of situations. Third, and perhaps most important, Lazarus and Folkman regard challenge as a type of primary appraisal, whereas we believe that challenge, especially in motivated performance situations, cannot be determined on the basis of primary appraisal alone, but must involve consideration of secondary appraisals of coping resources and abilities.

The situation-appraisal link in the BPS model is moderated by both intra- and interpersonal factors (see Figure 3). Intrapersonally, dispositional as

well as cognitive and affective factors influence resultant appraisals of goal-relevant situations. We contend that certain personality traits predispose individuals to appraise situations as more or less challenging or threatening. The most important of these include self-esteem, belief in a just world, and a sense of control—traits that, in the proper configuration, can increase an individual's resilience. Certainly, individuals high in self-esteem, high in belief in a just world, and high in degree of perceived control would more likely make overall challenge appraisals compared to individuals low in these traits in motivated performance situations. Thus, we would expect individuals with the former configuration to make much higher secondary appraisals (i.e., of coping abilities) than individuals with the latter configuration. However, in our view, dispositions, although important, do not explain all the variance in overall cognitive appraisals.

Cognitive factors can also moderate the situation-appraisal link intrapersonally. Knowledge, past experiences in similar situations, and even attitudes can affect appraisals. Such factors can influence both primary and secondary appraisals in either a positive or negative direction. Finally, affective states can also moderate the situation-appraisal link intraindividually. Whether they do so directly by influencing appraisals (cf. Salovey & Birnbaum, 1989) or indirectly by stimulating state-congruent memories (cf. Kavanaugh & Bower, 1985) remains open to question and empirical investigation. Few clinicians would argue against the notion that individuals experiencing negative affective states experience more situational threat than individuals experiencing positive affective states.

Interpersonal factors also moderate the situation-appraisal link. Social facilitation theory and research (e.g., Zajonc, 1965) suggests that even the mere presence of others may moderate this link. Relationship nature may also be important (Allen, Blascovich, Tomaka, & Kelsey, 1991). The quality of relationships with others in motivated performance situations undoubtedly influences appraisals. For example, the presence of evaluative others may increase primary appraisal in motivated performance situations. However, the presence of nonevaluative, supportive others may decrease primary appraisal in such situations. Liking and interpersonal attraction may work in similar ways. In addition, group membership and social identity may moderate the situation-appraisal link. Stigma (Crocker & Major, 1989), stereotype vulnerability (Steele, 1992), ingroup and even outgroup characteristics most likely contribute to the nature of appraisals in goal-relevant situations.

Biological factors (see Figure 3) also mediate the goal-relevant, situation-physiological arousal component of the BPS model. Here, genetic, structural, and functional factors undoubtedly play a role. The importance of the role of hereditary factors for appraisal-driven physiological responses

can be and certainly has been debated. However, as in all nativist-empiricist debates, extreme positions generally provide little substance for theoretical advancement. But, because biological structures and processes necessarily provide the mechanisms by which phenomenological experiences such as cognitive appraisals result in physiological responses, the mediating role of hereditary and anatomic factors cannot be dismissed.

Most assuredly, physiological influences moderate the biological factors–physiological arousal link in the BPS model (see Figure 3). Any factors that serve to disrupt the normal functioning of relevant neural and endocrine processes would also serve to disrupt normal physiological respones to cognitive appraisals in goal-relevant situations. For example, severe neurotransmitter depletion might substantially alter somatic and vascular responses. Pathophysiological (i.e., disease) states can substantially alter such responses. Metabolic changes induced by exercise or ingestion of foodstuffs and other substances (e.g., alcohol, caffeine, psychotropic drugs) can also alter such resposnes. Finally, maturational changes (e.g., puberty, senescence) can bring about such alterations.

In sum, biological factors (e.g., genetic, anatomic, functional) moderated by physiological processes (e.g., maturation, disease, metabolism) define the dynamic range of physiological arousal systems. Cognitive appraisals, moderated by intrapersonal factors (e.g., personality traits, attitudes, affective states) and interpersonal factors (e.g., presence of others, interpersonal attraction) provide momentum and determine the direction of change or adjustment of the physiological arousal system. Thus, *these mediating and moderating factors account for individual differences in the intensity and polarity of arousal evoked by the same or similar stimuli.*

In passive goal-relevant situations, we believe that distinguishable patterns of physiological arousal follow from primary appraisals of demand or danger and are best differentiated somatically via the muscles of facial expression and differentiated to a lesser extent autonomically. In the case of motivated performance situations, we believe that distinguishable patterns of physiological arousal follow from the interaction of primary appraisals of demand or danger and secondary appraisals of ability (i.e., overall challenge or threat appraisals) and can best be differentiated autonomically via myocardial and vascular responses.

2. Physiological Arousal-Response Component

This aspect of the BPS model focuses on the generation of arousal-motivated responses or behaviors. According to the BPS model (see Figure 3), biological factors, interoception, and attention, in turn, mediate the relationship between physiological arousal and resultant behaviors. We

propose that biological factors mediate the arousal–interoception link. These factors are similar, and potentially related to, those mediating the link between cognitive appraisal and physiological arousal (e.g., anatomy, genetics). Likewise, physiological factors similar to, and perhaps related to, those moderating the link between biological factors and physiological arousal (e.g., pathophysiology, metabolism, maturation) moderate the biological factors–interoception link.

According to the BPS model, internal (i.e., interoceptive or somesthetic) and external (i.e., environmental) cues of stimuli compete for the individual's attentional capacity.The allocation of attention varies, in part, as a function of the relative influence and strength of these two cue sources. A somesthetically hypersensitive individuals (e.g., a hypochondriac) might fix attention nearly exclusively on internal physiological cues, whereas, a somesthetically hyposensitive individual might fix attention almost exclusively on external or environmental cues.

The importance of the physiological arousal-response component of the BPS model derives from the orthogonality of dispositional physiological response levels (i.e., individual response stereotypy) and dispositional somesthetic sensitivity. Physiologically hyper-reactive individuals are not necessarily somesthetically hypersensitive. Wide individual and group differences exist in this regard (Katkin, Blascovich, & Goldband, 1981; Reed, Harver, & Katkin, 1990; Roberts & Pennebaker, 1995). Thus, except perhaps at extreme levels of physiological arousal, wide variation exists in the somesthetic accuracy of individuals even for relatively specific visceral responses such as heartbeats, respiratory cycles, and intestinal responses (Reed et al., 1990) (Figure 4).

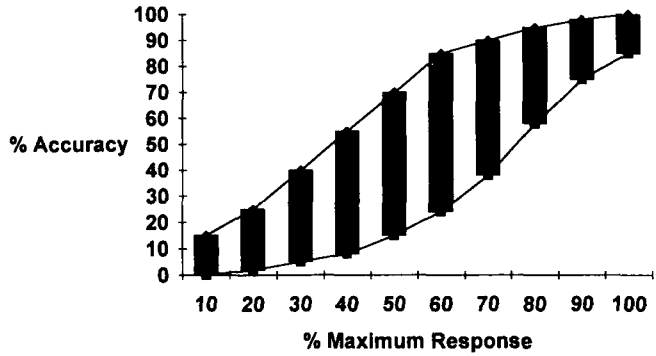

Fig. 4. Theoretical variability in somesthetic accuracy as a function of intensity of physiological response.

We maintain that phenomenological experiences driven by physiological responses in goal-relevant situations vary as a function of the interoceptive or somesthetic sensitivity of the individual. Furthermore, we maintain that when phenomenological/physiological verdicality occurs, most likely the overall *intensity* of physiological responses is more accurately experienced somesthetically rather than specific patterns necessarily composed of multiple physiological responses. We maintain that the *specificity* of arousal-based phenomenological experiences is mainly a function of the preceding overall cognitive appraisal and the presence of confirming and disconfirming external or environmental cues. Thus, internal physiological cues more likely drive the intensity rather than polarity of emotivational states resulting from overall cognitive appraisals of goal-relevant situations. In the absence of physiological cues, individuals must rely on initial appraisals and concomitant external cues for both the intensity and specificity of emotivational states.

According to the BPS model (see Figure 3), the primary process results in a motivated, multifaceted response. We assume that such a response includes affective, cognitive, and behavioral components, although in our view the affective component orients the others. Specifically, the affective polarity of a response generally determines the arousal-regulation goals of the cognitive or behavioral response components. If the polarity is negative, arousal-reducing cognitive and behavioral responses should predominate. If the polarity is positive, arousal-enhancing cognitive and behavioral responses should predominate.

3. Responses

Affect-relevant, arousal-regulation responses include a raft of possible self-protective and/or self-enhancing behavioral interventions and cognitive strategies. As illustrated by the upward pointing arrow in the far right of Figure 3, some responses (usually behavioral) are intended to alter the goal-relevant situation itself or at least external cues associated with the situation. Although the essential aspects of the goal-relevant situation cannot be changed without altering the goal-relevant nature of the situation itself, certain aspects of these situations relevant to primary appraisal (i.e., demand, uncertainty, danger) may be modified. For example, a doctoral student might arrange that his or her dissertation defense take place in a pleasant physical environment.

