Personality and Social Psychology Review
2003, Vol. 7, No. 3, 234–243

The Robust Nature of the Biopsychosocial Model Challenge and Threat: A Reply to Wright and Kirby

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This article responds to Wright and Kirby's (this issue) critique of our biopsychosocial (BPS) analysis of challenge and threat motivation. We counter their arguments by reviewing the current state of our theory as well as supporting data, then turn to their specific criticisms. We believe that Wright and Kirby failed to accurately represent the corpus of our work, including both our theoretical model and its supporting data. They critiqued our model from a contextual, rational–economic perspective that ignores the complexity and subjectivity of person–person and person–environmental interactions as well as nonconscious influences. Finally, they provided criticisms regarding possible underspecificity of antecedent components of our model that do not so much indicate theoretical flaws as provide important and interesting questions for future research. We conclude by affirming that our BPS model of challenge and threat is an evolving, generative theory directed toward understanding the complexity of personality and social psychological factors underlying challenge and threat states.

Wright and Kirby (this issue) critiqued our challenge and threat theory and its supporting empirical data. We disagree with their assessment and believe their criticisms (a) are based on a misunderstanding and selective presentation of elements of our current theory and data; (b) are based on a rational–economic perspective entailing only objective comparison of the amount of effort individuals are willing and able to expend to the amount required by the situation, which fails to integrate contextual elements involved in social behavior, in general, and subjectivity and automatic processing, in particular; and (c) provide some interesting challenges for our theory that should be construed as research questions within an ongoing, evolving theoretical framework rather than fatal flaws. Here, we first provide a brief summary of our current challenge and threat theory and research. We then respond to Wright and Kirby's criticisms and finally provide our conclusions regarding their critique.

We are grateful to former colleagues John Ernst and Sarah Hunter for their insight, advice, and comments regarding this article. We also thank Margaret Kemeny, Alanna Connor Snibbe, Lauren Barton, and David Haley for providing comments and suggestions on an earlier draft of this article.

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Challenge and Threat: Is the Model Coherent and the Evidence Compelling?

Our theory and research address how people evaluate, react to, and behave in goal-relevant performance

situations. Our model specifies that such task-engaging motivated performance situations can be evaluated as challenges or threats and that these psychological states differ in concomitant physiological, particularly cardiovascular (CV), markers. This theory has its roots in several decades of research on psychological stress (e.g., Lazarus & Folkman, 1991) and CV reactivity to stress (Blascovich & Katkin, 1993; Matthews et al., 1986). Its propositions are consistent with volumes of research on how biologically based systems (e.g., behavioral activation and inhibition systems) operate in concert with affective and motivational states (Bradley, 2000). We pursued a within-study, convergent, validational approach to examining challenge and threat, relying on multiple measures (i.e., cognitive, affective, behavioral, and physiological) to identify the primary constructs (Tomaka, Blascovich, Kelsey, & Leitten, 1993; see Blascovich, Mendes, & Seery, 2002, for an example of a multimethod analysis of challenge and threat). No single measure has been considered in isolation.

In these validational studies (Tomaka et al., 1993), we demonstrated that individuals for whom self-reported demands of performance situations were high relative to personal resources exhibited a CV response pattern that we labeled *threat.* In contrast, individuals for whom self-reported personal resources were high relative to demands exhibited a CV pattern we labeled *challenge*.

We have refined our CV indexes over time and currently use a constellation of four CV measures to identify task engagement, which indicates that a motivated performance situation exists, and to differentiate challenge and threat. These measures are heart rate (HR); ventricular contractility (VC), an index of the left ventricle's contractile force; cardiac output (CO), the amount of blood in liters pumped by the heart per minute; and total peripheral resistance (TPR), an index of net constriction versus dilation in the vascular system. Task engagement is common to both challenge and threat and is indexed primarily by an increase in HR from baseline to task performance. We then confirm sympathetic–adrenomedullary axis activation (SAM, which is speculated during both challenge and threat states) by testing for significant increases in VC, with larger VC increases typically, but not exclusively, occurring during challenge states. In absolute terms, challenge is indexed by an increase in CO and a decrease in TPR, whereas threat is indexed by little or no change in CO and no change or an increase in TPR. In relative terms, higher CO and lower TPR reflect relatively greater challenge or lesser threat. For presentational purposes, VC is calculated by multiplying the preejection period by –1, such that a larger VC value corresponds to greater contractility. TPR is calculated by dividing mean arterial pressure by CO and multiplying the total by 80 (Sherwood et al., 1990). Although we have speculated about possible blood pressure differences (i.e., higher under threat), we do not typically consider or report (unless an editor insists) blood pressure as a key variable in the CV patterns indexing challenge and threat.

