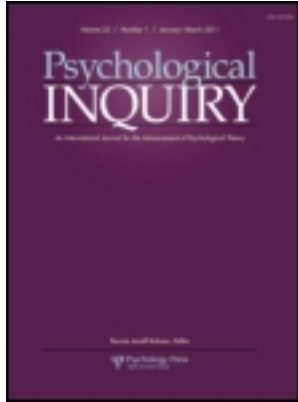


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Moderated Disanxiousuncertlibrium: Specifying the Moderating and Neuroaffective Determinants of Violation-Compensation Effects

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REPLY

Moderated Disanxiousuncertlibrium: Specifying the Moderating and Neuroaffective Determinants of Violation-Compensation Effects

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The concluding section of our target article was titled “Let’s Start Talking,” and it pointed to the reason we submitted our manuscript to *Psychological Inquiry*—an opportunity to present an idea, and have commentators from different disciplines representing different theoretical commitments present related perspectives on a related phenomenon. The idea we have is this: We are all discussing a related phenomenon, one that spans fields and research disciplines but that is seldom acknowledged as such. Since our first iteration of the meaning maintenance model (MMM), we have argued that the dissonance and disequilibrium and anxiety and uncertainty that derive from various cognitive conflicts lies at the core of a common literature—a “violation-compensation” account that is not bounded by a given theory or department or research methodology. In truth, this discussion began with the first generalist accounts that spanned psychological literatures (Festinger, 1957; Piaget, 1937/1954) and has been reiterated by recent accounts that situate this phenomenon in meaning (e.g., Peterson, 1999) and posit specified neurocognitive accounts of compensatory behaviors, often in this very journal (McGregor, 2006; Van den Bos, 2009a). With this current version of the MMM, we have embarked on an additional step of integrating these accounts with psychophysiological accounts, with additional modes of compensatory behavior, and with research literatures that lie outside of social psychology.

After reading the thoughtful commentaries of those who were gracious enough to join this discussion, we are struck by the diversity of research perspectives represented. Theoretical perspectives spanning existential social psychology (Galinsky, Whitson, Huang & Rucker, this issue; Routledge & Vess, this issue), cognitive psychology (Gawronski, this issue) cognitive and affective neuroscience (Harmon-Jones & Harmon Jones, this issue; Hirsh, this issue; Moser & Schroder,

this issue), psychophysiology (Major & Townsend, this issue), positive psychology (Steger, this issue), and the clinical literature (Davis & Novoa, this issue) converge on some or other understanding of meaning, which we take to be the fulcrum of these research programs. Many of the perspectives expressed in these commentaries also adopt a generalist perspective on violation-compensation phenomena. For example, Hirsh (this issue) offers an account of these behaviors that is similarly grounded in meaning, and the neuroaffective correlates of meaning-violating experiences. Gawronski (this issue) construes many of these behaviors as deriving from cognitive conflicts, and Moser and Schroder (this issue) specify the neurocognitive systems involved in the detection of these conflicts. Harmon-Jones and Harmon Jones (this issue) further specify these systems, along with behaviors aimed at addressing the experience of conflict. Major and Townsend (this issue) outline the unique cardiovascular responses to experiences that violate our understanding of the world, and Davis and Novoa (this issue) address the longer term consequences of meaning loss. Steger (this issue) places this literature in the broader perspective of meaning in life and existential growth. Although all of these commentators discuss the difficulties and limitations of our own generalist account, both Galinsky et al. (this issue) and Routledge and Vess (this issue) are skeptical that any common psychological phenomena underlies the violation-compensation literature. Both commentaries highlight the role of moderators differentially shaping various effects, with Routledge and Vess, in particular, arguing that these differences imply a distinct and unique psychological account for morality-related defenses.

In what follows, we address many of the specific comments and criticism offered by these insightful commentaries. Along the way, we elaborate a point

that we may have not made sufficiently clear in the target article, pertaining to the relationship between the MMM and the violation-compensation literature as a whole. Contrary to the interpretation offered by some of our commentators, the MMM is not being put forward as a perspective to replace or supplant other theoretical perspectives. Rather, our aim is to focus research efforts on unlocking what it is that we believe many of these content-specific perspectives represent—clusters of moderators that follow from the specific meaning framework that is under threat, and the different goals and beliefs that are represented by these understandings. Although violations of meaning frameworks relevant to control, belongingness, justice, and personal persistence may bottleneck at a general system of arousal and compensation, how these processes manifest—and which processes manifest—are no doubt tied to the crucial moderators that follow from the respective content of the violated framework (also see Van den Bos, 2009b) and that are captured by several generative, content-specific perspectives. Nevertheless, we do not take the presence of these moderators as evidence for distinct psychological processes. Rather, we understand *moderated dis-anxiousuncertlibrium* as the core construct underlying violation-compensation effects.

