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INSPIRED BY THE QUESTION, NOT THE MEASURE

Exploiting Neurobiological Responses in the Service of Intergroup Research

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My Path

My interest in using psychophysiology to illuminate intergroup processes began long before entering graduate school. During my undergraduate days, I was on a path toward applied statistics, with an interest in applying quantitative models to understanding human behavior, specifically criminal behavior. This interest led me to seek an intern position with the Federal Bureau of Investigation (FBI), crime analysis division. The position required exposure to high- level security information, and as a result required a fairly extensive background check. As part of my pre-employment screening, I had to complete an interview during which my autonomic nervous system (ANS) responses were monitored—more commonly known as a "polygraph test." Of course, polygraph simply means multiple graphs, but people often (and incorrectly) use this term synonymously with "lie-detection test." For me, this experience cemented the idea that our mental states and bodily responses are inextricably linked, and that there are times when our neurobiological responses can expose thoughts and feelings that we would prefer people not know we have. The story of my "polygraph" experience illustrates some critical psychophysiological principles that I will review later in this chapter.

The interview was scheduled in the late afternoon at the main headquarters of the FBI in Los Angeles. When I arrived at the office of the man interviewing me (let us call him John), he was friendly and gracious and suggested we get some tea before the interview. As we made (what I thought was) idle chatter, John relayed a story from his past week, in which he had to dismiss a soon-to-be commissioned agent (let us call him Ted), because Ted had admitted to John that he was not "100% honest all the time." I mimicked John's horrified expression at hearing that someone who desired to work at *the FBI* would not be anything but 100% honest, but my mind also started racing with the high standards that this position required.

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As we were walking back to the interview room, John also casually offered that I really had nothing to worry about given that my background check had been pristine, and many of my personal references had remarked on my integrity and how I was the type of person who would"never gossip or say anything negative about others." Again, my mind raced with feelings of pride that my friends would offer such positive statements of my character, but also I wondered, who the hell did they talk to?! No matter, I was feeling relaxed, confident, and supported by my new friend. As for John , I suspect he was thinking something entirely different. Indeed, for him, the trap was set for a *guilty knowledge test*.

The session began with the application of a number of sensors to measure respiration, heart rate, skin conductance, and skin temperature. There was a lot of equipment, but without question, the most important aspect of the situation was the psychological components that preceded the interview. The session started like any psychophysiology experiment would, with me relaxing in a seated position to establish a *baseline* recording of responses. Of course, my responses were not as "relaxed" as they would have been if I were at home reading a book, but in experimental lab studies, we typically care about changes from a relatively neutral state to a task or event. After a few minutes, John began asking fairly serious questions regarding my extensive traveling history, in some cases to Communist countries—the concern was that I was a drug smuggler or, more dramatically, involved in espionage; I was, boringly, not either one. Then, in the midst of this intense questioning, John asked, "In the past 7 years, have you been 100% honest all the time?" Having a short-term memory that extended beyond 1 hour, the answer was easy—John had provided the only answer I could give based on the "Ted" story—I swallowed and offered, "Yes." The questions continued—drug use and activity, criminal activity, and other assorted illegal activities—and then this one: "In the past 7 years, have you ever said something negative about a friend?" Again, I offered the only response that made sense given our earlier conversation about my personal references—"No." After a few more questions, John told me to relax and then announced that the first trial was over.

I turned, expecting a beaming congratulatory smile, but instead John looked worried. Apparently, he explained, the polygraph suggested some deception, and so we would need to "try this again." He told me that two of my responses were problematic: the "100% honest" and the "negative statements about friends." John recommended that I try to think about my answers before responding, to make sure that my mind was not wandering. We then repeated the same line of questions, only this time, I was incredibly aware of my heart racing the moment he started asking "in the past 7 years. . ." After the second trial, John let out a long sigh and then expressed concern that this "doesn't seem like it will work out for you after all." He wanted to be optimistic, though, and suggested that we try it one more time.

The third trial was the worst. I could feel my entire body on edge: cold, sweaty palms, dry mouth, racing heart, all peaking the moment he started asking "in the

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past 7 years. . .” My body had betrayed me and exposed me for my white lies and gossipy ways; I began to contemplate other career options—business school seemed like a good idea. However, this time when I turned around, John smiled and told me I had passed the polygraph and that all was clear for my hire. So what happened?