More important, in recent studies (see the following) we have focused on manipulating features of the performance situation by either increasing the demands or providing additional resources rather than exploring or deconstructing the evaluation or appraisal process with self-report measures. This strategy avoids some of the limitations associated with self-report as dependent measures (see Blascovich, 2000; Blascovich et al., 2002), including the likelihood that some components of the appraisal process are unconscious (Blascovich & Mendes, 2000).

Wright and Kirby (this issue) argued that physiological research supporting our model is not compelling. We disagree. Indeed, their Table 2 reporting the results of a subset of our published studies demonstrates notable consistencies in the patterns of CV markers we proposed. Readers can evaluate the evidence more fairly by reviewing our many articles encompassing more than 30 experiments.

To validate our CV challenge and threat indexes, we initially ran three multimeasure validational studies (e.g., Tomaka et al., 1993) in which we predicted challenge or threat CV patterns on the basis of participants' self-reports of demands or abilities after they received task instructions but prior to task performance. These studies confirmed our CV predictions. We also ran experiments in which we manipulated challenge and threat independently (Hunter, 2001; Tomaka, Blascovich, Kibler, & Ernst, 1997), again confirming the hypothesized patterns.

Recently, we ran a predictive validational study in which we recorded CV responses while varsity baseball (male) and softball (female) players gave two speeches, one irrelevant to baseball and one relevant to performance in a hypothetical baseball situation. Cardiovascular indexes during the baseball speech uniquely predicted actual performance in the baseball and softball season 6 months later (i.e., stronger challenge patterns of CV responses predicted better performance during the athletic season; Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2002; Seery, Blascovich, Mugridge, Norris, & Weisbuch, 2002).

Our validated indexes of challenge and threat during motivated performance situations gave us the opportunity to test many substantive hypotheses across a broad range of classic social psychological research problems using online, covert, and continuous CV measures as well as self-report and behavioral ones (some of these studies are described later). In addition to testing hypotheses specific to each study, the overall pattern of results provides strong convergent support across studies and domains, further validating our specified patterns of challenge and threat.

For example, in a social facilitation experiment (Blascovich, Mendes, Hunter, & Salomon, 1999), we manipulated task-relevant knowledge and abilities by requiring that all participants learn a task to a predetermined criterion. We then randomly assigned one group of participants to perform the same task they had mastered in the presence of an audience, and another group to perform a different task in the presence of an audience. In effect, we held constant the situational demands (i.e., presence of an audience while performing a computer task); we manipulated simply whether participants possessed the knowledge to perform the task. We hypothesized that, holding all else constant, having resources in the form of task knowledge and abilities would result in a challenge pattern of reactivity, whereas not providing these resources would result in threat reactivity. The results confirmed these hypotheses.

Many of our recent studies (e.g., Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001; Mendes, Blascovich, Lickel, & Hunter, 2002) have focused on the threatening effects of social interactions with stigmatized partners on perceivers, a hypothesis pervading the stigma literature for nearly half a century (Goffman, 1963) but never tested experimentally. In these studies, we manipulated whether participants interacted with stigmatized or nonstigmatized group members. We hypothesized that interactions with members of stigmatized groups would be more demanding than interactions with members of nonstigmatized groups and, hence, would be more threatening. Over a half dozen experiments have supported these predictions. To be sure, the identification and confirmation of all possible theoretical mediators of this effect are not complete, but the predicted patterns of CV responses are strong and consistent, suggesting that further testing of more specific mechanisms is warranted.

We also examined CV responses during emotional disclosure and suppression (Mendes, Reis, Seery, & Blascovich, 2003). We predicted that in the presence of same-sex listeners, participants would exhibit CV responses consistent with challenge during disclosure and would exhibit CV threat responses when suppressing emotional disclosure (see Pennebaker, 1989, 1997, for a theoretical rationale for challenge effects during disclosure and Gross & Levenson, 1993, for rationale for suppression effects). Within this research program we demonstrated that the depth of disclosure was positively related to challenge responses and that the context of the emotional disclosure (i.e., to whom one was disclosing) was critical to observing challenge responses during disclosure.

Regarding dispositions, we (Tomaka & Blascovich, 1994; Tomaka et al., 1999) have shown that individual differences moderate challenge and threat responses during performance tasks in the laboratory. We predicted that individuals high in justice beliefs (i.e., people get what they deserve) would be more likely to exhibit challenge versus threat reactivity during potentially threatening motivated performance situations. Similarly, we predicted challenge for individuals high in assertiveness. Both predictions were supported across physiological, behavioral, and self-report measures.