A Brief History of Science (and the MMM)

Moving Past “Phlogiston”

A rock does not fall in the same way as a paper plane. Neither fall in the same way a feather—especially if it is a windy day. Lightning strikes and magnetic attraction appear nothing alike, and rusting metal seems entirely unrelated to a burning match. Nevertheless, scientific thinkers in the 18th and 19th centuries began to posit general forces underlying these observations, despite their surface dissimilarities. No doubt there are those who rolled their eyes when Newton suggested that “gravity” was a singular force that was responsible for pulling any object—eventually—to the ground. It also seems likely that Lavoisier was derided for his suggestion that all experiments with chemical reactions were just that—experiments of *chemical reactions*, which implied a common phenomenon that could be explained by a common scientific account. Nevertheless, we now understand these clusters of seemingly different phenomena as manifestations of underlying forces, and although our understanding of these proposed forces will continue to evolve—or be discarded altogether—there can be little doubt that understanding these phenomena in terms of common causes has dramatically increased our ability to explain and predict phenomena by means of the scientific method.

As we discuss in the target article, historian of science Thomas Kuhn (1962/1996) outlined this common history of scientific endeavor. It begins with researchers exploring a single phenomena—be it burning coal or rusting iron. In attempting to explain these phenomena, theories are generated that constitute little more than descriptions of the event—the causal antecedents and the subsequent effects. Later, other scientists (often working from different fields) observe these different phenomena with their respective scientific accounts and begin to wonder whether some causal substrate is responsible for the seemingly different effects. For example, perhaps it is the case that coal burns and iron rusts because they both contain a common substance—*phlogiston*—that is lost over the course of burning or rusting. Perhaps it is the case that burning and rusting are merely different means of an object losing phlogiston—after all, objects weigh much less after they have been burned or rusted away; to the extent that burning or rusting can appear as distinct processes, this may be due to the additionally distinct qualities of coal and iron, which differentially impact how phlogiston loss will differentially manifest. Insofar as this “phlogiston theory” can offer an explanation for many different phenomena—an account of anything that burns or rusts—it can be understood as a *paradigm* that focuses and facilitates future research efforts.

Yet, even as research efforts are facilitated by these paradigmatic accounts, Kuhn hesitated to call their adoption as an example of scientific progress, to the extent that they often turn out to be wrong—or, at least, inadequate at accounting for all future observations. In the face of mounting anomalies, paradigms can be amended only so far: As it turns out, magnesium actually gets heavier when it burns, as do oxidized metals; these and other observations consigned phlogiston theory to the dustbin of history. What replaced phlogiston theory was an understanding of how *oxygen* interacts with these different substances, where oxygen is—noncoincidentally—exactly the kind of distinct, identifiable, and measurable substance that phlogiston never was.

Moving Past “Brain Phlogiston”

With our initial iteration of the MMM (Heine, Proulx, & Vohs, 2006), we attempted a first step in this transition relevant to social psychology—surveying dozens of the hundreds of studies that demonstrate a heightened commitment to beliefs and goals after other beliefs and goals have been violated. Most of these beliefs and goals can be categorized into content clusters, often following from various basic needs or desires for control (e.g., Kay, Whitson, Gaucher, & Galinsky, 2009), belongingness (e.g., Williams & Nida, 2011) self-esteem (e.g., Tesser, 2000), justice (e.g., Jost,

Banaji, & Nosek, 2004), or immortality (e.g., Pyszczynski, Greenberg, & Solomon, 1999). Many of these clusters continue to be understood in terms of theories that are generally bounded by the content of what is violated and affirmed, where people compensate for a lack of control, feelings of rejection, perceived inequality, or the awareness of our unavoidable demise. At times, adherents of one or other these perspectives have argued that one or other cluster of effects can best be explained in terms a single need, such that efforts to reduce behavioral dissonance can be best understood in terms of maintaining one's self-image (Steele & Liu, 1983), that efforts to maintain one's self-image can be best understood as efforts to maintain one's self-esteem (Tesser, 2000), or that self-esteem can be best understood in terms of symbolic immortality (Pyszczynski, Greenberg, Solomon, Arndt, & Schimel, 2004; along with the rest of the "worldview defense" literature; Schimel, Hayes, Williams, & Jahrig, 2007).

However, from our perspective, these analogous experiments pointed to an even deeper causal substrate—one that spans the clusters of beliefs and goals that were violated and affirmed. We did not come to this conclusion by claiming that the presence of convergent effects *necessarily* implies a common cause (as suggested by Routledge & Vess, this issue), rather, we came to this conclusion by the same road that it is always arrived at—a route determined by parsimony and pragmatism. Approached in this spirit, we noted that all of these experiments involving the violation and affirmation of beliefs and goals were just that—experiments involving the violation and affirmation of beliefs and goals. Whatever was common across these beliefs and goals, it did not seem possible that it could involve some or other common content. Rather, what we understood to be common is the manner in which we represent these beliefs and goals—expected relationships. We are not the first to give this general notion a name: *meaning* (Baumeister, 1991).