I had been an unwitting participant in a *guilty knowledge test*, in which the interviewer obtains autonomic nervous system responses during control and “lie” answers. The more you can increase the respondent’s belief in the importance of the “lie” questions, the better this technique works. John needed me to lie so that he could compare the intensity of the physiological responses when I was lying to answers when I was, presumably, telling the truth. If I were skilled at beating the “polygraph test,” then the “lie” answers would have shown little reactivity. Given the likelihood that someone in their early 20s has told a white lie or said something negative about a friend, the “lie” questions offer an important comparison to the target questions. By increasing my anxiety over the two “lie” questions, John had responses when I was lying to compare to the target questions.[1]

For me, this experience was foundational. I was fascinated that my body could betray me, and that no matter how much I tried to control my internal responses, I was a slave to them in many respects. Most notably, however, was the realization that it was the *combination* of the psychological context and physiological changes that were important during the polygraph test. This experience planted the seed of interest that emerged a few years later when I went to graduate school.

Neurobiological Measures

There are many different biological changes that can be reliably measured and might be profitably applied to the study of intergroup relations. Indeed, the first obstacle is deciding, among the many options, how and where to focus one’s energy and resources. It is true that you cannot do everything, but as it relates to neurobiological methodology, in the Isaiah Berlin dichotomy, I am a fox and not a hedgehog. There are certainly advantages and disadvantages to being a neurobiological researcher who is a hedgehog—narrowly, but expertly, focused on a single domain; compared to a fox—broadly focused, but at the risk of not being deeply proficient across all topics. However, I would argue that our discipline needs both types of researchers, since only with foxes and hedgehogs working together can progress occur both in the development of more precise neurobiological measures (depth), as well as linking across systems to paint a comprehensive picture of the intersection of the mind, brain, body, and behavior (breadth).

The Obstacles

Prior to describing some of the work in my lab, it would only be fair to describe the various obstacles that one might encounter when trying to integrate these

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measures successfully into one's research. My intentions in describing these obstacles are not to dissuade the interested researcher, but rather to manage the expectations of what lies ahead.

The first obstacle is deciding what to measure. Students and scholars interested in using neurobiology as a method to inform their work are well-advised to start small and focused, and only consider branching out after mastering a single domain. Another option would be to pair up with a colleague with neurobiological expertise from a different area or department; for example, public health and medical schools often have experts in neurobiological domains that are not always obvious collaborators. As with any interdisciplinary endeavor, progress will be slower and more difficult at all stages of research. You will have different methodological and theoretical perspectives, speak a different language from each other, and may not have aligned goals on where to publish. As such, integrating neurobiological responses into your research program should only be done after much consideration and with cautious expectations. It is also worth noting here that neural or biological responses should not be privileged over other outcome variables—they are neither more nor less scientific, nor do they provide a direct window into an individual's mind—but instead they are best considered as part of a multi-componential understanding of how social context influences mental states and behavior.

A second obstacle in integrating neurobiology into your research program is determining what the physiological responses indicate at a psychological level—that is, what can we infer about mental states by examining physiological responses? I would argue that this is the most difficult obstacle for psychologists to overcome. Our discipline would not be satisfied if we simply reported changes in heart rate or increases in sweat gland activity without some interpretation of what the responses indicate at a psychological level. But how certain can we be that, for example, a correlation between a hormone and a personality dimension is not simply epiphenomenal, or that a shift in the parasympathetic response indicates an underlying change in emotions? The unsatisfying answer is, "It depends." And this is where knowledge of psychophysiological theory becomes paramount.

Understanding Psychophysiological Theory

There are several thorough chapters that review psychophysiological inference that should be mandatory reading for researchers interested in these methods (e.g., Cacioppo, Tassinary, & Berntson, 2000, 2007). Here, I summarize and augment what others have written about psychophysiological inference. At the broadest level, we can begin to think of neurobiological measures in terms of their *sensitivity* and *specificity*. These constructs are conceptually orthogonal, but a cursory reading might lead one to conclude that measures that are more sensitive tend not to be as specific, and vice versa, though this would be a faulty conclusion.