Other behavioral responses can influence the moderating factors previously discussed (see Figure 3). For example, our doctoral student might arrange that nonessential, evaluative others (e.g., peers, parents) absent themselves from the oral defense, or, conversely, that nonessential, noneval-

uative others appear at the defense. Ingestion of alcohol or other psychotropic drugs might alter moderating physiological factors in ways that can either increase or decrease physiological arousal responses and/or interoception, or that can affect physiological arousal directly. Finally, cognitive strategies including defensive mechanisms, attitude change, self-handicapping strategies, meditation, imagery, and so on, can alter these same moderating factors.

C. SECONDARY PROCESS

The BPS model allows for direct association (i.e., secondary process) between goal-relevant situations and arousal-regulation responses. Specifically, the primary process need not occur in every goal-relevant situation for arousal-regulation to occur. A secondary process can operate (illustrated by the long descending arrow linking the situation and response components in Figure 3). If the association between a goal-relevant situation and arousal-regulation responses becomes well learned, the secondary, associationistic process may operate (cf. Harris & Katkin, 1975). The relative rapidity of an arousal-regulation response once the individual finds him- or herself in a motivated performance situation indicates the likely operation of a secondary process. Thus, to the extent that the goal-relevant situation is familiar, a direct link between the situation and response will facilitate arousal-regulation responses. Conversely, to the extent that the goal-relevant situation is novel, the full primary process will occur.

D. THE ITERATIVE NATURE OF THE PRIMARY PROCESS

Because of the dynamic character of most goal-relevant situations, individuals constantly reappraise them. For example, the fact that an individual endured the first few moments of a horror film (i.e., passive situation) might cause the individual to reduce his or her primary appraisal of it or increase his or her perceptions of ability to emotionally endure the film. Similarly, the fact that an individual survived the first few moments of an important speech (i.e., motivated performance situation) with positive audience feedback might cause the individual to reappraise the situation more positively. Of course, such reappraisals might take a negative turn as well, or even alternate very quickly between positive and negative reappraisals. In addition, once the individual initiates an arousal-regulation response, the situation must be reappraised.

IV. Empirical Model

As previously discussed we believe that the BPS model can help us to understand the nature of arousal-regulation within goal-relevant situations. However, empirical tests of the model require a contextually (i.e., goal-relevant situation) appropriate, theoretically based (i.e., psychophysiologically based) concept of arousal, with valid specified indices of arousal—that is, *an empirical model.*

We have benefited from access to such an empirical model in the same way that biomedical researchers have benefited from access to "animal models" of health and disease. To illustrate, certain strains of mice are predisposed to develop certain types of cancers, whereas other strains are relatively immune to such disease. In the natural course of maturation, individual animals within the susceptible strain will almost certainly develop disease, whereas individual animals from the immune strain will not. By assessing deviations from the natural developmental course of the disease (e.g., among susceptible strains), biomedical researchers are able to examine experimentally potential mediators and moderators of disease outcomes.

Following the same rationale, we have aspired to develop and use standard empirical models in order to investigate the BPS model empirically. In addition to being ecologically and theoretically valid, such models must also be pragmatic, that is, relatively easily incorporated into experiments. Conceptually, the empirical models that we have used in the past and currently employ are short-lived, laboratory-based *motivated performance situations.* Such situations, as previously described are goal relevant to the individual, are presented to the individual in relatively interactive form, and demand relatively immediate overt or cognitive action that can be evaluated by the performer and observers.

Many laboratory situations involving performance tasks qualify as motivated performance situations, not only because they include a task demanding overt or cognitive action on the part of study participants, but also because they engender a meaningful degree of evaluation apprehension (Rosenberg, 1965). That is, participants generally believe that their performance on the laboratory task provides the observer (i.e., experimenter) with valid information about task-relevant skills and abilities that generally reflect on their self-worth. In a psychophysiology laboratory, the attachment of electrophysiological sensors and other transducers reinforces and enhances evaluation apprehension, an argument supported by the rationale of, and data pertinent to the "bogus pipeline" (Jones & Sigall, 1971) and various forms of lie detection. Specific performance tasks that we have

used within our laboratory-based motivated performance situation category include mathematical (e.g., serial subtraction, number series problems), analytic (e.g., the Remote Associates Task) (McFarlin & Blascovich, 1981; Mednick, 1962), attitudinal (e.g., pairwise preference judgments), signal detection (e.g., choice-deadline reaction time tasks), and verbal (e.g., speech anticipation and delivery) tasks.

Much of our empirical work actually has been devoted to the explication of cardiovascular response patterns evoked during motivated performance situations. These response patterns have theoretical roots in the pioneering work of Obrist (1981) on active coping and Dienstbier's (1989) work on physiological toughness. According to Obrist, integration of cardiovascular and somatomotor activity via the central nervous system occurs frequently in daily life. Such integration results in what Obrist termed "cardiac-somatic coupling," during which parasympathetic (i.e., vagal) control dominates over sympathetic control of the heart. Cardiac-somatic coupling occurs during activities such as rest and exercise, and during conditions that involve passive receipt of environmental stimulation. According to Obrist, lack of cardiovascular and somatomotor integration, which he termed "cardiac-somatic uncoupling," occurs during situations that require the individual to cope actively. During cardiac-somatic uncoupling, Obrist maintained that sympathetic influences dominate cardiac control.

Functionally, however, it seems unlikely that a unitary pattern of cardiovascular response (i.e., one indexing cardiac-somatic uncoupling) that is consistently and invariably elicited during active coping (or what we term "motivated performance") exists. Such a unitary pattern would suggest no biological or physiological differentiation between motivated performance situations in which benign, positive appraisals predominate from those motivated performance situations in which malignant, negative appraisals predominate—a situation that is unlikely at best.

More recently, Dienstbier (1989) and others (e.g., Manuck, Kamarck, Kasprowicz, & Waldstein, 1993) have delineated more than one possible pattern of autonomic responses during motivated performances situations. Increased activity of the sympathetic-adrenomedullary (SAM) axis marks a benign pattern. Increased activity of the pituitary-adrenocortical (PAC) axis marks a malignant pattern when such activation occurs alone or in combination with SAM activation. In the context of cardiovascular arousal during motivated performance situations, the benign pattern (i.e., SAM activation) would be expected to be associated with positive cognitive appraisals and marked by increasing cardiac or myocardial performance and by decreasing vascular resistance. In contrast, the malignant pattern (i.e., PAC activation or SAM/PAC coactivation) would be expected to be associ-

ated with negative cognitive appraisals and increasing cardiac or myocardial performance, but accompanied by stable or increasing vascular resistance.[5]

With regard to neural control, we suspect that the benign pattern of physiological activation is reflected by relatively pure SAM activation, which includes 1) sympathetic neural stimulation of the myocardium that enhances cardiac performance, and 2) adrenal medullary release of epinephrine causing vasodilation in large skeletal muscle beds and bronchi, resulting in an overall decline in systemic vascular resistance, as well as some additional enhancement of cardiac performance. Functionally, this pattern represents the efficient mobilization of energy for coping. Regarding the malignant pattern, as noted, we suspect dual activation of the SAM and PAC axes. In our view, SAM neural stimulation of the myocardium causes elevations of cardiac performance over resting levels. However, accompanying PAC activity inhibits SAM release of epinephrine and norephinephrine from the adrenal medulla. Such inhibition results in moderate elevations in cardiac output without accompanying decreases in systemic vascular resistance. We believe that the inhibitory effect of PAC activity on SAM activity reflects anxiety and uncertainty over options for coping (e.g., flight or avoidance versus task performance). To a certain extent, our hypotheses regardig PAC inhibition are based on neurophysiological work linking anxiety and anxiety-related behavior to brain centers that control PAC activity (e.g., the septo-hippocampal system) (Gray, 1982; McNaughton, 1993).

V. Research

A. BACKGROUND

Prior to our work and the appearance of our BPS model, arousal-relevant physiological coping models, such as Obrist's (1981) model, and cognitive

[5] Many authors have noted differences in activation along these two SNS subsystems (Lundberg & Frankenhaeuser, 1980; Mason, 1975), and such differences can be traced to theoretical differences between Cannon and Selye as to how to view stress responses. Contemporary researchers have argued that the SAM is an "effort" system, responsible primarily for energy mobilization to support actual or anticipated behavioral coping. The PAC system, in contrast, is a "distress" system associated with perceptions of actual or potential physical or psychological harm. Relevant to our hypothesis that the PAC system is associated with malignant cognitive appraisals, Mason (1975) and others (Lovallo, Pincomb, Brackett, & Wilson, 1990) have demonstrated convincingly the extreme sensitivity of the PAC system to negative emotional experience. Moreover, regarding the hypothesized relationship of the SAM to benign cognitive appraisals, the SAM system appears sensitive to emotional factors (i.e., positive and negative) only to the extent that they involve energy mobilization (e.g., fear or exhilaration).

appraisal coping models, such as Lazarus and Folkman's (1984), had not been integrated. Psychophysiological and cognitive-appraisal researchers made implicit assumptions regarding the other domain, largely ignoring advances in those domains. For example, for Obrist and many subsequent cardiovascular psychophysiological theorists and researchers (with the notable exception of Dientsbier), all active-coping situations were presumed as stressful or threatening, and resulting cardiovascular responses were used to index the degree of stress or threat. However, for Lazarus, differences in physiological response patterns underlying passive and active situations were largely ignored.