This first iteration of the MMM could also be construed as a more broadly based *description* of what we took to be a general psychological phenomenon—fluid compensation following the violation of meaning frameworks—whatever goals or beliefs they happened to represent. This general construal gave rise to a central hypothesis of the MMM: If these analogous experiments are largely about *meaning* maintenance, then it should be possible for two violations to produce the same compensatory effort—even if one of these violations shares no content whatsoever with the other, or with the meaning framework that is subsequently affirmed. In demonstrating this convergent effect, we also provided the first support for our structuralist construal of meaning, insofar as the violated meaning framework was entirely tangential to the task that participants were engaged in, that is, it was irrelevant to activated goals. More generally, none of the meaning violations we

have reported are relevant to activated goals; as such, we believe that our structuralist account of meaning maintenance is a better fit for our data and offers a broader basis for understanding this phenomenon relative to pragmatic accounts (e.g., Hirsh, this issue).

As further support for our structuralist account of meaning maintenance, our subsequent empirical work explored the possibility that different meaning violations—conscious or unconscious, self-relevant or trivial—would heighten the capacity to identify task-unrelated patterns in the environment (Proulx & Heine, 2009). We termed this heightened motivation and capacity to determine simple structures *abstraction*, and the subsequent iteration of the MMM incorporated this compensatory effort into our descriptive taxonomy (Proulx & Heine, 2010). In later empirical work, we demonstrated that unrelated meaning violations, such as absurd art and mortality threats, increased a state need for simple structure (Proulx, Heine, & Vohs, 2010)—as had previously been demonstrated following violations of personal control (Whitson & Galinsky, 2008). We took these additional findings as further evidence that different violations are best understood in terms of expected associations, more generally, rather than as operating primarily in terms of a specified content, whether it involves human mortality, surreal images, or personal control (the latter account suggested by Galinsky et al., this issue).

Moreover, evidence that these violations bottleneck at a common arousal mechanism can be derived from a number of sources, including the "misattribution of the arousal" literature discussed in the target article: Compensation efforts following behavioral dissonance (Zanna & Cooper, 1974), visual anomalies (Proulx & Heine, 2008), and control violations (Kay, Moscovitch, & Laurin, 2010) are all extinguished if people are able to attribute their arousal to a placebo pill, or if they are told that a placebo pill will render them immune to arousal (Greenberg et al., 2003). More recently, Randles, Heine, and Santos (in press) demonstrated that compensatory affirmation following mortality reminders and surreal images was extinguished if participants received an actual pain pill. In general, it appears that all of these violations bottleneck at some form of aversive arousal, with violation–compensation perspectives throughout the field of psychology positing some mode of aversive arousal following the violation a given belief or goal. What, then, is this sensation, and is it the same mode of arousal following any given violation? Is disequilibrium (Piaget, 1937/1954) the same as behavioral dissonance (Festinger, 1957)? Is it the same as ideological dissonance (Jost, Pelham, Sheldon, & Sullivan, 2003)? What about its similarity to the "potential terror" that arises from a reminder of our own mortality (Pyszczynski et al., 1999)?

Until we are able to specify this arousal beyond a kind of "brain phlogiston," our literature will

be left without an answer to this (*the*) core question of the violation-compensation literature. Given the importance of this central determination, it is not surprising that several theoretical perspectives have focused on the neurocognitive, neuroaffective, and psychophysiological correlates of the violation-compensation literature—and it is also of little surprise that these complementary perspectives focus on the generalities of what is violated, rather than any specified content (e.g., “worldviews” rather than any given worldview; Major & Townsend, this issue), the common startle responses to violated expectations (Van den Bos et al., 2008), and the brain systems that respond to violations of beliefs (Tullett, Teper, & Inzlicht, 2011) or goals (Harmon-Jones, Amodio, & Harmon-Jones, 2009; McGregor, Nash, Mann & Phills, 2010). Rather than compete with these perspectives, we have attempted to integrate their accounts with this latest iteration of the MMM—one that we hope will provide further guideposts in specifying the nature of the arousal that is so often described in conjunction with violation-compensation effects.