Sensitivity is the extent to which the neurobiological response reliably changes as a function of shifts in mental states (emotions, thoughts, intentions, etc.) with

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the idea that subtle or minor shifts in mental states would affect *highly sensitive* measures, but measures *lower in sensitivity* would require more intense mental states to observe changes. Skin conductance (SC) provides a good example of a measure that is highly sensitive because very subtle and low-level changes in affect, cognition, and intentions can influence SC changes. In contrast, cortisol changes would be considered very low in sensitivity because cortisol increases typically require a very intense psychological experience. For example, in a meta-analysis of over 200 studies, the experimental paradigms that were reliably linked to cortisol increases were ones described as *uncontrollable, socially evaluative, and threatening* (Dickerson & Kemeny, 2004). Passive events, like watching scary movies or the threat of electric shock, did not reliably increase cortisol levels. Casual social interactions, even with outgroup or stigmatized partners, are not likely to engender cortisol increases. Instead, researchers often observe cortisol levels that decline over the course of an experiment (reflecting the decline in cortisol as a function of the diurnal cycle), and they are left to interpret what differential declines in cortisol could mean psychologically, often making the vague and clumsy assumption that greater declines indicate "less stress" or "more relaxation." This can muddy psychological inference, given that there is limited evidence that differential declines from resting states are psychologically meaningful.

Specificity refers to the extent to which the neurobiological response is related to a particular mental state, with *low specificity* indicating that a neurobiological response is related to many mental states, and *high specificity* indicating that a neurobiological response is related to fewer or (possibly) a single mental state. Skin conductance, though highly sensitive, is not very specific. Many psychological states, some even polar opposites of each other, can engender a skin conductance change. I often give the example that, if while I measured your skin conductance, a person whom you loathe enters the room, your skin conductance would increase; if, on the other hand, a person whom you love enters the room, your skin conductance would also increase. In other words, the measure is not specific to negative or positive affect—instead it responds to intensity, general arousal, or effort.

Perfect specificity—or one-to-one correspondence between a psychological state and physiological responses—is rare, and in most cases, perfect specificity is observed only in constrained contexts. For example, skin conductance responses (SCR), as described above, are sensitive, but non-specific; however, when coupled with a fear-conditioning paradigm, SCRs can be reasonably interpreted as an indication of fear. In a fear-conditioning paradigm, participants view pictures paired with an aversive stimulus, like an electrical shock. After several pairings of the pictures and shocks, the aversive stimulus is removed, and the participants' responses to the conditioned stimuli are examined. Upon presentation of the conditioned stimuli, SCRs are examined, and often the interpretation is that SCRs to the conditioned stimulus indicate "fear." Note the very constrained paradigm of fear conditioning that enables one to then make the inference that SCRs are

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synonymous with "fear." The situational constraints of the fear-conditioning paradigm limit the number of mental states that can be experienced, which leaves changes in SCRs as most likely indicating fear. The point here is that physiological responses gain psychological meaning when the psychological context is considered.

Stumbling with Psychophysiology

I started my doctoral training with Jim Blascovich who, with Joe Tomaka, had just published an article in *Advances in Experimental Social Psychology* on the theory of challenge and threat, which claimed that cardiovascular responses during stressful tasks could be differentiated to index whether someone was experiencing an approach state, *challenge*, or a defeat state, *threat* (Blascovich & Tomaka, 1996; see also Blascovich, Chapter 12 in this volume). At this point, there had been a handful of papers that made the argument that cardiovascular reactivity during *motivated performance situations*— defined as self-relevant active tasks requiring cognitive responses—could be differentiated, based on whether participants perceived the task as more demanding than their resources to cope (*threatening*) or perceived their resources as greater than the demands of the task (*challenging*).

The threat versus challenge distinction integrated early appraisal work by Lazarus and Folkman (1984), who argued that how individuals perceive the demands of an event, coupled with their resources to cope, determines how successfully they manage the stressor; and Dienstbier's physiological arousal theory (1989), which argued that the two primary stress systems (sympathetic– adrenal–medullary [SAM] and hypothalamic–pituitary–adrenal [HPA] axes) can differentiate *tough* or resilient patterns of reactivity (large SAM activation, with smaller HPA responses) from *weak* patterns (smaller increases in SAM responses coupled with greater activation of HPA). The theory claimed that the mental states of challenge and threat could be differentiated by examining, among other biological responses, cardiovascular reactivity. Specifically, in challenge states, there would be large increases in sympathetic nervous system (SNS) responses: The heart would work more efficiently, thus increasing cardiac output; and the vasculature system would expand (dilate) allowing for more oxygenated blood to travel to the brain and periphery. These changes could be indexed by examining cardiac output (a volume- based measure of blood ejected from the heart each minute) and total peripheral resistance, estimated from the ratio of average blood pressure and cardiac output. In contrast, threat states would be associated with increased SNS responses— but often not as large as those observed in challenge states—less efficient cardiac responses, and increased vascular resistance.