These are just some of the published substantive research topics in social psychology that we have pursued using our indexes of challenge and threat. Surely, this is a compelling body of evidence for a theory that has yet to celebrate 10 years of empirical examination.

It is even more compelling in the absence of any alternative theoretical model, even the energization model described by Wright and Kirby (2001). We take no issue with required effort being an important antecedent component of appraisal or evaluation models of challenge and threat. Indeed, it is one of the demand components in our model, but it is not the whole story. We controlled for metabolic demands (e.g., silently preparing a speech; Mendes, Blascovich, Lickel, et al., 2002) and still found effects unexplained simply by energy requirements. As described previously, we even found that we could predict success in future metabolically demanding situations (i.e., baseball) from our CV indexes of challenge and threat alone during minimally metabolically demanding speeches 6 months prior.

As social psychologists we are not interested in a simple physiological approach (e.g., the energization model), which merely calibrates demands as metabolic requirements of task-relevant acts. Rather, we are interested in the social psychology of the motivated performance situation as a whole, including the conscious but subjective evaluative antecedents, as well as the unconscious antecedents of challenge and threat. The strengths of a social psychological approach include attention to, and a keen understanding of, the power of perceptions. Challenge and threat during motivated performance tasks are not so much based on what effort is required to be successful, but on how people perceive events, what social and personality factors contribute consciously and unconsciously to these perceptions, and how these perceptions drive behavior, be they objectively accurate (e.g., to a third party) or not. More traditional psychophysiological analyses of CV correlates of effort and performance assume these to be fixed entities of the task itself, holding all other factors constant. As social psychologists we are interested in the nature of these factors and how variations in them drive perceptions and behavior.

More important, we do not solely rely on CV response patterns as indexes of challenge and threat but also include behavior, performance, emotional content, affect, or appraisals to provide convergent evidence of challenge and threat phenomenology. Because of this empirical strategy, we believe that Wright and Kirby's (this issue) criticisms related to evaluation or appraisal processes are either incorrect, moot, or must be held in

abeyance until additional data are collected. Nevertheless, we address each of their criticisms in turn, offering theoretical clarification and rebuttal.

Responses to Wright and Kirby's Criticisms

Conception of Demands

Wright and Kirby's (this issue) first "problem" with challenge and threat theory concerns how we conceptualize demand. They reported that (a) the components are insufficiently distinct, precluding empirical testing; and (b) the demand conception is not compelling logically. As evidence for the latter, they reiterated their first argument, that is, that the demand components are not conceptually distinct and therefore not logically compelling. They then added that one element, uncertainty, is multifaceted.

Wright and Kirby (this issue) correctly noted that we use the term *demand* in a different way than does Webster's English dictionary. Given that many terms used in psychology have scientific meanings different from common language ones, it is unclear why this presents a problem as long as we explicitly define our terms, as we do. According to the current state of our theory, demands consist of danger, uncertainty, and required effort. In our critics' work (e.g., Wright & Kirby, 2001), required effort is the main parameter of interest; Wright and Kirby (this issue) argued that required effort is the only one of our three demand components that can be compared to resources, which in our model consist of skills, knowledge, and abilities, dispositional factors, and external support. From the perspective of Wright and Kirby's (2001) theory, this argument seems valid, but only if one shares Wright and Kirby's (2001) assumption of a rational–economic metaphysics in which individuals coldly calculate (i.e., objectively determine) the amount of effort they are willing and able to expend and the amount objectively required by the situation.

Although the required-effort component of demands in our theory encompasses such evaluations, the danger and uncertainty components move beyond rational–economic cognitive processes into subjective, unconscious, or automatic ones (see Blascovich & Mendes, 2000, for a more thorough discussion). Recently collected data (Mendes, Weisbuch, Seery, & Blascovich, 2002; Weisbuch, Mendes, Seery, & Blascovich, 2002) demonstrated the influence of subliminal images on the experience of challenge and threat. Following subliminally presented negative religious pictures (e.g., depictions of Satan, devils, etc.), participants exhibited CV responses consistent with threat reactivity compared to participants subliminally presented with positive religious pictures. We cannot see how deliberate rational–economic appraisals of required effort can explain these results. However, the unconscious or automatic processing aspects of our model can (Blascovich & Mendes, 2000). Wright and Kirby's (this issue) critique totally neglected this important aspect of our model.