As social psychophysiologists, it seemed to us that laboratory tasks used to explore the nature of cardiovascular reactivity to stress could be used to experimentally test cognitive appraisal notions as well. That is, individuals should show less of a stress response (i.e., less cardiovascular reactivity) if we can intervene and decrease their primary appraisals of demand and danger, increase their secondary appraisals of ability, or both. Of course, such an idea did not develop as clearly and as quickly as the previous couple of sentences imply. Rather, the idea came about as the result of two experiments that we conducted. In addition, it is important to note that our notion regarding stress response and cardiovascular reactivity was naive and not yet as sophisticated as the challenge and threat patterns previously discussed.

B. EARLY STUDIES

1. Self-Deception and Self-Presentation Concern

Numerous investigators have demonstrated differences in cardiovascular arousal during active-coping tasks (i.e., motivated performance situations) as a function of dispositional or personality factors, such as coronary-prone personality, hostility, and so on. Although it is now clear to us that these dispositional factors moderate the situation-appraisal link in the BPS model (see Figure 3), it was not always so apparent. Our early efforts in the area of personality factors focused on dispositional defensiveness. Tomaka, Blascovich, and Kelsey (1992)[6] investigated the relationships between cardiovascular reactivity and dispositional defensiveness constructs, including self-deception and self-presentation concern, using mental arithmetic tasks in a motivated performance situation.

[6] Due to the vagaries of publication, reference dates throughout the article to our empirical work are not indicative of the actual order in which studies were conducted. Studies were conducted in the order explicit or implied in the text of the manuscript.

Subjects arrived at our laboratory by appointment. As is typical in cardiovascular reactivity studies, they received instructions regarding the upcoming experiment including the nature of the task that they would be performing and the nature of the physiological measures that would be taken. After providing informed consent, subjects entered a recording room where appropriate physiological sensors and transducers were affixed. Subsequently, subjects were allowed to relax and adapt to the recording room environmental before baseline physiological recordings were made. Following the baseline recording period, subjects received instructions regarding the upcoming mental arithmetic task (i.e., serial subtraction) and answered questions designed to ascertain both their primary and secondary appraisals of the ensuing task. After it was clear that participants understood the task instructions, their performance commenced.

For this particular study, subjects had filled out questionnaires during a prior mass testing session designed to measure target disposition. Self-deception and self-presentation concern were assessed via Sackheim and Gur's (1979) self-deception scale and Crowne and Marlowe's (1964) social desirability scale, respectively. In our sample, the correlation between these two variables was positive and significant [$r(63) = .33$, $p < .01$]. For purposes of subsequent analyses, subjects were divided (based on median splits) into high and low groups on each target disposition. These analyses revealed that the high self-deception group made lower primary appraisals of the upcoming task and showed smaller increases in physiological response (i.e., heart rate) during the task (Figure 5) than the low self-deception group. The high compared to the low self-presentation concern group, however, did not differ in appraisals but did differ in physiological response.

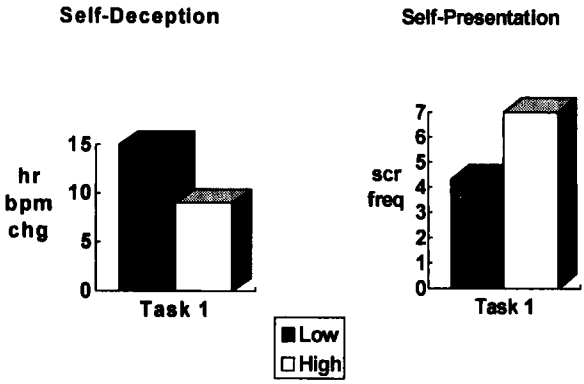

Fig. 5. Autonomic responses as a function of dispositional defensiveness (Adapted from Tomaka et al., 1992).

The former group exhibited greater increases in physiological response (i.e., skin conductance responses) during the task (see Figure 5).

These data intrigued us because they demonstrated that two dispositional constructs, although positively related, were related to different patterns of autonomic response during a motivated performance situation. We reasoned that individuals high in self-deception were less affected by the potentially stressful experimental task than individuals low in self-deception, whereas individuals high in self-presentation concern were more affected by the experimental task than individuals low in self-presentation concern. Because of the key pretask difference in primary appraisal between high and low self-deceivers, we concluded that these dispositions affected the phenomenological experience of the experimental task and that such experience was potentially mediated via cognitive appraisal processes.

2. Human and Canine Friends

At about the same time, we conducted another study varying the presence of others during performance of an active-coping task, again, mental arithmetic. In this study (Allen et al., 1991), we recorded autonomic responses while middle-age women performed mental arithmetic tasks in our laboratory and again 2 weeks later in their homes. The presence manipulations were accomplished in the home setting where the subjects either performed the active-coping tasks "alone" (control condition), in the presence of their best female human friend, or in the presence of their beloved pet dog with the experimenter present in all three conditions.

The presence of the human friend resulted in significantly larger increases in autonomic responses (Figure 6) compared to the presence of just the experimenter (control condition). Conversely, the presence of the pet dog

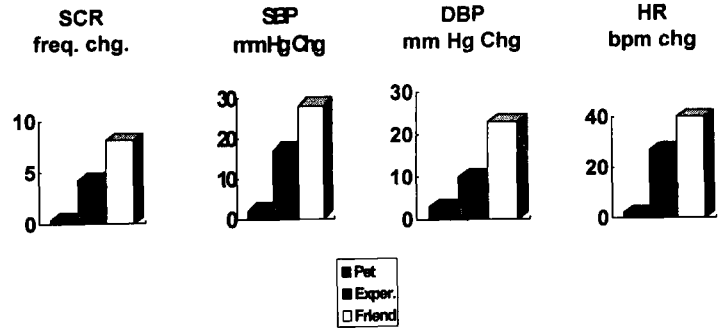

Fig. 6. Cardiovascular reactivity as a function of the presence of others (Adapted from Allen et al., 1991).

resulted in significantly smaller autonomic increases than the presence of just the experimenter. Futhermore, the presence of a human friend resulted in substantial performance decrements compared to the other conditions. We interpreted the results of this study in terms of the perceived evaluative nature of the human friend. We reasoned that the human friend was more likely to be perceived as evaluative than the canine friend. Hence, in our view, the presence of the friend increased the threat of the situation.

3. Theoretical Impact

These early studies confirmed that intrapersonal (i.e., self-deception and self-presentation concern) and interpersonal (i.e., presence of others) factors could moderate autonomic responses, particularly skin conductance and cardiovascular responses (e.g., blood pressure, heart rate). Furthermore, these studies suggested to us that these factors probably moderate an early stage or link in the situation-arousal component of the BPS model.[7] This link likely involved the perception and interpretation or "cognitive appraisal" of the stimulus situation itself. In the dispositional study (Tomaka et al., 1992) previously described, we hypothesized that denial-based dispositions such as self-deception might alter the cognitive-appraisal process causing individuals high in such traits to make more benign appraisals of potentially stressful events. Indeed, high self-deceivers reported the initial upcoming mental arithmetic task (i.e., after instructions and immediately before performance) as significantly less thretening than low self-deceivers.

The specific physiological responses measured in these studies were primarily chosen naively as more or less interchangeable indices of arousal associated with cardiac-somatic uncoupling and on the basis of available technology. As we show, both the theoretical underpinnings and the specific physiological indices of arousal in motivated performance situations were to change.

C. THE MEDIATING ROLE OF COGNITIVE APPRAISAL

We next undertook a series of studies to examine the possible mediating role of cognitive appraisal within the situation-physiological arousal component of the BPS model. As we conducted these studies, it became apparent to us from both theoretical work (e.g., Dienstbier, 1989, as previously discussed) and empirical work (based on some chapters in Blascovich &

[7] At the time this study was conducted, cognitive appraisal was not specified in the BPS model (cf. Blascovich, 1990).

Katkin, 1993a) that there were two discernible patterns of cardiovascular responses or reactivity that could be found in motivated performance situations. Large increases in cardiac responses accompanied by large decreases in systemic vascular resistance marked one pattern, whereas some increase in cardiac responses accompanied by small increases in systemic vascular resistance marked the other pattern. Furthermore, the benign nature of the former pattern and the malignant nature of the latter pattern had been suggested by Dienstbier (1989) and Manuck et al. (1993), respectively.

Cardiac changes could be ascertained using mesures such as pre-ejection period (PEP) (i.e., ventricular contractility), cardiac output (CO) (i.e., the product of stroke volume and heart rate), and heart rate (HR). Systemic vascular changes could be ascertained using a measure of total peripheral resistance (TPR). The availability of impedance cardiographic and continuous blood pressure monitoring equipment, as well as appropriate data acquisition and scoring software that had been previously developed and tested in large part in our laboratory (Kelsey & Guethlein, 1990), faciliated such multidimensional cardiovascular assessment.[8]

We conducted three types of studies designed to determine whether positive or benign cognitive appraisals in motivated performance situations were associated with the benign pattern of cardiovascular responses and whether negative appraisals were associated with the malignant pattern. In the first type of study, subjects freely appraised upcoming tasks in a motivated performance situation. In the second type, we independently manipulated appraisals. In the third, we manipulated patterns of cardiovascular response (i.e., benign versus malignant). As will become apparent, each methodology has distinct implications for the BPS model. For example, if cognitive appraisal mediated the situation-physiological arousal link of the BPS model, we would expect that both free and manipulated appraisals would be associated with the appropriate cardiovascular response patterns, but that the manipulation of the cardiovascular responses themselves would be unrelated to appraisals.