In my first year in graduate school, we began discussing applying this theory to intergroup interactions. Along with Brian Lickel and Sarah Hunter, we began a series of studies attempting to show that intergroup interactions were *threatening*, as indicated by a profile of cardiovascular responses. Finding supportive data turned

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out to be much more difficult than we initially expected. One of the obstacles was to create a task that was engaging enough to activate the sympathetic nervous system—a requirement for challenge and threat distinctions—but was not so stressful that everyone experienced threat. This is the exact place an experimental psychologist does not want to be—designing an experiment around the constraints of the measures. There were several false starts with this research program. First we tried to have participants simply imagine a partner (either the same race or a different race) and then give a video-recorded speech about working with him/her. The speech activated the SNS, but we did not observe challenge and threat differences—for the most part, participants were challenged, and they did not perceive the task as distressing. We then tried giving participants a picture of their partner (racial ingroup or outgroup) to make the partner's race more salient. Again, we observed no differences between conditions. We then intuited that the interaction might have to be live, so we began to use confederates (see Norton, Dunn, Carney, & Ariely, 2012, for a recent empirical example of this point).

When we switched to live interactions, we finally started seeing the expected differences in reactivity. We used this paradigm in over a dozen studies, in which we demonstrated that partners who were stigmatized in some way (either due to race, socio-economic status, or physical stigmas) engendered threat reactivity in non-stigmatized participants (Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001; Mendes, Blascovich, Hunter, & Lickel, 2002; Mendes, Major, Blascovich, & McCoy, 2008; see also Blascovich, Chapter 12 in this volume). We also found nuances that shed light on the psychological processes that may lead to *threat* reactivity; for instance, partners who violated expectations because they were counter-stereotypical or atypical (e.g., a wealthy Latino or an Asian American with a thick Southern accent) also engendered threat (Mendes, Blascovich, Hunter, Lickel, & Jost, 2007). This last finding was critical because it demonstrated that uncertainty, and not simply negative affect, could drive *threat* responses.

I offer my naïve intellectual journey partly as a cautionary tale of what not to do. Of course measurement and methodological frameworks are important (see Greenwald, 2012, for a lively discussion), but the theory or question should drive the choice of methods, not vice versa. In my lab, new students and post-doctoral fellows focus on a specific question before we decide what makes sense to include (if anything) in terms of neurobiological measures. I strongly encourage this approach, and I think we feel liberated in the questions we pursue when we are not constrained by one methodological framework.

Integrating Neurobiological Measures to Test Intergroup Theories

Over the past decade in my lab, my collaborators and students have been actively engaged in a program of research examining, at the broadest level, social inter-

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actions between two strangers, during which we measure a variety of neurobiological responses to understand prejudice behavior and experiences of discrimination. Broadly, our studies seek to understand intergroup interactions from multiple perspectives:

- the *perceiver*, the non-stigmatized or "advantaged" group member;
- the *target*, the minority, stigmatized, or disadvantaged group member; and more recently
- the *dyad*, referring to reciprocal, complementary, or coordinated action between two strangers.

Using neurobiological measures in these interaction studies has offered illuminating and sometimes contradictory findings when compared to self-report or controlled behavior.

When looking at the broader context of prejudiced behavior, by most historical accounts during the last half of the 20th Century and the start of the new millennium, there has been a decrease in expressed prejudice toward racial minority group members in the United States. There are laws that ban discriminatory practices in employment, housing, and healthcare. Many affirmative action policies are intended to correct previous racial injustices by explicitly encouraging, and in some cases requiring, decisions to favor racial minorities, all else being equal. Focusing on African Americans, over the past 50 years, the United States has observed dramatic changes: from Jim Crow laws and school segregation in the 1950s and 1960s, to African Americans serving as heads of industries, Supreme Court justices, presidents of universities, and the highest executive position of power in the United States.

Laws and policies are one way to gauge the progress of minority or stigmatized people, attitudes that people hold are another. One optimistic sign of progress toward a less biased nation can be seen in Americans' attitudes regarding their willingness to vote for an African American for President. In 1958, the majority of voters surveyed by Gallup, 53%, said they would not. In 2002, the percentage of voters who reported that they would not vote for an African American candidate was down to 6%; and in 2006, a *Newsweek* poll reported the percentage below 3%. These numbers, coupled with objective indicators of African Americans occupying the highest offices in the country, offer an optimistic sign of how the United States has progressed over the past 50 years, and have led some journalists and politicians to proclaim that "racism is dead" (Bowden, 2008).