As with many constructs in social psychology, there are dangers associated with overly narrow or overly broad specificity. The former can lead to severely restricted conceptions of constructs, which lead researchers to miss (or avoid) the complexity of antecedent or consequent processes underlying the construct (e.g., a focus solely on a single factor). The latter can complicate the identification and operationalization of important variables for research purposes. Regarding demand, we are accused of overly broad specificity, a charge to which we might plead guilty. However, we believe overly broad specificity is the preferred error now. As Lazarus and his colleagues so aptly described, the "appraisal" process is influenced in a multivariate, multiprocess system, which requires acknowledgment of a variety of environmental and dispositional factors. We agree with Lazarus that

> One can easily see that no single variable—whether in the environment or within the person or whether a structural, causal antecedent variable; a process; or an outcome can stand for stress. All the variables in the system contribute potentially to the immediate appraisal of stress and emotional effects. … By considering the system as a whole, one can see what it means to speak of stress as a rubric rather than as a variable and can recognize that none of the variables *individually* [italics added] is capable of explaining the emotional response. (Lazarus, DeLongis, Folkman, & Gruen, 1985, p. 777)

We view danger, uncertainty, and required effort as three potential, but not exhaustive, components of demand. Wright and Kirby (this issue) concluded that because danger ("X" in their terms) is a function of uncertainty ("Y"), then one cannot conclude that demands ("Z") are determined by danger and uncertainty ("X and Y") together. Admittedly, some features of demand evaluations, specifically danger and uncertainty, may share some variance; however, they may also contribute uniquely to demand evaluations. Wright and Kirby's reasoning suggests that danger is always a function of uncertainty, which it is not. One can be very certain that he or she is in danger without uncertainty (e.g., has terminal cancer), and one can feel uncertain without the presence of actual danger (e.g., awaiting a diagnosis of benign physical symptoms). Also, we specify that danger can be either physical or psychological. Psychological danger refers to the potential for loss of self-esteem, threats to the self, potential anxiety, and so forth. Again, psychological danger

and uncertainty may have some overlapping features, but they also have some unique features that additively affect overall demand evaluations (e.g., knowledge of a low grade in a class is a direct threat to the self, but waiting for the results of a grade is stressful because of the uncertainty of the outcome).

We believe that several of our studies demonstrate the independence of danger and uncertainty. For example, our social comparison studies demonstrate the effects of increased psychological danger without increased uncertainty (Mendes, 2002; Mendes, Blascovich, Major, & Seery, 2001). In these studies, participants engaged in a word-finding task with a clearly superior comparison partner (an upward comparison target). Because, prior to beginning the task, participants received feedback regarding their own performance relative to their partners', there should have been little or no uncertainty regarding relative performance differences (i.e., the participants had knowledge regarding the performance differences that ostensibly existed). However, psychological danger was still present, and participants with superior partners exhibited threat patterns of CV reactivity, greater demand–resource ratios, and reported greater negative affect relative to those interacting with inferior partners.

Similarly, the data from one of our social interaction experiments demonstrates the effects of uncertainty without the presence of danger. Participants were paired with either White or Asian female confederates who either spoke with no accent or a detectable Southern U.S. accent (Mendes, 2001; Mendes, Blascovich, Hunter, Lickel, & Jost, 2002). Our prediction was that interactions with Asians with Southern accents would be the most threatening because that condition would be associated with the most uncertainty. Indeed, participants interacting with Asians with Southern accents rated them as more atypical than participants interacting with Whites with no accents, and these ratings were positively related to patterns of CV threat responses. We argue that the atypical combination of ethnicity and accent did not increase perceived psychological (or physical) danger of the interaction, but rather increased the uncertainty of the social interaction. Hence, danger and uncertainty can be examined as distinct elements and do not have to be construed as inextricably linked.

Goal Relevance and Evaluative Situations

Our model of challenge and threat effects is limited to motivated performance situations. We define these situations as ones that are active rather than passive, require instrumental cognitive responses, and are goal relevant. In their second "problem," Wright and Kirby (this issue) focused on goal relevance, suggesting it is an insufficiently clear construct for empirical testing.

Goal relevance, broadly defined, refers to the extent to which individuals perceive the task as having meaning for the self. Wright and Kirby (this issue) bemoaned the fact that we do not explicitly define performance contingencies within the goal-relevance definition. Specifically, they argued that effort or task engagement should be a function of task difficulty until success is not worthwhile or impossible when effort becomes low at all difficulty levels. This argument, coupled with the belief that sympathetic influences vary with effort in a simplistic straightforward fashion, led Wright and his colleagues to several conclusions, the relevant one here being that CV responses should be moderated by the importance of success (see Wright & Kirby, 2001, for a review).