1. Free Appraisal Studies

In our first set of studies (Tomaka, Blascovich, Kelsey, & Leitten, 1993), subjects performed mental arithmetic tasks in a motivated performance situation (i.e., two mental arithmetic tasks in an evaluative context). Before each task but after task instructions, the subjects' primary appraisals (i.e.,

[8] Robert A. Kelsey provided the psychophysiological expertise and conducted beta tests of the software, and William Guethlein provided the programming expertise in this joint effort.

task demands) and secondary appraisals (i.e., available resources) for the upcoming tasks were assessed. Before and during each task, subjects' cardiovascular responses were continuously recorded. In all three experiments, cognitive appraisals were positively related to self-reported stress levels such that the more threatened the individual before the task, the more stress the subject reported experiencing during a task.[9]

Assessments of primary and secondary appraisals were accomplished by means of self-report to queries designed to tap explicitly notions of primary and secondary appraisals as previously described (cf. Lazarus & Folkman, 1984). Primary appraisal was assessed with the question, "How threatening do you expect the upcoming task to be?" Secondary appraisal was assessed with the question, "How able are you to cope with the upcomng task?" Judgments were made on similar seven-point scales. However, in a deviation from previous appraisal research, and based on our belief that challenge appraisals necessarily involve secondary appraisals of coping ability, we chose to distinguish challenged subjects from threatened subjects based on the patterns of primary and secondary appraisal. Subsequently, subjects were classified as challenged if their secondary appraisals of coping ability exceeded their primary appraisals of task threat. Conversely, subjects were classified as threatened if the opposite relationship was true.[10]

In the first study, in which we did not include measures allowing us to assess vascular resistance, we found that overall challenge (i.e., benign) appraisals were associated with greater cardiac and hemodynamic responses during task performance than overall threat (i.e., malignant) appraisals. In the second study, in which we used impedance cardiography together with continuous blood pressure monitoring, groups of subjects with categorically different appraisals, challenge or threat, exhibited reliably different patterns of cardiovascular responses during task performance (Figure 7). Specifically, an overall *challenge appraisal* resulted in relatively strong increases in myocardial performance during performance and an accompanying strong decrease in vascular resistance; whereas an overall *threat appraisal* resulted in somewhat smaller increases in myocardial performance, but also a small increase in vascular resistance during performance. Furthermore, as expected, subjects who made challenge appraisals outperformed subjects who made threat appraisals (Figure 8).

The physiological pattern as well as performance data were replicated for the motivated performance type of situation in a third study, which included type of situation as a between subjects factor. Situation was manip-

[9] These task stress self-reports were assessed post hoc immediately following task completion.

[10] This simplistic algorithm is certainly not the only one possible. More complicated, potentially more accurate algorithms are in the offing.

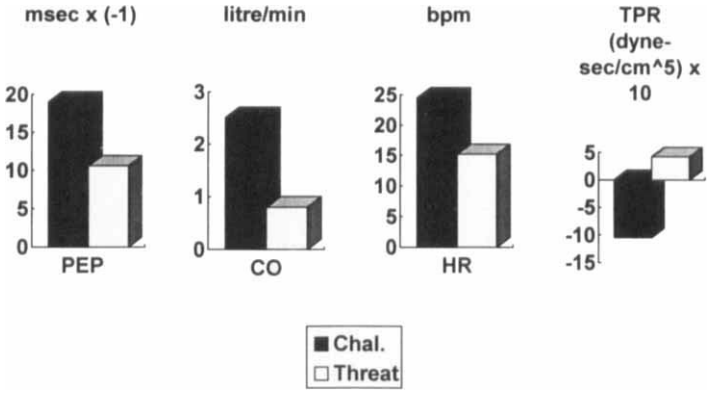

Fig. 7. Cardiac and vascular responses during a motivated performance situation (Adapted from Tomaka et al., 1993; Study 2).

ulated by requiring either that subjects perform in a psychologically demanding motivated performance situation (i.e., mental arithmetic) or engage in a passive task situation (i.e., view slides of mutilated automobile accident victims, maxillofacial surgery patients).

Figure 9 shows that, as in the prior study, the same patterns of cardiac and vascular reactivity resulted for those making challenge and threat appraisals in the motivated performance situation. For the passive task, however, as Figure 10 depicts, only primary appraisals were relevant and

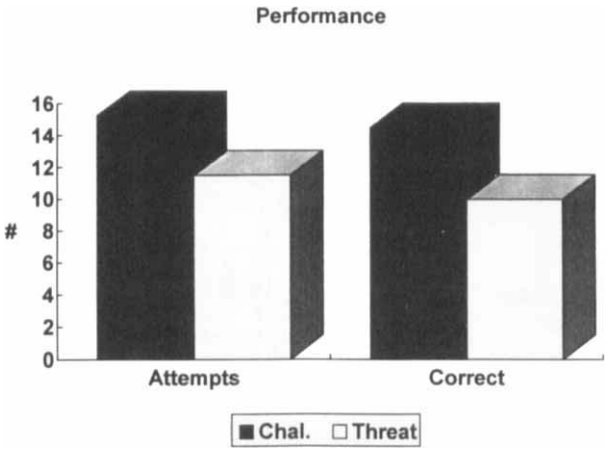

Fig. 8. Performance data (Adapted from Tomaka et al., 1993; Study 2).

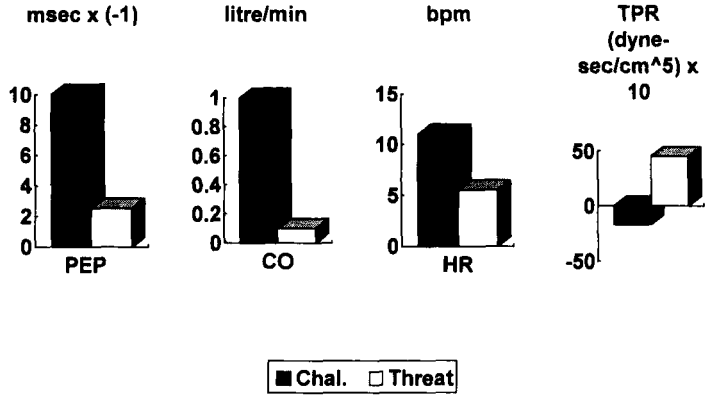

Fig. 9. Cardiac and vascular responses during a motivated performance situation (Adapted from Tomaka et al., 1993; Study 3).

directly related to the relative intensity of cardiac responses. There were no differences for vascular responses (i.e., TPR). This pattern of relations for passive coping underscores our earlier point that type of goal-relevant situation is critical to the determination of expected appraisal-physiological response linkages.

2. Appraisal Manipulation

At this point, we were certainly aware that the relationships we had demonstrated between cognitive appraisals, as we had operationally defined

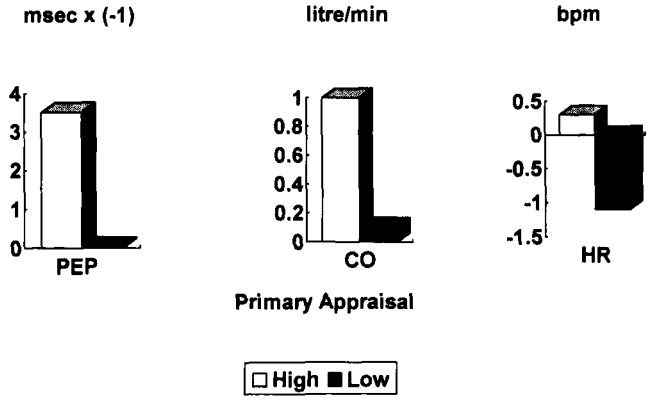

Fig. 10. Cardiac and vascular responses during a passive situation (Adapted from Tomaka et al., 1993; Study 3).

them, and patterns of cardiac and vascular responses were essentially correlational. In addition, these relationships did not verify the direction of causality—from appraisal to physiological response—that we had postulated.

In another study (Tomaka & Lovegrove, 1995), we addressed this concern by manipulating an instructional set to encourage challenge or threat appraisals in a motivated performance situation involving a mental arithmetic task. The manipulation of the instructional set was within subjects and appropriately counterbalanced. Challenge instructions reflected our request that subjects try their best and think of the task as something to be met and overcome. Threat instructions, in contrast, emphasized that task performance was mandatory for subjects and that our intention was to evaluate task performance. Results indicated that the instructional sets produced the expected patterns of appraisal (Figure 11) and physiological reactivity (i.e., less cardiac contractility), and an increase in systemic vascular resistance (see Figure 11). Challenge instructions resulted in lower stress appraisals, greater cardiac reactivity, and a decline in systemic vascular resistance. Thus, these data provide compelling support that causality runs from cognition (i.e., appraisals) to physiological response.