Moderated Disanxiousuncertlibrium

However, none of this is to say that the current theories of the threat compensation literature will be washed away in a tide of generalist accounts, whether it is the MMM or complimentary perspectives following from reactive approach motivation (McGregor et al., 2010) or uncertainty reduction efforts (Van den Bos, 2009a). We are not, as stated by Routledge and Vess (this issue), attempting to “set the MMM at its proper place at the head of the theoretical table” (p. 378) or “reboot the field using the MMM” (p. 374) or “supplant other theories on the basis of a few studies” (p. 379). To the extent that this literature needs to be remapped, it should instead be done “From the contours of the phenomena” (Proulx & Inzlicht, this issue, p. 330), which follows from the hundreds of violation-compensation effects that constitute an entire literature. This mapping process is under way, and ongoing—consisting of two related efforts: (a) the careful mapping of neuroaffective and psychophysiological *disanxiousuncertlibrium* that appears in response to various violations, and (b) a systematic enumeration of the different *moderators* that likely determine the manner in which we respond to *disanxiousuncertlibrium*. Although we agree with Routledge and Vess (this issue) that the MMM is in no way required to engage in these efforts, we note that these efforts, by and large, have been carried out by proponents of generalist accounts (e.g., RAM or uncertainty management; McGregor et al., 2010; Van den Bos, 2009a) rather than content-specific theories like terror management theory (TMT). For example, it is remarkable that we—along with Routledge and

Vess (this issue) and Galinsky et al. (this issue)—were able to cite only a single example representing serious efforts to contrast and delineate two common violation-compensation manipulations (Shepherd, Kay, Landau, & Keefer, 2011)—and we note that this single example is framed as a direct response to the MMM.

Looking for Moderated Disanxiousuncertlibrium (or Not)

Some content-specific violation-compensation perspectives have made serious and repeated efforts to map these related phenomena. For example, Kay and his colleagues have explored the common psychophysiological mechanisms that appear to underlie compensatory control and other violation-compensation effects (Kay et al., 2010), and Kay has taken part in the unique work distinguishing the compensatory affirmation efforts that follow from control and mortality threats (Shepherd et al., 2011). TMT, however, has traditionally been less inclined to directly address the physiological responses to various mortality manipulations (cf. Tritt, Inzlicht, & Harmon-Jones, in press) and has avoided efforts to directly compare mortality manipulations with other violations that reliably demonstrate compensatory affirmation efforts (e.g., Greenberg, Kosloff, Solomon, Cohen, & Landau, as cited in Routledge & Vess, this issue). In their response, Routledge and Vess (this issue) state that TMT has never represented the belief that only mortality concerns underlie compensatory affirmation efforts. Nevertheless, some TMT theorists have argued that mortality concerns do underlie “worldview defense” behaviors, more generally (Schimel et al., 2007), along with other common psychological needs, such as self-esteem (Pyszczynski et al., 2004). As characterized by Routledge and Vess (this issue), TMT is a much more circumscribed perspective, where compensatory affirmation following from mortality reminders is exclusively motivated by the discrepancy between our awareness of mortality and our desire for immortality. In truth, this sounds very much like the generalist accounts that offer a pragmatic (Hirsh, this issue) or goal-relevant (RAM model; McGregor et al., 2010) understanding of compensatory affirmation behaviors—including those that follow from mortality reminders.

Whether a given TMT theorist understands mortality concerns as underlying all worldview affirmation efforts, or only those that follow directly from a mortality salience prime, either stance may have motivated a systematic effort to demonstrate the convergent or divergent psychological reactions to mortality reminders and other violations. However, after 25 years and hundreds of experimental manipulations, research following from TMT has made no systematic

effort to extend their research into the psychophysiological or neurocognitive literature. Instead, TMT has moved toward theoretical positions that explicitly preclude the appearance of physiological arousal following from mortality reminders—positing a “dual process” defense model (Pyszczynski et al., 1999) that maintains the presence of proximal psychological defenses that prevent the appearance of any measurable arousal. From this iteration of TMT, “potential terror” is the core explanatory construct understood to underlie compensatory affirmation following a mortality reminder, rather than a concrete, measurable causal intermediary (see Tritt et al., in press). With this current iteration of the MMM, we explicitly reject this mode of scientific theorizing, one that we believe has not added a great deal to our understanding of violation-compensation phenomena, especially those effects that are typically the purview of TMT. More recently, work has addressed the neurocognitive responses to morality reminders, which appear to involve the amygdala and the anterior cingulate cortex (ACC; Quirin et al., 2012). To our knowledge, this is the first and only study of its kind, and we hope that it represents a novel interest on the part of TMT researchers concerning the physiological consequences of mortality reminders and other reliable violation-compensation effects.

