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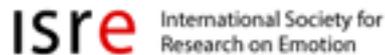
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Emotion and Motivation: Toward Consensus Definitions and a Common Research Purpose

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Abstract

Historically, the hypothesis driving emotion research has been that emotion's data-base—in language, physiology, and behavior—is organized around specific mental states, as reflected in evaluative language. It is suggested that this approach has not greatly advanced a natural science of emotion and that the developing motivational model of emotion defines a better path: emotion is an evolved trait founded on motivational neural circuitry shared by mammalian species, primitively prompting heightened perceptual processing and reflex mobilization for action to appetitive or threatening survival cues. As the field moves forward with increasingly sophisticated measurement technology and assessing more complex affective functioning, scientific understanding of human emotion will proceed best within the framework of this mammalian brain model.

Keywords

emotion theory, motivation, threat and reward, William James

Frijda and Scherer (2009) open a recent discussion of emotion's definition by stating that "The term 'emotion' may be one of the fuzziest concepts in all of the sciences" (p. 142) and suggest a variety of reasons for the absence of a clear consensus, e.g., emotions are complex; lay people and scientists use the term in a "loose and inconsistent fashion"; the cacophony of different scholarly disciplines that have historically addressed the subject. Indeed, definitions and theories abound as a diverse affective science community appraises the problem from myriad perspectives.

The essayists participating in this symposium are asked to reflect on the future of emotion theory and research: "Where is the field going? Where should we go?" Assuming past behavior best predicts the future, the answer to the first question is, at least for the near term, that the field may well continue in the same fashion, with a proliferation of theories and many unrelated paths of experimentation. Considering the "should" question, it is suggested that real progress will depend on achieving a consensus definition, a shared conception that illuminates a common path forward for research.

The advancement of science depends on developing a degree of shared purpose within its community. One scientist

must be able to see what another sees, procedures must be replicated and the same results achieved. Ideally, each confirmed experimental finding is like a building brick. If the brick fits with other bricks in a larger design, the scientific collective can use it to build a firm structure of explanation. Nothing gets built, however, if the bricks are all shaped differently and lie as scattered about as "the rocks on a New Hampshire farm" (James, 1890, p. 448).

Of course, much depends on agreeing to a basic design and a place to build, and no Newton/Einstein has yet appeared to give emotion science an accepted comprehensive plan. Nevertheless, we can collectively prepare the way if a few foundation bricks (at the risk of overworking the metaphor) are agreed upon. What follows is very much my own view of these matters, but a perspective that might highlight a few useful concepts (and some missteps to avoid) that could move us toward the elusive consensual agreement.

What Are the Data of Emotion?

Scientists and laity agree (at least when the former are not on the job) that emotions are inner feelings—the experience of

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states of fear, anger, shame, etc. This definition reflects a shared folk psychology that has been institutionalized, for example, in jurisprudence (e.g., murder committed in a righteous rage may be considered a lesser crime than one performed with cool intent). The inner landscape of *will*, *intent*, and *feeling*, however, is completely private and opaque to scientific inquiry. The data of emotion that scientists can actually measure is traditionally threefold (e.g., Lang, 1988): (1) the language of emotion (expressive and evaluative); (2) reflexive physiological changes (somatic and autonomic); and (3) behavior (e.g., approach and avoidance, “freezing”, and performance deficits/enhancements). That these measurables are determined by inner feeling states is an assumption of everyman, but millennia of philosophical analysis as well as more recent scientific efforts prompt only a Scottish verdict—unproven.

William James famously tried to break through the subjective barrier, proposing that the conscious experience of emotional states was a self-perception of behavior and bodily changes (James, 1894), unleashing a century of research designed to test the hypothesis. I commented extensively on this effort in the Centennial Issue of the *Psychological Review* (Lang, 1994) and will only reiterate here that the consciousness/perception hypothesis is not testable simply because there is no objective measure of conscious feelings. Furthermore, despite the century of research, the default, objective hypothesis that evaluative reports of specific emotions co-vary with specific physiologies has not found convincing support.¹ Thus, we suggest that researchers would be wise to seek alternative organizational themes to guide future experimentation and to interpret emotion’s data.

Emotion and the Brain: Evolution and the Animal Model

Except for cries and calls and facial signs, language as an elaborated communicative and reflective tool is absent in species other than the human. Nevertheless, many mammals respond similarly in behavior and physiology to humans when in pain, under threat of predation, or when anticipating or receiving rewards—all situations that prompt people to report emotional feelings. These parallels have encouraged researchers to study other mammalian species in these contexts, in the expectation that such experimental work will provide an animal model that increases understanding of human emotion. A Darwinian conception underlies such studies: expressed emotion in humans is viewed as an evolved faculty that reflects the behavior of more primitive species: responses that occurred in contexts of threat or appetite have been retained because they promoted survival of individuals and their progeny.