But as social scientists, we have known for decades that ingrained attitudes, preferences, and associations can linger under the surface long after individuals appear to have eschewed these beliefs. Also, we know that when individuals actively try to suppress thoughts, emotions, or beliefs, they often ironically bubble up to the surface, and that this is more likely to occur when the ability to regulate our reactions is compromised (Wegner, 2009). This suggests that explicit desires

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to be egalitarian may be at odds with automatic responses to stigmatized or outgroup members. When this tension exists, there are situations when visceral responses might be difficult or impossible to regulate—resulting in responses that might be counter to one's *expressed* beliefs.

Here, I will describe a series of interrelated studies concerning *meta-monitoring* during intergroup interactions. That is, during interactions with members from different social groups, individuals often engage in self-presentational and monitoring strategies that are distinct from the strategies they use when interacting with ingroup members. We attempted to show that these strategies—probably intended to make the interaction smoother—can undermine the authenticity of the interaction and may be part of the root of strained intergroup interactions.

The strategies in which perceivers and targets engage are likely to be different, as are their goals (Bergsieker, Shelton, & Richeson, 2010), but in both cases, the extra monitoring may present an additional strain on the interaction that can be observed using a variety of neurobiological methods. I will describe the different research programs below, starting with the *perceiver*, who I contend often engages in *overcorrection*, an exaggerated positive reaction toward the target. Next, I will discuss the *target*, who may engage in *hypervigilance*, scanning the environment and the behaviors of the interaction partner to attempt to determine his/her motives, intent, and genuine beliefs. Finally, I will describe a study in which, while simultaneously examining the perceiver and target, we attempted to manipulate whether or not the dyad could engage in these meta-monitoring strategies, as a way to examine the counterintuitive hypothesis that, by reducing cognitive resources *prior* to a social interaction, dyads might show more authentic reactions to each other and ultimately develop more mutual trust and shared understanding. Importantly, the neurobiological measures that we obtained were critical in providing insight into how individuals were regulating their affective responses, given their self-reports and behavior presented contradictory findings.

Perceiver Perspective

A good amount of research has accumulated examining neurobiological responses from perceivers who are interacting with or observing outgroup (target) others. Early intergroup research dates back to the mid-1950s, when Rankin and Campbell (1955) reported that skin conductance responses were higher when White participants were touched by a Black compared to a White experimenter. But since the late 1990s, research on intergroup interactions using neurobiological methods has increased exponentially. Part of the increase in the number of studies is probably due to advances in functional magnetic resonance imaging (fMRI) and other psychophysiological techniques, coupled with greater precision in theory on intergroup anxiety and threat (e.g., Blascovich & Mendes, 2010; Shelton & Richeson, 2006; Stephan & Stephan, 2000).

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If one read only the physiological or neural literature on intergroup interactions, one might come away with the impression that interactions with outgroup members are reliably associated with more stress, threat, and negative affect, such as fear and anxiety. If, however, one examined literature exclusively using self-reports, a different conclusion would be made— that we are moving toward being a more egalitarian and less xenophobic society. In several studies, we simultaneously examined these responses so we could explore the relations between them.

In one study (Mendes et al., 2007), we recruited European American adults (N = 78; ages 20–55, M = 31.5) to come to the lab for a 90-minute experiment. At least 48 hours prior to coming to the lab, the participants completed some measures on-line that included a Black–White Implicit Association Test (IAT) (Greenwald, McGhee, & Schwartz, 1998), to provide a measure of implicit racial bias. Upon arrival at the lab, we obtained an initial consent for participation in the study that described everything up to the stress task; a health intake interview was conducted; and the participant rested for at least 20 minutes prior to giving an initial saliva sample. We then described the task that they would be asked to complete—a mock job interview to two evaluators—and at this time, we obtained a second consent. It is important not to contaminate baseline responses by informing participants of the stress task at the onset of the study. Upon consent to continue, the experimenter then introduced the two evaluators.

The only manipulation in this study was whether the two evaluators (one male, one female) were two White or two Black evaluators. The evaluators then described the task in more detail and left the room for the participant to prepare the speech. After the preparation period, the evaluators came back into the room, sat across from the participant, and engaged in a mock job interview (modeled after the Trier Social Stress Test; see Kirschbaum, Pirke, & Hellhammer , 1993). The task lasted just over 15 minutes, from the time of the initial explanation until the evaluators left the room. A second saliva sample was obtained 5 minutes after the task, with the intent being to obtain the peak neuroendocrine change due to the evaluation task. Once the study was complete, the saliva samples were assayed for cortisol and dehydroepiandrosterone-sulfate (DHEA-S), an adrenal steroid that can counter-regulate the effects of cortisol. We also had research assistants, blind to evaluators' race, code the videos for affective, behavioral, and observable stress responses.