Disanxiousuncertlibrium

The Brain Implantation of Meaning Violations: The ACC and Beyond

Much of our own discussion of the neurocognitive underpinning of meaning threat centered on the ACC. We focused on this structure because there is now an abundance of evidence linking it to uncertainty (Hirsh & Inzlicht, 2008; Ridderinkhof, Ulsperger, Crone, & Nieuwenhuis, 2004), surprise (Egner, 2011), and expectancy-violation (Alexander & Brown, 2011; Holroyd & Coles, 2002; Moser & Schroder, this issue; Moser & Simons, 2009), which are precisely the psychological states produced by meaning violations. However, because of the vast interconnections between different brain areas and because of the connections between brain and body, it would be a gross simplification to conclude that the ACC plays some privileged role in implementing meaning violations. As we have suggested in the past (e.g., Inzlicht, Tullett, & Good, 2011; Proulx, Inzlicht, & Harmon-Jones, 2012; Tritt et al., in press), the ACC is no “meaning-violation-spot.” On the contrary, the ACC is only one small node of a threat network that becomes activated by violations of meaning. Hirsh (Hirsh, this issue; Hirsh, Mar, & Peterson, 2012) rightly highlights the important role played by the behavioral inhibition system

and the locus-coeruleus norepinephrine system, and both Hirsh (this issue) and Moser and Schroder (this issue) make mention of the related orienting reflex. All of these systems are interrelated and all are involved in meaning violations to one degree or another.

According to Gray (1982; Gray & McNaughton, 2000), the behavioral inhibition system (BIS) contributes to the neuropsychology of anxiety and forms the basis of a general anxiety network in the brain. Although revised reinforcement sensitivity theory (Gray & McNaughton, 2000) suggests that BIS is primarily activated by goal conflict, it also lumps things like novelty and uncertainty into this broad category, justifying the theoretical connection between meaning threat and BIS. Further, because we have suggested that meaning violations evoke some type aversive arousal, most likely anxiety, BIS should play some role.

BIS contributes to feelings of anxiety and may be experienced phenomenologically as worry, caution, and vigilance (Carver & White, 1994). Anxiolytic drugs like Valium, Xanax, or Diazepam act on the neural substrate of BIS, most notably the septo-hippocampal comparator system. These antianxiety agents do this by impairing control of the hippocampal theta rhythm (rhythmical firing of cells at 6–10 Hz), which is the principle response of the septo-hippocampal system to arousal (McNaughton & Gray, 2000). The hippocampal theta response typically accompanies behavioral indicators of anxiety, such as the slowing or cessation of goal-directed behavior. The ACC shares a number of features with Gray’s subcortical network and so appears like the cortical extension of the BIS (Gray & McNaughton, 2000; Hirsh et al., 2012). The point here is that states of uncertainty—which in theory includes the kinds of uncertain mind states generated by meaning violations (Hirsh et al., 2012)—evoke vigilant and anxious states of arousal and therefore likely implicate subcortical and cortical substrates of BIS.

Meaning violations are also likely to include the orienting response (Hirsh et al., 2012; Sokolov, 2002; Vinogradova, 2001). This response or reflex serves as an anomaly detector, helping to draw an organism’s attention to unexpected sensory events, with the characteristic behavioral expression being a rapid shift of attention toward the unexpected stimulus. The orienting reflex, like BIS, is an expression of a septo-hippocampal comparator system that compares neural signals stemming from representations of the environment with incoming sensory information (Brackbill, 1971; Vinogradova, 2001). When people’s expectations are violated, the orienting response not only increases vigilance and attention but also causes a chain of affective reactions including an increase in heart rate (Fowles, 1980) and the release of cortisol into the bloodstream (Gray, 1987), which serves to quickly recruit attention upon the unexpected event.

Finally, meaning violations likely implicate the operation of the locus coeruleus-norepinephrine system (Hirsh et al., 2012). Norepinephrine is a catecholamine neurotransmitter that is associated with attention but also with alerting, sensory arousal, and anxious distress (Aston-Jones, Chiang, & Alexinsky, 1991; Panksepp, 1998). For example, single-cell recording studies suggest that norepinephrine neurons in the locus coeruleus are sensitive to emotional stressors (Abercrombie & Jacobs, 1987), and pharmacological studies confirm this by indicating that emotional stress causes a marked increase in norepinephrine release in several brain regions (Tanaka, Yoshida, Emoto, & Ishii, 2000). Critically, norepinephrine is related to both the coactivation of competing response tendencies (Warren, Tanaka, & Holroyd, 2011) and to ACC-mediated error processing (Riba, Rodriguez-Fornells, Morte, Munte, & Barbanoj, 2005), lending credence to the idea that norepinephrine is also involved in violations of meaning.

Are Meaning Violations Aversive?

Although we particularly appreciate the erudite comments made by Moser and Schroder (this issue), and largely agree with their perspective, there are a few points of disagreement that we would like to discuss. In particular, Moser and Schroder question whether meaning violations are actually aversive and further question whether emotional concepts are needed to understand them. Specifically, Moser and Schroder discuss the case of positive expectancy violations—when people expect something negative but experience something positive—and question whether this type of meaning violation could be characterized by aversive arousal. For example, if a student expects to do poorly on a test item, yet performs well (e.g., Oliveira, McDonald, & Goodman, 2007; Plaks & Stecher, 2007), would this student be unsettled by such a turn of events? Similarly, if an individual from a minority group expects to be treated with discrimination yet experiences fair and unbiased treatment (Mendes, Major, McCoy, & Blascovich, 2008), would this individual be bothered by such treatment?