We do not disagree that importance of success is an integral part of motivation and task engagement. Indeed, the demand evaluation component of challenge and threat theory subsumes outcome expectancies and the magnitude of contingencies. To illustrate, we can use the same example Wright and Kirby (this issue) described. They offered the example of fishing for survival, as opposed to the implied fishing for sport or leisure, as a demonstration of differences in outcomes that should affect goal relevance, ultimately concluding that the different scenarios should impact individuals' motivation to succeed and physiological responses. We agree. However, we consider not only the metabolic requirements associated with fishing acts (i.e., baiting the hook, casting the rod, pulling in the fish), but we also consider the context within which these acts occur (i.e., fellow survivors counting on you to provide food). Therefore, we would argue that fishing is more demanding in the context of surviving (due to increases in threats to self and others—psychological danger—and possible starvation—physical danger) than in the context of fishing for sport, but in both cases the act of fishing could be construed as goal relevant.

Wright and Kirby (this issue) complained that our goal-relevance definition is so vague as not to be testable, but we argue that we did so in a social facilitation study (Blascovich et al., 1999) in which we manipulated goal relevance–task engagement by varying evaluation apprehension concerns via the presence versus absence of an audience during task performance and in which we obtained the results predicted by our model (mentioned previously). It should not be difficult to construct additional experimental scenarios where at least relative differences in goal relevance can be anticipated and tested. Our definition is phrased in general terms because a wide variety of factors can create or influence goal relevance (e.g., monetary incentives, making an impression on an audience or the experimenter, personal domain importance, etc.). All else being equal, differential levels of any single such influence should cause differential levels of goal relevance and task engagement.

As previously stated, our theory and research are dynamic works in progress. The determinants of goal relevance–task engagement have thus far not been one of our focal research questions, but as Wright and Kirby (this issue) suggested, issues such as the minimum threshold required for goal relevance and the factors that create it provide potential avenues for future research. However, these details do not play a central role in the biopsychosocial (BPS) model; as such, it is unlikely that additional findings would have any affect on the interpretation of previous work.

"Primary" and "Secondary" Appraisals

The third "problem" relates to the discrepancy between demand and resource appraisals and its relation to challenge and threat.[1] Wright and Kirby (this issue) made much of our conservative approach (i.e., "lack of specifity") regarding exactly how demands and resources combine to result in challenge and threat states. They implied that individuals assess performance situations algorithmically, and they seem to assume that individuals are rational automatons who are capable of coldly calculating the exact quantity of "demands" in a situation, as well as the exact quantity of "resources" they have available. Their assumption demonstrates an extremely restricted conception of person–environment interactions. In contrast, we believe that individuals encounter performance situations and process the information both deliberately and consciously, and automatically and unconsciously. Hence, we have not yet specified an exact algorithm for calculating how these evaluation components interact, and although desirable, we judge such specification as premature (Blascovich & Mendes, 2000). As such, individuals may not have conscious access to their evaluations of all components of a performance context. The inability for individuals to report veridical evaluations poses an obstacle for challenge and threat researchers, but not an insurmountable one. Rather than repudiate the evaluation or appraisal process as untenable or metaphysical, our strategy has been to design experiments that, for the most part, manipulate one critical feature of either the demand or the resource component, controlling for the other components, and then predicting the patterns of responses associated with either challenge or threat (e.g., CV responses, subjective well-being, and performance).

[1]Curiously, Wright and Kirby (this issue) labeled our demand-and-resource evaluation components as "primary" and "secondary" appraisal. We abandoned this terminology many years ago in favor of the "demand" and "resource" labels, in part, to avoid confusion between our model and that of Lazarus.

Combining of demands and resources. We have typically stated that when resources outweigh demands challenge results; when demands outweigh resources threat results (Blascovich et al., 2001; Blascovich et al., 1999; Mendes, Blascovich, Lickel, et al., 2002; Mendes et al., 2001; Tomaka & Blascovich, 1994; Tomaka et al., 1993; Tomaka et al., 1997; Tomaka et al., 1999). Admittedly, this is a fuzzy algorithm, and we have been reluctant to prematurely specify the exact nature of how demands and resources combine. In a theoretical chapter, we (Blascovich & Mendes, 2000) speculated in a single sentence that challenge might even occur when an individual evaluates sufficient or just nearly sufficient resources to meet the situational demands of a task, whereas threat occurs when an individual evaluates insufficient resources to meet the demands of a task. Our intent was to describe the complexity of the relation between demands and resources and how unconscious influences may interact with conscious goals resulting in differential appraisals that could not be obtained by self-report data alone. Indeed, this may be one time where we are guilty of overly narrow specification.