3. Arousal Manipulation

It was also incumbent upon us to test the more Jamesian-like notion of causality—from physiological response to appraisal. This involved two studies conducted in our laboratory (Blascovich, Kibler, Ernst, Tomaka, & Vargas, 1994) one in which we independently manipulated the threat pattern of cardiovascular response, and one in which we independently manipulated the challenge pattern of cardiovascular response prior to engaging

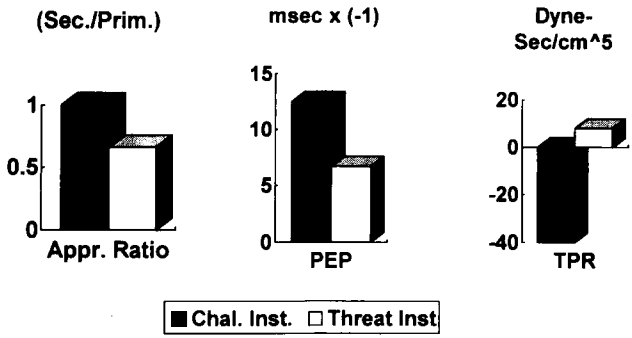

Fig. 11. Cardiac and vascular responses as a function of instructional set (Adapted from Tomaka & Lovegrove, 1995).

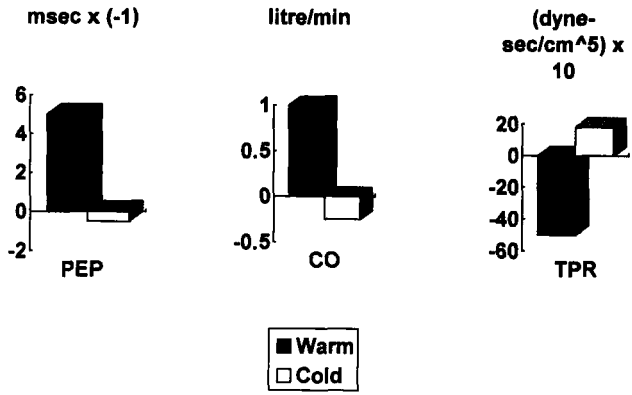

Fig. 12. Pressor responses (Adapted from Blascovich, Kibler, Ernst, Tomaka, 1994).

subjects in a motivated performance situation involving mental arithmetic. To make a long story short, our physiological manipulations were successful. The use of cold and warm pressors allowed us to reproduce a pattern of cardiovascular responses similar to the prototypical challenge and threat patterns (Figure 12). Similarly, the use of moderate exercise (50 W on a recumbent ergometer) allowed us to reproduce a pattern of cardiovascular response similar to the challenge pattern (Figure 13). The control group in this study simply sat without pedaling the ergometer. Importantly, there were *no* resulting differences (appropriate $F's < 1$) in cognitive appraisal as a function of the manipulated physiological responses. In sum, these

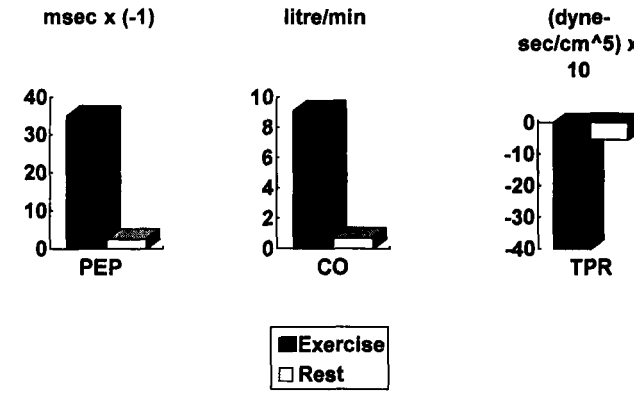

Fig. 13. Exercise responses (Adapted from Blascovich et al., 1994).

findings, although null, suggest that physiological response patterns do not mediate cognitive appraisal.

4. Summary

Our appraisal studies demonstrated that critically different patterns of cardiovascular responses result from overall challenge and threat appraisals in nonmetabolically demanding, motivated performance situations. Specifically, these patterns held in experiments involving free appraisals and manipulated appraisals. Moreover, independent manipulations of the different patterns of cardiovascular responses themselves were not related to differences in overall cognitive appraisals. Hence, we believe that cognitive appraisal is a critical mediator in the arousal-regulation process (see Figure 3).

D. INTRAPERSONAL MODERATORS OF THE SITUATION-COGNITIVE APPRAISAL LINK

As discussed, the BPS model specifies both intra- and interpersonal moderators of the situation-cognitive appraisal link. We have focused theoretically and empirically on three types of intrapersonal moderators: dispositional, cognitive, and affective. To date, we have completed at least one study within each type or category and have several more in progress. The completed studies demonstrate that these types of intraindividual factors do indeed moderate the situation-appraisal link.

1. Dispositional Moderators: Belief in a Just World

Individuals vary dispositionally in their general beliefs regarding fairness in the world. Some believe that people generally "get what they deserve" from life, whereas others believe that "life is inherently unfair" (Lerner, 1980). According to several theorists (e.g., Lazarus & Folkman, 1984; Lerner, 1980, Lerner & Miller, 1978) dispositional belief in a just world protects individuals, allowing them to adapt better to the demands of everyday life.

We (Tomaka & Blascovich, 1994) conducted a study to determine whether dispositional belief in a just world moderates appraisals in motivated performance situations. Prior to instructions and "hook-up" within a typical motivated performance situation in our laboratory (i.e., serial subtraction), subjects completed the Belief in a Just World (BJW) scale (Rubin & Peplau, 1975). Subsequently, we assessed subjects' cardiovascular responses during a sequence of two rest and task performance periods.

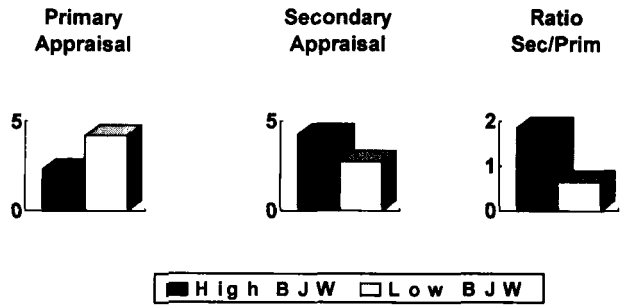

Fig. 14. Cognitive appraisal as a function of Belief in a Just World (BJW) (Adapted from Tomaka & Blascovich, 1994).

Primary and secondary appraisals were assessed following task instructions. Subjective measures of task stress and performance were assessed immediately following each task performance.

As expected, appraisals of the upcoming tasks differed as a function of BJW. High BJW subjects made significantly lower primary appraisals and more challenging overall appraisals (i.e., ratio of secondary to primary appraisal) of the upcoming tasks (Figure 14). Also, as expected high BJW subjects exhibited the challenge pattern (i.e., strong increases in cardiac performance coupled with strong vasodilation), whereas low BJW subjects exhibited the threat pattern (i.e., increases in cardiac performance coupled with slight vasoconstriction) (Figure 15). Furthermore, regarding perceptions, high BJW subjects perceived the tasks as less stressful and perceived their performance to be better than low BJW subjects (Figure 16). Finally, high BJW subjects performed better than low BJW subjects (Figure 17).

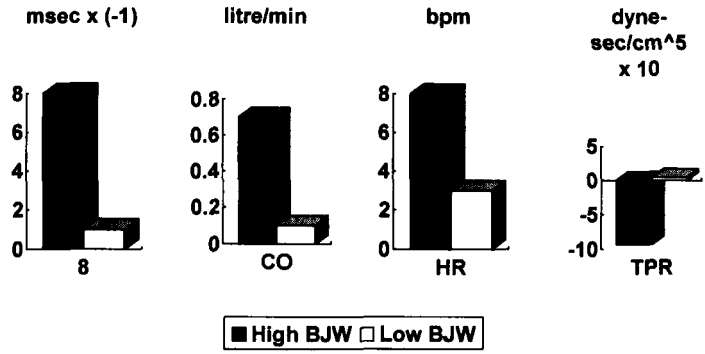

Fig. 15. Cardiac and vascular responses as a function of Belief in a Just World (BJW) (Adapted from Tomaka & Blascovich, 1994).

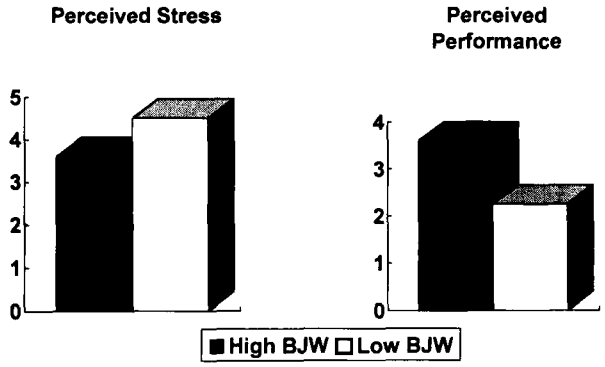

Fig. 16. Task perceptions as a function of Belief in a Just World (BJW) (Adapted from Tomaka & Blascovich, 1994).