On the face of it, positive expectancy violations should not be aversive at all, but rather pleasant. After all, having experiences that are better than expected evoke phasic increases in dopamine (Schultz, 2002), which is a rewarding neurotransmitter. Nonetheless, these types of expectancy violations *are* aversive, at least in the short term. When students experience an unexpected improvement in their academic performance, they report feeling anxious about it (Plaks & Stetcher, 2007). When individuals expect bias yet receive unbiased treatment, they react physiologically as if they are in a threatened motivated state (Mendes et al., 2008). And we think this makes perfect sense. A surprise, even a positive one, is aversive, at least temporarily. In one

clever study (Noordewier & Breugelmanns, 2011; also see Noordewier & Breugelmanns, 2012), participants were asked to taste food items that looked remarkably like bite-size morsels of cheese, but in reality they were tasting a piece of marzipan that was shaped to look like cheese. Despite these participants being preselected for their love of marzipan, when they expected to eat cheese but instead tasted marzipan they quickly and very briefly made a face of disgust. Although this facial expression lasted only a fraction of a second and was soon followed by a more positive facial expression, the aversive facial expression was present nonetheless.

Moser and Schroder (this issue) rightly note that the ACC codes for expectancy violation (Alexander & Brown, 2011), thereby shifting ACC function to one that codes for surprise but not necessarily valence. However, the ACC is also linked to negative affect and the distress of pain (Shackman et al., 2011). For example, the ACC is involved in anxiety, depression, and trait negative affect (Drevets, Price, Simpson, & Todd, 1997; Hajcak, McDonald, & Simons, 2004; Moser, Moran, & Jendrusina, 2012). It is also associated with the sympathetic modulation of heart rate (Critchley et al., 2003), skin conductance (Hajcak, McDonald, & Simons, 2003), autonomic control of pupil diameter (Critchley, Tang, Glaser, Butterworth, & Dolan, 2005), levels of basal cortisol (Tops & Boksem, 2011), pain (Rainville, Duncan, Price, Carrier, & Bushnell, 1997), and distress (Eisenberger & Lieberman, 2004; Hajcak & Foti, 2008). In sum, although the ACC may code for surprise, we cannot help but wonder if it does so because of the ACC's more broad involvement in aversive affective states.

Can the MMM Inform Cognitive Neuroscience?

A key component of the MMM is that violations of meaning lead to a whole host of compensatory behaviors—the Five “A”s of meaning maintenance. Moser and Schroder (this issue) discuss one form of compensatory behavior, namely, posterror adjustments. They note that errors and posterror behavior are well suited for the MMM because errors often reflect expectancy violation and, in theory at least, elicit neural and behavioral responses that may reflect compensatory efforts. When people make errors on choice reaction time task, they typically show some form of behavioral adjustment, typically slowing down so as to improve accuracy on subsequent trials (Rabbitt, 1966). It is interesting that despite being widely predicted, the relationship between ACC-implemented performance monitoring—which may reflect aversive affect more than cognition (Hajcak & Foti, 2008; Inzlicht & Al-Khindi, in press)—and posterror adjustments is not consistently found (Hajcak et al., 2003; Tops & Boksem, 2011). That is, error-related distress (Bartholow

et al., 2005) is not often followed by posterror behavioral corrections. How can this be?

Although the MMM has been greatly informed by cognitive and affective neuroscience, here is a case where we think neuroscience can be informed by the MMM. Perhaps ACC-related performance monitoring is not consistently followed by behavioral correction because behavioral correction is merely one of a whole host of compensatory behaviors available. In a sense, one can think of posterror adjustments as a kind of accommodative behavior: When people make errors, one way they can react is to update their mental schemas of what they have done and what they ought to do and then behave in accordance with their new mental map. This form of accommodation would contribute to improved performance after errors. However, people can resolve their error-related distress through other means—they could deny that they have made an error (assimilation) and go on with business as usual; they could trivialize their error and focus on other, more flattering aspects of their lives (affirmation). Or they could become energized by their error-related distress to form new connection elsewhere (abstraction) or create new things altogether (assembly). The point here is that accommodation in the form of behavioral correction is only one way people can deal with their distress. And perhaps the reason that cognitive neuroscientists inconsistently find and report connections between ACC-based measures and behavioral adjustment is that participants find other ways to effectively diffuse their energies. This, of course, is speculative but worthy of future pursuit.