Wright and Kirby (this issue) argued that, logically, if demands outweigh resources by even a miniscule amount, then failure should seem certain to the individual. If failure indeed seemed certain, we might expect that the situation would no longer represent a motivated performance situation, given that there may be little or no reason to attempt active responses. However, again, Wright and Kirby's analysis assumes a cold and calculating rational–economic metaphysics of human appraisal. If the comparison of resources to demands were like putting a given number of coins in a vending machine to reach an unambiguous price for an item (cf. Wright & Kirby, 2001), their argument might be valid. Yet, as even economists have recognized, the human mind is rarely so simple and logical. Because of the affective and unconscious elements that the BPS model incorporates, it seems very difficult to ever be able to coldly calculate demands and resources. Even if one could, motivated performance situations are necessarily dynamic and iterative, and thus reappraisals can change the trajectory of the CV responses (Quigley, Feldman Barrett, & Weinstein, 2002). Thus, as demands and resources are evaluated and reevaluated, challenge and threat states can vacillate during the course of a task.

Although we do not have empirical data to support our speculation, and Wright and Kirby (this issue) may be correct to argue that whenever demands outweigh resources, even by the smallest of margins, threat results, we think that theory and research on achievement motivation and effortful striving—suggesting that individuals can be highly motivated when competing against individuals slightly better than them—may capture the motivational underpinnings of the demand-to-resource ratio.

Cardiovascular Predictions

Blood pressure differences in challenge and threat. Wright and Kirby (this issue) questioned the lack of blood pressure data in our articles, and they also highlighted previous statements regarding blood pressure changes during challenge responses. We have not typically presented blood pressure data in our reports of challenge and threat because blood pressure responses are not definitive indicators of the hemodynamic patterns underlying challenge and threat. However, they are not necessarily inconsistent. Indeed, in a recently published article (Mendes, Blascovich, Lickel, et al., 2002), under editorial suggestion, we reported that non-Black participants exhibited higher systolic (SBP) and diastolic blood pressure (DBP) when interacting with Black partners (a condition that ultimately resulted in threat responses) compared to participants interacting with White partners (a condition that ultimately resulted in challenge responses).

Regarding changes in blood pressure, our early statements intimating little or no blood pressure differences during challenge were most likely too general. Although there may be some situations that for some individuals evoke cardiac activation with no co-occurring blood pressure increases, these conditions are more likely the exception rather than the rule. As an illustration of this exception, in Mendes, Blascovich, Lickel, et al. (2002), we observed little or no blood pressure changes (SBP: $M = .3$; DBP: $M = 1.3$) during a speech task when participants were delivering a speech to an in-group member (i.e., White confederate), whereas for participants delivering a speech to an out-group member (i.e., Black confederate), we observed large changes from baseline in blood pressure (SBP: $M = 6.3$; DBP: $M = 4.4$) and significantly different SBP between conditions. Contrast these findings with data from the same experiment, but using a different task—a cooperative word-finding game. When examining CV responses during this task, we observed greater blood pressure changes among those interacting with Black confederates relative to those interacting with White confederates (SBP and DBP reactivity for those paired with Black partners: Ms = 12.1, 9.5; White partners: Ms = 6.0, 2.6); however, as can be seen, we clearly observed increases in blood pressure even for the condition that we concluded resulted in challenge responses.[2]

These results demonstrate the importance of relativity in CV responses, as well as the role of metabolic demands associated with motivated performance situations. The apparent study-to-study shifts in CV patterns of challenge and threat could be a function of type of task examined (e.g., mental arithmetic, speech delivery, word-finding task, etc.), the type of instrumentation used (e.g., continuous vs. intermittent), the amount of practice or exposure to the task (habituation typically results in dampened sympathetic activation; see Kelsey et al., 1999), or the combination of these three elements. Therefore, relative differences between the patterns are important when comparing across performance contexts and laboratories. However, absolute differences may be examined when comparing similar contexts of comparable exposure using similar instrumentation. We have always maintained that relative differences in CV reactivity, specifically the relation of cardiac to vascular activity, differentiates threat from challenge states.[3]

Biological mechanisms responsible for cardiac and vascular reactivity. We used Dienstbier's (1989) model to explain why some individuals (e.g., those who are challenged) respond with a different CV response pattern than other individuals (e.g., those who are threatened). Obviously not having measured catecholamines directly (i.e., epinephrine [E] and norepinephrine [NE]) using invasive blood draws during challenge and threat, we cannot say definitively that catecholamines provide the antecedent mechanism mediating CV challenge and threat differences. However, we do argue that it is possible for SAM activity to cause a TPR decrease. As Wright and Kirby (this issue) pointed out, SAM activity is associated with release of both circulating E (vasodilatory) and NE (vasoconstrictive), but they failed to point out that cir-