The results of the BJW study confirm that dispositional factors can moderate the situation-appraisal link. Undoubtedly, other dispositional factors also moderate the link. For example, that self-esteem and personal control moderate the same process can easily be justified theoretically and on the basis of nonphysiological research (Becker, 1975; Greenberg, Pyszczynski, & Solomon, 1987; Lazarus, 1983; Lerner, 1980).

2. Cognitive Moderators: Attitudes

Many theorists argue that attitudes function to facilitate decision making, thereby easing one's journey through life (Allport, 1935; Fazio, 1989; Katz, 1960; Smith, Bruner, & White, 1956). Presumably, attitudes provide individ-

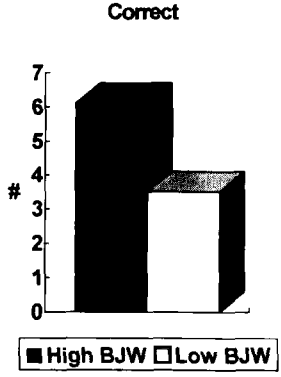

Fig. 17. Task performance as a function of Belief in a Just World (BJW) (Adapted from Tomaka & Blascovich, 1994).

uals with relatively accessible knowledge that enables them to make easier decisions in demanding situations. From the perspective of the theoretical BPS model, attitudes should serve to decrease primary appraisal by decreasing the perceived uncertainty and demands of the situation and to increase secondary appraisal by increasing the perceived knowledge or abilities that one brings to a motivated performance situation in which attitude objects play a pivotal role. Overall, then, task object-relevant attitudes should increase the likelihood of a challenge rather than a threat appraisal in a motivated performance situation, thereby causing a challenge rather than a threat pattern of cardiovascular activity.

Fazio, Blascovich, and Driscoll (1992) reported a relevant paradigm and some interesting studies suggesting that attitudes toward specific objects could serve to lower blood pressure for individuals during demanding decision-making tasks involving those objects. Although these findings are certainly consistent with a moderating role for attitudes in the situation-appraisal link of the situation-arousal component of the BPS model, they are not specific vis-à-vis the distinctive pattern of cardiovascular responses associated with challenge and threat, respectively.

Although not specifically testing attitudes as a moderator within the situation-arousal component of the BPS model at the time, we (Blascovich et al., 1993; Experiment 2) did conduct a study that, in retrospect, tested this aspect of the model quite nicely. In this study, individuals were brought into the laboratory for a two-phase experiment. In the first phase, subjects developed attitudes toward a set of novel objects, abstract paintings, using an attitude rehearsal procedure developed by Fazio and colleagues (e.g., Fazio, Chen, McDonel, & Sherman, 1982). Half of the subjects rehearsed attitudes toward one subset (15) of the abstract paintings, and the other half rehearsed attitudes toward a mutually exclusive subset (15) of the abstract paintings. In the second phase, a motivated performance situation, subjects made rapid pairwise preference judgments for 34 slides of randomly paired abstract paintings (i.e., attitude objects). Half of each group of subjects expressed preferences within paired abstract paintings selected from the subset toward which they had rehearsed attitudes, whereas the other half were presented pairs from the unfamiliar subset. Throughout the experiment, the subjects' cardiovascular responses were continuously monitored using impedance cardiographic and blood pressure monitoring equipment.

Drawing on the BPS model, we hypothesized that in the pairwise preference situation (i.e., motivated performance situation) for which rehearsed attitudes were relevant (i.e., involving rehearsed, familiar attitude objects), a challenge pattern of cardiovascular arousal should be evident, whereas in the situation for which rehearsed attitudes were irrelevnt, more of a

threat pattern should be evident. The data confirm our hypothesis. As Figure 18 shows, subjects in the rehearsed painting condition exhibited increased cardiac response and vasodilation, the challenge pattern, whereas subjects in the novel painting condition exhibited increased cardiac response and vasoconstriction, the threat pattern.

Just as the BJW study confirmed that dispositional factors can moderate the situation-appraisal link and resulting patterns of physiological response, our attitude study confirmed that cognitive factors can also moderate the link and resulting physiological patterns. The nature of these other cognitive factors remains speculative at this point, although we certainly believe that associative learning and memory play an important role. In addition, we believe that cognitive factors may moderate the situation-appraisal link, either positively or negatively. Thus, individuals who find themselves in motivated performance situations similar to those in which they have previously prevailed may be more likely to appraise the new situation as challenging, whereas those who find themselves in situations similar to those in which they have previously failed may be more likely to appraise the new situation as threatening.

3. Affective Moderators: Music and Pain

Theoretical arguments can be mustered to support the notion that affective states such as mood and emotion can moderate the situation-appraisal link in the BPS model. Individuals in positive moods are likely to have lower primary appraisals (i.e., decreased demand and danger) and perhaps higher secondary appraisals (i.e., increased abilities) resulting in overall

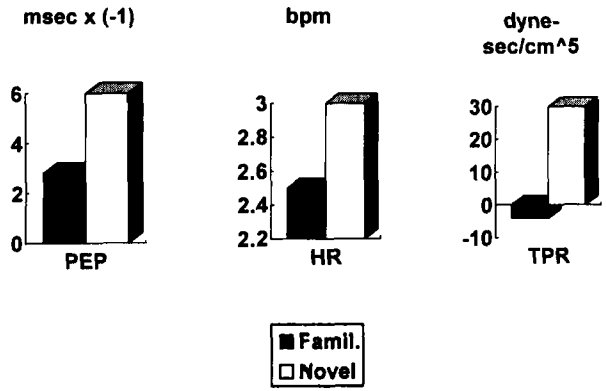

Fig. 18. Cardiac and vascular responses as a function of attitude objects (Adapted from Blascovich et al., 1993).

challenge appraisals in motivated performance situations, whereas individuals in negative moods are likely to have higher primary and lower secondary appraisals resulting in overall threat appraisals. That depressed individuals find life in general more threatening than nondepressed individuals appears likely (cf. Beck, 1967). That joyous individuals find life more challenging can also be argued. Unfortunately, little data link mood and cognitive appraisal, and no data exist linking moods differentially to challenge and threat patterns of cardiovascular response (Ernst, 1994).

Two of our studies suggest, albeit indirectly, that mood affects the motivated performance situation-appraisal link in the BPS model. In one study (Allen & Blascovich, 1994), we involved surgeons in a motivated performance situation in which they performed three different mental arithmetic tasks (i.e., serial subtraction). The surgeons listened to music prior to, and during, two of the mental arithmetic tasks. The particular selections to which they listened consisted of a standard or control piece, Pachelbel's Canon in D (a selection often used in commerical "stress-reduction" tapes) and an idiosyncratic piece—that is, a self-selected piece (one that they typically played during their surgeries). Because this study was conducted outside of our own laboratory, we were unable to gather the full range of cardiovascular measures that enable us to distinguish challenge and threat patterns definitively. Nevertheless, our results demonstrated that music did, in fact, affect cardiovascular responses in ways compatible with our challenge/threat patterns. Significantly lower blood pressure responses (consistent with vasodilation) in the motivated performance situation occurred during the task with idiosyncratic background music than during the task with control background music, and significantly lower blood pressure responses occurred during the task with control background music than during the task without background music (Figure 19). Assuming that the

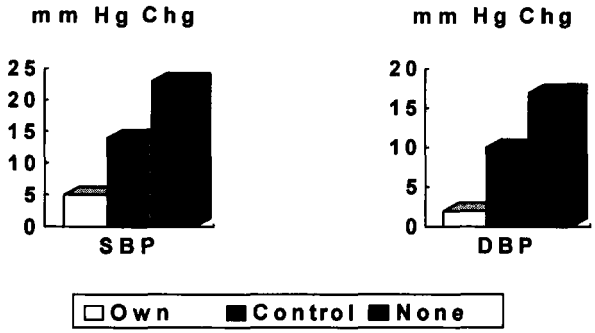

Fig. 19. Blood pressure responses as a function of music condition. SBP, systolic blood pressure; DBP, diastolic blood pressure (Adapted from Allen & Blascovich, 1994).

two music conditions elevated mood, with the idiosyncratic music condition elevating mood the most, these data are certainly consistent with the notion that mood moderates the situation-appraisal link. Because music often appears in the literature as a mood induction technique (Martin, 1990), the veracity of the assumption is likely.

Another of our studies, the pressor study (Blascovich et al., 1994), also bears upon the issue of affect as a moderator of the situation-appraisal link. As discussed, the pressor manipulation did not influence appraisal. However, self-reported pain during the pressors did. Specifically, individuals reporting high levels of pain appraised the upcoming task as more threatening than individuals reporting low levels of pain regardless of pressor condition. Because pain is regarded as a psychological phenomenon and because the quality of the objective stimulus (e.g., the cold pressor at 34° F) remained the same, reported pain can be considered a proxy for relative feeling state or affect. This finding provides additional data consistent with the notion that affective state can moderate the situation-appraisal link.