Moderators

Moderators Are Not Distinct Mechanisms

As noted by Hirsh, any “periodic table” of meaning maintenance will require a specified understanding of the underlying structure. Much of this structure involves the neurocognitive and sympathetic nervous system arousal that follows from meaning violations and that precedes meaning maintenance efforts. As noted by Galinsky and Whitson (this issue), not all arousal follows from expectancy violations, and these alternative modes of arousal may also lead to enhanced vigilance and increased learning (Simonov, Frolov, Evtushenko, & Sviridov, 1977). As noted by Harmon-Jones and Harmon-Jones (this issue), numerous event-related potential waveforms are associated with different types of cognitive inconsistency—the manner in which each is associated with compensatory behaviors has yet to be specified. At least as important as understanding any arousal that is uniquely implicated in violation-compensation behaviors will be an understanding of the factors that determine how this arousal manifests in terms of compensatory behaviors.

Or put more succinctly: What are the moderators of meaning-maintenance behaviors? As both Galinsky et al. (this issue) and Routledge and Vess (this issue) discuss, not all compensatory behaviors that follow from reliable violations are expressed in parallel. To a large extent, individual difference (e.g., personal need for structure; Landau, Greenberg, Solomon, Pyszczynski, & Martens, 2006) and content moderators (e.g., relevance of the affirmed meaning framework to violated framework; e.g., Shephard et al., 2010) determine which compensatory behavior an individual is likely to engage in following a given meaning violation.

However, in contrast to these commentators, we do not take the presence of moderators as evidence for multiple mechanisms—in this or any other science. To borrow from Hirsh (this issue), the vastly different chemical reactions associated with different elements does not speak against the core concept of atomic mass, any more than scores on a personal need for structure measure (Neuberg & Newsom, 1993) differentially moderating compensatory affirmation speak against the core concept of expectancy-violating arousal. We also note that if every moderator spawned a different theoretical account, this would have implications for every current theory in social psychology, not just the MMM. (If PNS moderates responses to mortality primes in some instances but not others, why is this framed as an objection to MMM, but not TMT?; Routledge & Vess, this issue.)

In the concluding portion of the target article, we outlined a variety of factors that either do or likely will form the basis for distinctions within what we take to be a general meaning maintenance phenomenon. For the most part, this section consists of factors that moderate the impact of meaning violations and the expression of subsequent compensatory behaviors. Rather than reenumerate these factors, we would like to emphasize those additional moderators proposed by our commentators, where any of these proposals would provide the basis for important, targeted research efforts. On the whole, these moderators pertain to the crucial question of which compensation effort will follow from a given meaning violation based on the content of the framework that is violated, or whether an experienced lack of meaning is due to a meaning violation, or the absence of meaning at the outset.

Proposed Moderators

Many of our commentators address the former factor by making a distinction between proximal and distal compensation processes (e.g., Galinsky, et al., this issue; Steger, this issue). Although all of these compensation efforts may serve a palliative function immediately following a violation, many of these efforts will be relatively less effective as palliatives in the longer term, and may hinder effective action in the wake of the

violation (Harmon-Jones & Harmon-Jones, this issue) or in the months and years to come (Davis & Novoa, this issue). In the shorter term, anxiety following a given meaning violation is often adaptive, providing a vital cue to anomalies in our environment that could be resolved by means of compensatory accommodation (Hirsh, this issue). As we note in the target article, efforts at addressing a meaning violation are preferred over efforts to affirm unrelated meaning frameworks (e.g., Tullett et al., 2011). For example, students will be more likely to claim that they are in favor of a tuition increase after they have been induced to argue in favor of increased tuition—presumably, they prefer compensatory accommodation of their beliefs to temporarily resolve the attitude/behavior conflict, even if it means altering what they believed before the induced conflict (and, presumably, what they continue to believe after they have left the “cognitive dissonance” lab). Similarly, Routledge and Vess (this issue) provide examples of atheists affirming religious beliefs they do not hold if these beliefs temporarily resolve the question of human mortality. And as cited by Galinsky et al. (this issue), people have a general preference for affirmation behaviors that address a source of behavioral dissonance, rather than those which affirm unrelated values (Stone, Wiegand, Cooper, & Aronson, 1997).

Nevertheless, even efforts to resolve meaning violations by means of accommodation appear to be extinguished if people are given the opportunity to misattribute aversive arousal (e.g., Zanna & Cooper, 1974), which suggests that accommodation serves a proximally palliative function, in addition to distally palliative or adaptive functions. As well, people will often engage in unrelated meaning affirmation efforts that can provide little more than a proximal palliative, where the absence of resolution means that the source of the conflict may arise again in the future (Harmon-Jones & Harmon-Jones, this issue; Hirsh, this issue). This may be especially the case for personally traumatic events, where the meaning frameworks that are violated may be central to ongoing adaptive function. Unresolved violations relevant to self-esteem, or to the assumptions that allow us to trust others, may have a catastrophic impact on how we conduct our lives. Although this additional impact of trauma may lead to ongoing anxieties, it may often be the proximal pain of facing these traumas that directs us toward palliative compensation efforts that avoid acknowledging the event (e.g., affirmation) rather than resolving the initial crisis (accommodation). Nevertheless, it could also be argued that these unrelated affirmation efforts provide other adaptive benefits, or benefit society as a whole (Davis & Novoa, this issue). This may especially be the case when compensatory efforts involve creative assembly that could proactively buffer us against future meaning violations (Steger, this issue).