When we focused on the cortisol reactivity data, we did not observe either a main effect for evaluators' race nor moderation by racial bias. Instead, regardless of the evaluators' race or the participant's level of implicit racial bias, participants showed a large increase in cortisol as a result of the stress task. However, when we considered a more complete profile of neuroendocrine responses by examining DHEA-S and anabolic balance (ratio of DHEA-S and cortisol), we observed the expected role of racial bias. Among White participants evaluated by Black evaluators, racial bias was related to DHEA-S changes, such that higher racial bias was related to lower DHEA-S and anabolic balance.

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If one only considered these findings, the conclusion would be clear: among White participants, the higher the racial bias, the worse the neuroendocrine outcome. However, when we examined participants' non-verbal behaviors and emotions as rated by observers unaware of the evaluators' race, a very different conclusion emerged. With observer ratings, we noted main effects for evaluators' race, and racial bias moderated the response. Specifically, White participants displayed *more* positive emotion and smiled more when evaluated by Black interviewers than those evaluated by White interviewers, and greater racial bias was associated with *more* positive emotion and more smiling (Blascovich, Mendes, & Seery, 2002; Mendes et al., 2007; Mendes & Koslov, in press). In sum, when we examined physiological responses, we observed interactions with outgroup members engendering greater threat and negative reactions; but when examining explicit self-reports and behavior, we observed more positive responses toward the outgroup partners.

These effects have been documented by others, and a variety of labels have been used— overcorrection, color blindness, positive biases—but we wanted to understand the roots of these *correction* effects. One road that we took was to use psychophysiology as both a measure of bias as well as a way to understand emotion regulation capacity, with the idea being that when individuals had the resources to correct for racial biases, they would do so—and often make a miscalibration error of *overcorrecting*; but that when resources were depleted, individuals would not be able to monitor their responses, and instead the *overcorrection* effect would be eliminated.

To explore this idea, we (Mendes & Koslov, in press) designed an experiment in which participants had to complete a stressful task— an evaluative job interview in the presence of two stoic interviewers—while we measured their cardiovascular responses. Immediately after the task, we asked participants to review a stack of resumés in which there were low-, medium-, and high-quality candidates, of which one-third had African American names and the other two-thirds had European American names. We instructed the participants to select the eight best resumés, forcing them to select at least two medium-quality resumés. If one approached this task with either an egalitarian perspective or a completely color-blind approach, they would choose either no African American resumés or one medium-quality African American resumé. If someone were *overcorrecting*, they would pick two or more medium-quality African American resumés.

Our prediction was that individuals would overcorrect if they had the resources to do so, and in this case, we defined "resources" as showing cardiovascular (CV) reactivity consistent with challenge. We used the CV responses obtained from the interview to categorize participants into one of two groups based on their reactivity. About 60% of the participants responded to the speech task with a *challenge* profile, whereas the other participants responded with a *threat* profile. When we examined resumé choice based on challenge and threat classification, we found that individuals higher in racial bias and who were challenged *overcorrected*

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—chose two or more medium-quality African American resumés; but if participants were higher in bias and were *threatened*, they did not over-select African American resumés. Low-bias individuals, whether challenged or threatened, showed egalitarian responses. These data demonstrated that among individuals with higher racial bias, when they have the resources to do so, there is overcorrection. Of course, this study was limited due to the individual difference approach we used: We did not randomly assign participants to challenge or threat states, but rather categorized them based on their CV reactivity. We therefore followed up on this study by randomly assigning participants to a resource-depletion condition or a control condition.

The follow-up study comprised a two-experiment ruse in which the first part of the experiment examined White participants' preferences between two celebrities, and the second experiment examined racial bias by measuring neuroendocrine reactivity during an evaluation by two Black interviewers. During the first session, we depleted participants' ability to correct their preferences by having them complete a celebrity-choice task while under cognitive load— keeping track of how many times they heard a piano tone on an audiotape with four different instruments playing the same tone. The control participants were played the same audiotape, but were told that its purpose was to muffle outside sounds. In the second session, participants completed a mock job-interview task in front of two Black evaluators. We collected a saliva sample at baseline and after the interview task and later assayed these for cortisol.