[2] An even more complicated finding was observed when examining the second main effect in this experiment, socioeconomic status of the confederate. Although the findings for blood pressure differences were consistent with what we would expect for SBP (i.e., advantaged confederates engendered more challenge responses and relatively lower SBP than disadvantaged confederates), the results of DBP differences based on the socioeconomic status of one's partner were not clear. This finding could be due to the multifaceted nature of the status effect, or it could be a function of the difference in α-adrenergic versus β-adrenergic effects on blood pressure.

[3] Wright and Kirby (this issue) stated incorrectly in a footnote that challenge and threat have been consistently described as being all-or-none phenomena, so they do not consider the idea of whether the states of challenge and threat are relative because it has not been presented in detail. Although Wright and Kirby have in previous worked assumed that challenge and threat are discrete, nongraded states (Wright & Kirby, 2001), this is not actually the case, nor have we ever claimed it to be. In fact, it has been our practice for some time to statistically test for both absolute and relative differences on the CV variables that best differentiate challenge and threat (CO and TPR). For example, as is now typical for our research, Mendes et al. (2001) tested group means against zero to assess whether the pattern for the group was consistent with the challenge pattern, the threat pattern, or neither. In addition, the authors tested group means against each other to assess relative challenge and threat differences. Indeed, relative differences were a key part of the hypotheses in this case, where it was expected that attitudinal similarity would attenuate the challenge experienced during downward comparison, as well as the threat experienced during upward comparison (results confirmed predictions). We believe that failing to consider the graded nature of challenge and threat does not allow for a reasonable evaluation of our model.

culating E tends to inhibit NE release (Brownley, Hurwitz, & Schneiderman, 2000).

Regarding Wright and Kirby's (this issue) criticism that the relative changes from baseline in CV response during challenge and threat have not been consistent (although they agree that the differences between challenge and threat groups are consistent), we believe they have fallen prey to a common misconception regarding physiological responses. It is often erroneously assumed that because physiological responses are more objective relative to other measures (i.e., less subject to demand characteristics), they are also free from other forms of biases, such as sample characteristics, measurement error, and construct validity. Yes, relative changes from baseline have not been as consistent as a scientist would hope. However, what measure in psychological research is as consistent across samples and time as Wright and Kirby would seem to require? For example, would we expect that state self-esteem should always decrease by exactly 3 points after negative feedback, regardless of the type of negative feedback or the sample characteristics, even given the same measure of state self-esteem? We would not. For decades, psychologists have battled against the stereotype that somehow the type of science we do conduct is not as rigorous as the hard sciences, such as biology, physiology, or physics. And yet, suggesting that we are somehow using more "real" or "valid" measures with physiological responses, and thus they should be more reliable and valid, falls prey to that same assumption. Level of analysis should not be confused with quality of science. As we have stated, the challenge and threat model has been tested by converging methods, contexts, and measures, including not just physiological responses but also self-report and behavioral measures. The variation in degree of response across studies should be of no surprise to any psychologist.

Admittedly, as social psychologists we have been more interested in defining the social and psychological aspects of a BPS model, rather than the biological ones. Perhaps we are at some fault for ignoring evidence that changes in vascular resistance are due to more than just catecholamine effects on alpha- or beta-adrenergic receptors or receptor sensitivity. For example, factors such as local release of endothelin-1, a potent vasoactive peptide, from the endothelial walls of the blood vessels themselves, contributes significantly to vascular resistance changes during stress (Treiber et al., 2000, Treiber, Kapuku, Davis, Pollock, & Pollock, 2002). We agree with Wright and Kirby (this issue) that parasympathetic withdrawal is an important component to heart rate responses during stress. In support of our views, vagal reactivity may be related not only to attention (Jennings, 1986; Porges, 1992) but also to factors such as anxiety (Friedman & Thayer, 1998a, 1998b), depression (Hughes & Stoney, 2000), psychological adjustment (El-Sheikh, 2001), and family conflict (Salomon, Matthews, & Allen, 2000). Again, we feel that our reference to Dienstbier's (1989) model is not a flaw of the challenge and threat model, but it is a valid point for future research into the underlying physiological mechanisms resulting in cardiac and vascular reactivity and their relation to not only effort and performance but social and emotional factors as well.

Can Effort Explain CV Differences Related to Challenge and Threat?