An ad hoc analysis of our physiological data during the cold-pressor task provides even more interesting data in this regard. Grouping subjects by virtue of a median split on self-reported pain, we found significant differences in systemic vascular resistance. As shown in Figure 20, individuals in the cold-pressor condition had similar responses during the first minute (minute 1 in Figure 20) of the 3-min, cold-pressor task. Those in the high pain condition subsequently responded with increased systemic vascular resistance (i.e., vasoconstriction), whereas those in the low pain condition subsequently responded with decreased systemic vascular resistance (i.e., vasodilation), even though subjects in both groups kept their hands immersed in the ice water bath for the same length of time (i.e., through

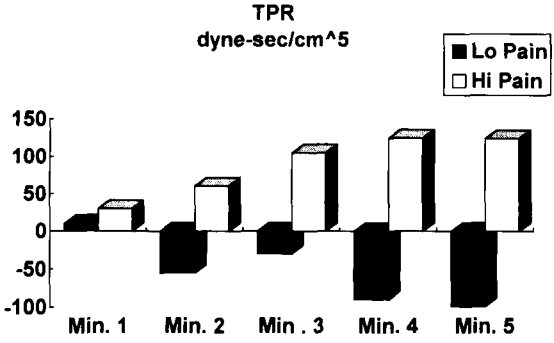

Fig. 20. Vascular resistance during a cold pressor as a function of perceived pain (Blascovich et al., 1994).

minute 3 in Figure 20). In addition, this difference in vascular reactivity continued through subjects' performances of mental arithmetic (minutes 4 and 5 in Figure 20). These data, together with the pain data described in the preceding paragraph, suggest that an overall challenge cognitive appraisal in a motivated performance situation can overcome the normal vascular response (i.e., vasoconstriction) to a physical stressor. Furthermore, these data support an earlier argument of ours that the pituitary-adrenal-cortical (PAC) axis, which responds to harm and potential harm (i.e., anticipation of pain) (see Mason, 1975), likely contributes to threat-related responses.

Although we realize that these data do not provide the strongest possible basis for inference regarding the effect of affect on cognitive appraisal, we believe that they are strongly suggestive of such an effect. Experiments testing this notion directly are currently underway. We expect that experiments examining ambient mood, specific emotional, and/or feeling states as moderators of the situation-appraisal link will provide important data in this regard.

4. Intraindividual Differences

Intrapersonal factors within the dispositional category moderate the situation-appraisal link; however, this does not rule out within-subject, or intrapersonal, differences in overall cognitive appraisals and accompanying patterns of cardiovascular responses in motivated performance situations. Although dispositional factors may predispose individuals toward either an overall challenge or threat appraisal (recall the BJW study), these factors by no means explain all the variance and could easily be counteracted by cognitive and affective factors. Certainly, individuals may perceive more skill or abilities (i.e., higher secondary appraisal) in one type of motivated performance situation (e.g., giving a speech) than another (e.g., writing an essay), or may be in a better or worse mood in the same type of motivated performance situation at different times. A given individual may well have different appraisals across different motivated performance situations and/or for the same or very similar motivated performance situations across time.

The data from our within-subjects appraisal manipulation study described in the previous paragraph (Tomaka & Lovegrove, 1995) demonstrate intra-individual differences in challenge and threat appraisals and the associated cardiovascular patterns. We expect the same in free-appraisal situations as well. This latter point was suggested by the first pilot patient in a study in which we have begun to reexamine the relationship between patterns of cardiovascular responses to psychological stress and cardiovascular disease,

taking into account our more sophisticated BPS model and physiological measures. This patient appraised and performed consecutive but different tasks in a 20-min motivated performance situation. He freely appraised one task, serial subtraction, as a challenge. He freely appraised the other, a choice-deadline signal detection task, as a threat. As Figure 21 shows, these differential appraisals were accompanied appropriately by the two different response patterns.

The likelihood of intraindividual differences in overall appraisals in motivated performance situations has important empirical, as well as applied, implications. Regarding the former, we believe that the BPS model and our patterns of differential cardiovascular response to the same tasks show strongly that one *cannot* assume that any given task in a motivated performance situation represents a "standard" psychological stressor or challenge for all subjects. Hence, *there can be no standard psychological load in a sense analogous to the standard physical load used in an exercise ECG stress testing.* Our model and data suggest that psychological stress testing in the laboratory for diagnostic and/or predictive purposes should include idiosyncratically stressful tasks.

Regarding applied implications, our work suggests that individual experiences in motivated performance situations can change over time for the better (i.e., toward overall challenge appraisals) or for the worse (i.e., toward overall threat appraisals). This leaves open the possibility of successful intervention and training efforts, as well as dysfunctional ones. To the extent that interventions are successful in reducing primary appraisals and increasing secondary appraisals, individuals will appraise given motivated performance situations more benignly.

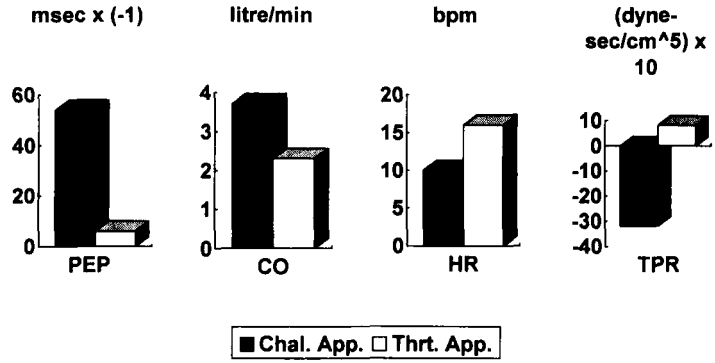

Fig. 21. Pilot patient responses.

E. INTERPERSONAL MODERATORS OF THE SITUATION-COGNITIVE APPRAISAL LINK

As specified by the BPS model, interpersonal factors may also moderate the situation-appraisal link. We have focused theoretically and empirically on two types of interpersonal moderators: the presence of others and stigma. As with intrapersonal moderators, to date, we have completed at least one study within each type or category and have several more in progress. The completed studies demonstrate that these types of interindividual factors do indeed moderate the situation-appraisal link.

1. The Presence of Others

The pet–human friend study described earlier (Allen et al., 1991) as well as similar work by others (Kamarck, Manuck, & Jennings, 1990; Snydersmith & Cacioppo, 1992), led us to hypothesize that the presence of others moderated the situation-appraisal link in motivated performance situations. Furthermore, data from these studies led us to believe that the possible effects of this moderator are bidirectional—that is, the presence of others can predispose individuals toward challenge or threat appraisals. As we (Allen et al., 1991) reasoned, the perceived evaluative nature of observers influences this direction. The presence of presumably nonevaluative friends (i.e., the pet dogs) and presumably evaluative friends (i.e., the female human friends) led to different appraisals and ultimately different cardiovascular patterns. Alternative explanations, of course, are also possible. For example, Snydersmith and Cacioppo (1992) suggest that liking may play an important role.

Salomon and Blascovich (1995) conducted a motivated performance situation study using a confederate as an observer. In this study, they manipulated the perceived liking of the observer for the subject and the perceived evaluative nature of the observer. They matched the genders of subject and observer in a crossed design. The major analysis of the physiological responses revealed a significant three-way interaction. As Figure 22 depicts, females exhibited a threat pattern of cardiovascular responses in the disliked, evaluative-other condition. Males appeared unaffected by the presence of the observer in any combination of liking and perceived evaluative conditions. Interestingly, the previous relevant studies (i.e., Allen et al., 1991; Kamarck et al., 1990; Snydersmith & Cacioppo, 1992) used female subjects exclusively.

2. Stigma

Stigma is another aspect of interpersonal moderation of the situation-appraisal link that researchers have begun to investigate (Crocker & Major,

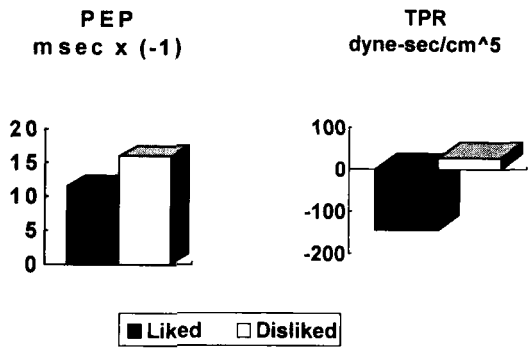

Fig. 22. Cardiac and vascular responses during the female-evaluative condition (Salomon & Blascovich, 1995).

1989). Stigma occurs when an individual feels denigrated or stigmatized by others on the basis of some physical or other characteristic. Stigma affects many categories of individuals including those judged to be disabled, disfigured, or otherwise unattractive by mainstream society. The initial stigma study (Blascovich, Epstein, Quinn, Kibler, & Ernst, 1995) involved overweight and nonoverweight women. The motivated performance situation in this study involved speech-making, a potentially stressful task (Light, Turner, Hinderliter, & Sherwood, 1993). After receiving instructions and having the appropriate physiological sensors attached, overweight and nonoverweight women received instructions to mentally prepare a speech for 3 min and then spend 3 min delivering the speech. All subjects were told that a group of their peers would evaluate a tape of their speech. Half of the women in each group were told that their speeches would be audiotaped. The other half were told that their speeches would be videotaped. It was hypothesized that the stigma of being overweight would have greater relevance for the individuals who were videotaped compared to those who were audiotaped and would influence cardiovascular responses accordingly. A significant condition by overweight interaction supported the hypothesis. As depicted in Figure 23, neither group showed a threat pattern (no reliable differences in vasodilatory response). However, nonoverweight women in the video condition evidenced more challenge (i.e., significantly increased contractility accompanied by vasodilation). There were no significant differences for those in the audiotape condition.