Consistent with the overcorrection hypothesis, participants in the no-depletion (control) condition indicated a preference for Black over White celebrities, whereas participants in the depletion condition did not show this preference. Furthermore, when we examined racial bias, as indicated by cortisol reactivity during the speech, we found that cortisol levels were associated with greater preference for Black celebrities, but only in the no-depletion condition. This effect was reversed in the depletion condition: Large cortisol increases were associated with fewer Black celebrities chosen, though this slope was not significant. We also measured racial bias by asking the evaluators to rate how anxious participants appeared during the interview. Paralleling the cortisol data, the more anxious participants appeared to the Black evaluators, the more these participants had chosen Black celebrities in the no-depletion condition. Interestingly, the correlation between the two measures of "racial bias" (cortisol reactivity and interviewers' ratings of anxiety) were non-significantly correlated at $r = .10$, underscoring the distinctiveness of these measures even though they yielded similar correlations with the outcome measures.

Targets' Perspective

This series of studies led us to question if African Americans perceived Whites' positive treatment as disingenuous. There were several previous studies that examined this idea and concluded that positive feedback from Whites might be

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discounted by minority members. For example, Crocker, Voelkl, Testa, and Major (1991) found that Black participants' self-esteem dropped after positive evaluations from White partners (see also Major & Kunstman, Chapter 17 in this volume). Similarly, Cohen, Steele, and Ross (1999) provided Black participants with praise on a written essay, which resulted in Black participants *de-identifying* from the academic domain more than Whites receiving the same feedback. The possible limitation with these previous approaches is that minority participants might be reluctant to report negative affect for fear of looking like a complainer (Kaiser & Miller, 2001). We thought physiological measures might yield important insight into this question.

We (Mendes et al., 2008) examined this question, in part, by having Black and White participants receive socially evaluative *positive* feedback from either a Black or White same-sex (confederate) partner. Participants then engaged in a time-pressured, cooperative task that included a joint monetary bonus if the dyad "performed well together." These task constraints were not arbitrary, and indeed when we did not include joint bonuses or tasks with time pressures, we did not observe significant increases in sympathetic nervous system responses.

The cardiovascular reactivity from the task yielded significant interactions for all of our key physiological responses. Specifically, for all race-partner combinations, except one, positive feedback resulted in reactivity consistent with challenge profiles—increased cardiac output and decreased total peripheral resistance. This is consistent with the idea that positive feedback can be perceived as a type of *resource* for participants, triggering more challenge than threat responses. However, for African Americans, positive feedback from a White partner was associated with *threat* reactivity—decreased cardiac output and increased total peripheral resistance.

We also coded the behavior during the cooperative task for *vigilance*—operationalized as how often the participant looked away from the computer task to watch their partner. This measure yielded the same interaction—the only differences were found in the Black participant–White confederate dyads, in which the Black participants monitored their White partners more often than any other dyads. Not surprisingly, given this distracted behavior, performance was lower, with Black participants who received positive feedback performing significantly worse when paired with White partners than when paired with Black partners. Notably, very few self-reports of emotions and stress showed any effects that paralleled what we observed for physiology, behavior, and performance. Whether participants were not aware of these changes, or were aware but did not want to report on them, is unknown; but it would be interesting to try to integrate a guilty knowledge test (see "My Path," above) in an intergroup paradigm to see if that test could shed light on participants' awareness of intergroup anxiety effects that are manifested physiologically.

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Intergroup Dyads

Thus far I have described studies that extended early work showing that intergroup interactions typically engender more *threat* reactivity than same-race interactions, and showed that one possibility of why this occurs is due to more *meta-monitoring* during intergroup interactions. In the final study I describe, which is based on a dissertation by one of my graduate students (Koslov, 2010), we explored this idea within a *dyadic* study, in which we recruited same-race or different-race dyads and measured their autonomic nervous system (ANS) reactivity while working together. This paradigm allowed us to examine questions regarding physiological synchrony—the coordinated physiological responses between dyads, typically referred to as *physiological covariation*. Importantly, we manipulated cognitive resource depletion *prior* to the interaction, to examine the counterintuitive idea that depleting resources might increase the genuineness of the interaction by preventing meta-monitoring.