Wright and Kirby (this issue) concluded their analyses with the suggestion that effort may be solely responsible for the CV differences that we attribute to challenge and threat states. There are several reasons to dismiss effort as the only critical element in the demand component.[4] As we argued previously, motivation is a multidimensional, multiprocess system that entails multifaceted responses and is not limited merely to metabolic effort associated with the specific acts within the context.

In our intergroup studies (Blascovich et al., 2001; Mendes, Blascovich, Lickel, et al., 2002), for example, we instructed participants to deliver speeches in the presence of an in-group or out-group partner. Of course, there is some recruitment of metabolic resources associated with delivering a speech, which would not necessarily differ between conditions. What did differ was to whom the participant was speaking. It would be difficult to argue that the metabolic effort of speaking differed; we did not have one group constrained in such a way that speaking was more difficult or required more physiological effort than for the other group. Instead we varied the context of the speech. And, we found large CV differences as predicted: threat pattern during speeches to out-group partners and challenge pattern during speeches to in-group partners. Moreover, in Mendes, Blascovich, Lickel, et al. (2002), we reported predicted CV differences during speech preparation when very little or no metabolic effort was expended. We speculated that speeches to out-group partners were more demanding because the out-group interaction may be perceived as more psychologically dangerous, engender more uncertainty (see Blascovich et al., 2001, Study 3, for empirical support of this notion), and possibly increase perceived effort because of a lack of a shared reality or a common communicative schema.

[4]Required effort and exerted effort are conceptually distinct and should not be considered synonymous within our theoretical context. Required effort, as we construe the meaning, refers to the extent to which participants believe the task will tax their abilities. We believe exerted effort refers to amount of physiological recruitment actually expended during a task, which may or may not differ from perceived effort.

Conclusions

In summary, we believe Wright and Kirby's (this issue) criticisms of our BPS model of challenge are unsubstantiated. First, they question our theoretical conception of demand, eschewing our explicit scientific definition of the term for a common language definition. A critical feature of our demand construct is the extent to which it stems from motivated performance situations, which include the task, the environment, the person, and the interaction of any or all of the three. Our definitional approach is in sharp contrast to the rational–economic and reductionistic perspective that Wright and Kirby take. Certainly, the consideration of the multiplicity of demand components we consider exponentially increases the complexity of the challenge and threat model; however, to ignore all of the possible components that interact to produce CV responses during motivated performance situations would be to ignore the more interesting aspects of social psychological factors.

Second, they criticized our theory as if it has been static rather than evolving and generative. Hence, their selectivity of very specific conjectures we have sometimes made in the past misses the forest for the trees. Wright and Kirby (this issue) failed to recognize that our theory differs from other theories—including their own—in breadth and important conceptual respects, which renders many of their criticisms inaccurate and irrelevant, especially regarding the concept of demand and the role of required effort.

Third, we believe Wright and Kirby (this issue) based their criticisms of our CV indexes on a psychologically outdated and oversimplified notion of the CV system. Furthermore, they failed to acknowledge the evolution of our CV indexes of challenge and threat. Instead, they relied on simplistic notions regarding heart rate and energy expenditure.

Although Wright and Kirby (this issue) suggested that their own model may be able to account for most but not all of our findings, they neglected to mention that their model is much narrower in scope than the BPS model. In terms of our model, the work of Wright and colleagues best addresses task engagement, which is our prerequisite for both challenge and threat—although it should be noted that we believe task engagement reflects goal relevance, whereas they maintain that task engagement merely reflects effort. Furthermore, Wright and Kirby (this issue) failed to acknowledge that our BPS model adds (a) affective and unconscious processes to the purely rational–economic ones proposed by Wright and Kirby (2001), and (b) a distinction between situations that are evaluated relatively positively (resources meeting or outweighing demands, yielding challenge) versus relatively negatively (demands outweighing resources, yielding threat). On a physiological level, the BPS model incorporates a more modern view of the complexity of the CV system and its responses during motivated performance situations.

All theories benefit by criticism, which itself comes easier than model building. Although Wright and Kirby (this issue) generated a number of alternative ways to interpret our work, they have little or no data to support their conjectures. The fact remains that we continually find physiological, self-report, and performance data consistent with our model and our specific predictions. Nonetheless, we have not yet identified all details, components, and boundary conditions of the processes we identified in our theorizing and tested in our empirical work, nor do we maintain that the current state of our theory represents a complete and final answer to the questions we address. Hence, we conceive of challenge and threat theory as generative, and we hope that others including Wright and Kirby will also be interested in pursuing research questions that arise when considering challenge and threat phenomenology using the full set of our indexes, especially the CV ones along with whatever other measures they deem appropriate.

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