3. Interpersonally Relevant Organismic Variables

The gender effects of the study examining the presence of others described previously (Salomon & Blascovich, 1995) as well as the stigma

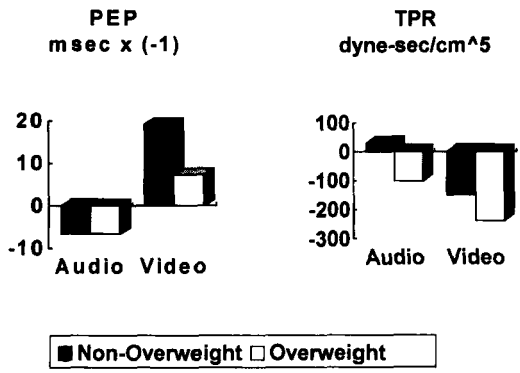

Fig. 23. Cardiac and vascular responses as a function of weight (Blascovich et al., 1995).

study suggested the notion that socially relevant, physical, or organismic characteristics might moderate the situation-appraisal link of the BPS model. Factors such as race and sex come easily to mind. We believe that such factors moderate the situation-appraisal link, not because of basic biological differences among the sexes or races, but because of socialized or learned differences (cf. Anderson, McNeilly, & Myers, 1993; Deaux & Major, 1987).

We (Tomaka, Blascovich, & Kibler, 1995) found gender differences in appraisals during a standard motivated performance situation involving mental arithmetic tasks and a passive situation involving a slide viewing task. We found accompanying somatic gender differences using electromyographic (EMG) facial measures of affect. Regarding the appraisal differences, women found our motivated performance task more demanding and perceived less ability to cope with it than men did. Women also found the slide-viewing task more threatening. Somatically, women exhibited greater corrugator supercilii activity (indexing negative affect) and lower zygomaticus major activity (indexing positive affect) than men. However, women and men who made overall challenge appraisals evidenced the same challenge-type cardiovascular patterns, and women and men who made overall threat appraisals evidenced the same threat-type cardiovascular pattern.

These data indicate to us that although women may be more threatened by our laboratory-motivated performance situations, the arousal-regulation processes operate in similar fashion for both genders. Moreover, it suggests an explanation for the gender effects in the zero-sum experimental game study discussed at the beginning of this chapter (Blascovich et al., 1978). Specifically, in this early study, because we used heart rate, an ambiguous

physiological response (in the sense that it does not allow us to distinguish positive from negative psychological reactions to a situation), and because we did not assess cognitive appraisals, we likely missed the fact that most, if not all, of the women in that study were threatened, whereas there was a better distribution of males over the challenge and threat categories.

Further investigating interpersonally relevant, organismic variables, Blascovich, Steele, and Spencer (1995) have commenced an examination of racial and gender stereotype vulnerability in academically relevant, motivated performance situations. To the extent that members of negatively stereotyped groups believe such stereotypes (e.g., that African Americans perform poorly on academic tasks such as tests; that females perform poorly on advanced mathematics), we expect them to appraise such tasks as threatening and evidence threat patterns of cardiovascular responses in motivated performance situations. At this time, however, the data have not been fully collected.

F. INTEROCEPTION

Admittedly, most of our empirical efforts have been devoted to the investigation of the mediating and moderating factors within the situation-arousal component of the BPS model. However, we have also made at least beginning empirical efforts to examine the mediating and moderating factors within the arousal-response component.

For example, in three separate studies, we (Blascovich et al., 1992) have shown that affect intensity, a general temperamental disposition accounting for individual variability in the regulation of arousal (Larsen & Diener, 1987; Larsen et al., 1986), relates primarily to somesthetic (i.e., interoceptive) sensitivity to cardiovascular response rather than either basal or evoked levels of cardiovascular responses in motivated performance situations. Specifically, as Table I shows,[11] affect intensity is unrelated to either basal or evoked cardiovascular responses but significantly and negatively related to perceived cardiac response. Accordingly, we conclude that individuals high in affect intensity do not derive their tendency to report extreme levels of emotion from extreme levels of physiological arousal. Indeed, they exhibit decreased somesthetic sensitivity to such arousal. Earlier work (Eichler, Katkin, Blascovich, & Kelsey, 1987), in which we demonstrated that the degree of negative affect reported during a passive situation (viewing slides of mutilated automobile accident victims) was inversely related to somesthetic sensitivity ($r(19) = -.53$), supports the affect intensity findings.

[11] Somesthetic sensitivity was assessed using a slight modification of our heartbeat detection paradigm (Katkin et al., 1981).

TABLE I
AFFECT INTENSITY–HEART RATE/BEAT CORRELATIONS[a]

	Basal	Evoked	Somesthetic sensitivity
Study 1	ns[b]	ns	−.28 ($p < .04$)
Study 2	ns	ns	−.58 ($p < .001$)
Study 3	ns	ns	−.33 ($p < .01$)

[a] *Source:* Blascovich et al. (1992).
[b] ns = not significant.

G. SUMMARY

To the best of our knowledge, these empirical efforts represent, not only the first examinations of self-reported cognitive appraisal as a mediator of physiological responses within the context of motivated performance situations, but also the first demonstrations of the meaningful differentiation of cardiovascular responses (i.e., cardiac and vascular) as a function of categorically different appraisals (i.e., threat vs. challenge). Furthermore, the results of our examinations of specific intrapersonal and interpersonal moderators of the situation-appraisal link of the BPS model not only demonstrate the important role of these factors in arousal regulation, but also provide evidence converging on the validity of our challenge and threat patterns. We have not found the opposite pattern of what we would expect from well-established social psychological theories and empirical data in any of the cases.

VI. Conclusions and Future Directions

Importantly, our understanding of the biopsychosocial processes involved in arousal regulation helps us to reconcile the illustrative dilemma previously described. That is, the inconsistency in the literature among data demonstrating a benign relationship between cardiovascular responses and motivation in performance studies and data demonstrating a malignant relationship between cardiovascular responses and disease can be resolved, at least for motivated performance situations, by the phenomenological and cardiovascular fractionation inherent in the BPS model.

If the challenge-to-myocardial reactivity and threat-to-vascular reactivity links hold up to replication and further scrutiny, we likely will have not only a better understanding of arousal-regulation processes, one that is truly biopsychosocial, but we also will have discovered an important psychophysiological assessment tool, a kind of real rather than bogus pipeline (Jones & Sigall, 1971). If we can indeed distinguish individuals in threatened states from those in challenged states during motivated performance situations, we will be able to do psychology better. Whatever the purpose and domain of the assessment (i.e., basic theoretical or applied), the identification of physiological patterns associated with threat or challenge states allows us to differentiate those who phenomenologically experience such states (marked by appraisal-physiological consistency) from those who merely report them (marked by appraisal-physiological inconsistency). Theoretically, we should be better able to test a myriad of psychological theories across a number of domains. Clinically, we should be able to develop and test better anxiety and stress-management interventions. In terms of application, we should be better able to optimize person-situation selection procedures.

We believe that our model and data are also quite relevant to the study of emotion. They suggest the importance of a biopsychosocial approach for understanding superordinate dichotomous positive and negative categories of emotion such as challenge and threat, approach and avoidance, flight and fight, and others. Regarding basic level emotions, we have no doubt that cognitive appraisals are often involved in their generation. We have purposively limited our model and interpreted our data in terms of challenge and threat as superordinate categories of emotion. Although it is hotly debated in the literature (Ekman, Levenson, & Friesen, 1983; Stemmler, 1989), we believe that it is entirely within the realm of possibility that more fine-grained analyses of appraisals (perhaps using dimensions based on Smith and Ellsworth's (1985, 1987) appraisal models), along with even more advanced physiological measurement techniques, would allow definitive identification of physiological response patterns, not necessarily but possibly autonomic, associated with basic level emotions. However, we are unlikely to turn to such empirical adventures anytime in the near future as we perceive the utility of our superordinate categorical distinction (i.e., threat and challenge) to be compelling.

Instead, we will turn to further investigations pertinent to the BPS model itself and to important social psychological theories to which it can bring important empirical information to bear. Key aspects of the BPS model of arousal regulation remain unexplored or relatively unexplored. For example, the mediating effects of biological factors and the moderating role of physiological factors within the situation-arousal component hold much

interest. The functional utility of various categories of arousal-regulation responses (e.g., self-handicapping strategies) also demands attention. The validity of secondary processes needs empirical investigation. Regarding social psychological theory, our near-term investigations will focus on stereotype vulnerability theory as implied. We also look to explore the utility of our model and the value of our physiological assessments within the domain of leader and situation match (Chemers, 1994).

Finally, it is our hope that more theorists and investigators will test and refine biopsychosocial models of arousal regulation, learn appropriate social psychophysiological measurement methods and techniques, and apply them to their own areas of expertise. We firmly believe that our understanding of traditional topics and issues within social psychology including attitudes, antisocial behaviors, conflict resolution, coping behaviors, emotion, persuasion, relationships, self-protective strategies, social facilitation, and social justice can only improve with such efforts.

Acknowledgments

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