Conducting a dyad study in which one hopes to measure physiological synchrony poses several challenges. First, to obtain temporal precision, one must coordinate physiological collection from the dyad exactly, either with time stamps or integrating the signals from the two participants into the same collection unit. Because ANS changes can occur within seconds of an experienced emotional state, one needs precise recordings of when changes are occurring from each member of the dyad. Additionally, some of the measurements we use, such as impedance cardiography and skin conductance, employ an external current. If measurement devices with external currents are used on both participants and the members of the dyad touch each other, the signal will be lost due to electrical interference.

We used this signal loss to our advantage in the dyad study; one of the tasks we developed was described as an "American sign language task," which required participants to touch each other's hands. By measuring the amount of electrical noise in the physiological signal, we were able to measure precisely how often and for how long, to the millisecond, these strangers touched. While this meant that we did not have all of the ANS responses during the task, we viewed this as a worthwhile trade-off for obtaining a precise measure of touch time.

The papers reporting these results are currently in progress, so I will only briefly outline some of the results reported in Koslov's (2010) dissertation. Consistent with our prediction that cognitive depletion would increase amiability in cross-race dyads, we found that Black and White partners in the control condition touched hands less than those in the depletion condition. In addition, Blacks' race-based rejection sensitivity moderated this effect: The higher they were in race-based rejection sensitivity, the less they touched the hands of White evaluators in the control conditions; this effect was reversed in the depletion condition, where we observed more touching among those higher in race-based rejection sensitivity.

With regard to physiological covariation in general, we found that White participants paired with other White participants showed strong physiological

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covariation—White participants' pre-ejection period (PEP) responses were highly correlated with their partner's PEP responses. For cross-race dyads, however, we observed non-significant covariation in the control condition; but in the depletion condition, Black and White dyads showed similar covariation to White dyads.

As physiological measurements become more commonplace and affordable, and as more researchers learn to incorporate these measures, dyadic- and group-level processes will be ripe for experimental paradigms. Additionally, I think these types of data are well suited for sophisticated dyadic analyses like those developed by Kenny, West, and their colleagues (Kenny, Kashy, & Cook, 2006; West, in press) that can isolate actor and observer effects. There are many critical intergroup theories that could benefit from these measurements, and I look forward to seeing other labs develop these paradigms.

Conclusions

Applying neurobiological measures to understand intergroup relations is not new, but we are entering an exciting era: Costs for the measures are decreasing, better technology will allow for smaller and more accurate devices, ambulatory measures are affordable, and psychophysiological theory continues to advance. Diving headfirst into using neurobiological measures will not be without frustration, energy, and financial costs, and like any study, there is no guarantee that your results will be consistent with your hypotheses or yield anything of value. Indeed, the unwieldiness of psychophysiological responses might make it more difficult to find effects than with other measures. That stated, psychophysiological measurements may advance social psychology, and intergroup relations in particular, given that individuals are often unwilling or unable to express their true beliefs.

Note

1 It should be noted that the validity of using psychophysiological responses to detect lies remains controversial, and in 2003, a National Academy of Sciences of the United States of America panel concluded that the use of these techniques to identify people who may show deception in the future was without merit. Additionally, the panel noted that there was support for using these measures when paired with a context like the *guilty knowledge task*.

Suggestions for Further Reading

Blascovich, J., Mendes, W. B., Vanman, E., & Dickerson, S. S. (2011). *Social psychophysiology for social and personality psychology*. Affective Science Series. London, UK: Sage.

This book was specifically written as a "how-to" guide for those new to psychophysiology. The scope is limited to ANS measures, EMG, and cortisol, and provides a basic vocabulary to allow researchers to build on.

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

This is the quintessential guide to psychophysiological measurement and covers theory, principles, physiology, and measurement issues. The handbook is in its 3rd edition as of this writing, but is updated approximately every decade.

Major, B., Mendes, W. B., & Dovidio, J. (in press). Intergroup relations and health disparities: A social psychological perspective. *Health Psychology*.

A comprehensive review paper examining how social psychological theories may inform health researchers interested in understanding health disparities.

Mendes, W. B. (2009). Assessing the autonomic nervous system. In E. Harmon-Jones and J. S. Beer (Eds.), *Methods in social neuroscience* (pp. 118–147). New York: Guilford Press.

A chapter dedicated solely to the use and interpretation of the autonomic nervous system responses.

Mendes, W. B., & Jamieson, J. (2012). Embodied stereotype threat: Exploring brain and body mechanisms underlying performance impairments. In M. Inzlicht & T. Schmader (Eds.), *Stereotype threat: Theory, process, and application* (pp. 51–68). New York: Oxford University Press.

A chapter examining neurobiological responses as possible mediators to stereotype threat effects.

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