Many of the moderators proposed by our commentators were framed in terms of concrete, testable hypotheses that we hope will provide the basis for future experimental work. For example, both Gawronski (this issue) and Harmon-Jones and Harmon Jones (this issue) suggest that the mode of compensation people engage in may be directed by the pragmatic impetus of the situation—specifically, in situations where addressing a meaning violation is essential for effective immediate action, people will be more likely to resolve the violation through compensatory accommodation than engage in generally palliative compensation efforts, such as the affirmation, abstraction, or assembly of unrelated meaning frameworks. Another potential moderator, suggested by both Gawronski (this issue) and Major and Townsend (this issue) bears on whether the meaning violation is nevertheless desirable, or whether the violated framework is one we would prefer to believe. One potential outcome, suggested by Major and Townsend (this issue), is that the violation of negative meaning frameworks would be more likely to evoke a compensatory accommodation of these undesirable propositions, or the assembly of novel meaning frameworks. Conversely, the violation of positive meaning frameworks would evoke compensation efforts that allow us to maintain what we would prefer to believe, such as assimilation, or the abstraction of unrelated meaning.

Finally, both Major and Townsend (this issue) and Gawronski (this issue) raise a situational distinction which is not often addressed in the violation-compensation literature: Do we respond differently to experiences that violate meaning, and situations that represent an absence of meaning? Put differently, there may be a difference between expectancy violations and situations where we do not know what to expect. Gawronski (this issue) notes that assimilation and accommodation strategies are possible only in situations where an existing meaning framework has been violated. However, in situations where meaning is initially absent, we should be more likely to fill this void by affirming alternative meaning, or abstracting and assembling novel understandings.

Conclusion

In the opening of their commentary, Major and Townsend suggest that, ultimately, our reach may exceed our grasp. Our response to this charge is simple: We wholeheartedly agree. The violation-compensation literature is still developing. Psychology, more generally, is a very young science. The available data fall short of our paradigmatic claims. However, we take notice of this shortcoming as a positive assessment—the reach of any useful paradigm should exceed its grasp,

insofar as the hypotheses that follow from the paradigm move beyond the description of existing phenomena. The central hypotheses of the MMM are just that, *hypotheses*, and the theory that underlies our perspective strives to be more than a mere *description* of a given cluster of violation-compensation behaviors. This means that we are not afraid to be wrong—at crucial junctures of this account, we are offering falsifiable hypotheses about the core mechanisms that we believe are underlying violation-compensation effects. In this current iteration of the MMM, these mechanisms are understood to follow from clearly identified brain structures and modes of physiological arousal. Will it turn out that these structures are implicated in every effect unearthed by every perspective within the broader violation-compensation literature? Almost certainly not. However, by testing these paradigmatic assumptions, we will learn far more, far faster, than if we assume these effects are best explained by nebulous constructs underlying an endlessly metastasizing series of microtheories.

This may be especially true within social psychology, which is a field that typically emphasizes effects over broad theoretical accounts. To the extent that theoretical innovation is directly emphasized, this is often construed as the development of a “new” theory rather than the discovery of incremental evidence that falsifies or supports an existing theory. Overall, we feel that much of this field is characterized by two unfortunate traits: an ongoing and pointed lack of curiosity concerning the common neurocognitive and psychophysiological substrates of these effects, and the identification of moderators as the justification for novel theoretical labels. As we have suggested elsewhere (Proulx, 2012; Proulx et al., 2012), these factors have combined to produce a scientific field that runs somewhat in reverse, generating an increasing number of labels for an increasing number of descriptions of increasing numbers of analogous effects. If one were especially cynical, they might randomly combine (a) something people want (e.g., control, belongingness, self-esteem), (b) an aversive arousal following the loss of what they want (e.g., anxiety, uncertainty, terror), (c) efforts to restore what has been lost or deal with the aversive arousal (e.g., compensate, defend, manage, reduce), and (d) stick “model” or “theory” at the end—thereby generating a variety of “new” violation-compensation accounts in social psychology (or duplicating the names of many of our current theories). Ultimately, we suggest that *moderated disanxiousuncertlibrium* would account for most of the effects described by any such model(s). In the coming years, we expect that more of these effects will be best understood by increasingly integrated generalist accounts, rather than an increasing array of analogous descriptions.

Note

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