Survival depends on actions that, on the one hand, facilitate gaining life-sustaining nutrients, obtaining sexual partners, nurturing offspring, and, on the other hand, defending the organism from predators and other dangers. It is in this evolutionary sense that human emotions are considered “action dispositions” (see Frijda, 2007)—reactions built on an inherited reflex base that originally served to perpetuate the lives of our mammalian

ancestors. Fear, for example, can be considered a disposition to flee, with the avator reflex mobilization of muscle and internal organs as part of the human reaction, even though an overt act itself may not occur.

From this perspective, it is assumed that the brain circuits mediating the human reflex physiology of emotion are old in evolutionary history, primarily located deep in the cortex and subcortex, and that the relevant structures and connections are likely common to all highly evolved mammalian species. It is theoretically interesting to also consider here that these circuits are essentially motivational: using Hebb’s (1949) definition of motivation, it is this circuitry that mediates both the *direction* and *vigor* of behavior in achieving survival’s goals. That is, motivation’s *directional* aspect is reflected in overlapping sub-circuits, one defensive, perhaps associated with reports of unpleasant affect, and the other appetitive, associated with pleasant affect—both varying in the *vigor* (intensity/arousal) of their activation.

Konorski (1967) early conceived such a motivational typology, keyed to the survival role of the body’s many unconditioned reflexes. These exteroceptive reflexes were *preservative* (e.g., ingestion, copulation, nurture of progeny) or *protective* (e.g., withdrawal from or rejection of noxious agents). He further suggested that affective states were consistent with a preservative/protective organization: *preservative* emotions include such affects as sexual passion, joy, and nurturance; fear and anger are *protective* affects. Dickinson and Dearing (1979) developed Konorski’s distinction, renaming the two motivational systems *aversive* and *attractive*. Each mediating a different, but equally wide range, of unconditioned stimuli that determined perceptual-motor patterns and the course of learning.

In this general view, activation of the appetitive (preservative/attractive) system is associated with positive affect; activation of the defense (protective/aversive) system prompts reports of negative affect. Both systems can vary in the “intensity” of motivational mobilization, determined originally by survival need and the imminence and probability of nociception or of appetitive reward. In this regard, it is pertinent that factor analyses of emotional/evaluative language (Osgood, Suci, & Tannenbaum, 1957; see also, Bradley & Lang, 1994; Russell & Feldman Barrett, 1999; Russell & Mehrabian, 1977;) have consistently found two main factors accounting for the most variance among affect descriptors: what can be seen as survival motivation’s *directional* aspect, i.e., hedonic valence (positive/pleasant/appetitive vs. negative/aversive/defensive), and *vigor*, i.e., emotional arousal (intensity of activation). Thus, it would appear that, despite the plethora of different emotion words, the underlying structure of affective language is relatively simple, and furthermore, that it is coordinate with the dual motive-circuit brain model that posits appetitive and defensive neural circuits that vary in the intensity/*vigor* of their activation.

Neurophysiology: Motivation and Emotion

At the time William James articulated his theory regarding the conscious experience of emotion, very little was known about

the functioning of the human brain. Over the course of the 20th century and into the 21st, however, our understanding of neural mechanisms underlying motivated behavior has expanded greatly. This increase in knowledge has been mainly predicated on animal research in which neurosurgical, pharmacological, and electrophysiological tools have been employed to determine, with remarkable precision, which neural structures and connections are critical to overt behavior and the activation of muscles and glands.

In the past few decades, a consensus has developed among investigators (e.g., Amaral, Price, Pitkanen, & Carmichael, 1992; Davis, 2000; Fanselow, 1994; Kapp et al., 1990; LeDoux, Iwata, Cicchetti, & Reis, 1988) that a small almond-shaped neural structure buried in the anterior temporal lobe of the brain is a central structure in a circuit mediating survival-motivated behavior, both appetitive and defensive. That is, the basolateral amygdala receives sensory and memorial input from the cortex, thalamus, and hippocampus. When this input signals an imminent or possible threat—or reward—the central nucleus of the amygdala projects to and selectively activates neural target sites, for example, lateral hypothalamus which connects in turn to the autonomic nervous system (modulating heart, blood pressure, endocrine and other glandular activity); a pontine center prompting potentiated startle: the central grey and striatum that variously initiate “freezing” or active approach or escape; the sensory cortices (visual, auditory, etc.), increasing attentive and perceptual processing.

The Mammalian Brain Model in Human Research

For over 20 years, this animal model of the motivated brain has been the main guide for research in our laboratory. The overarching aim was and is to determine if affective provocations—the emotional events and stimulus media characteristic of human culture—prompt similar reflex reactions found in animal subjects when under threat or anticipating reward. Our laboratory’s studies are not the only program of research that has pursued this goal, of course, but they are the most familiar to this writer. Hoping the reader will be stimulated to look at the wider literature, I use them here to illustrate how these evolutionary and motivational brain-based concepts might direct future work and provide a firm platform for new discovery.

When initially contemplating this research program, a major first task was to develop standardized sets of emotional stimuli that were ecologically appropriate, i.e., stimuli that would prompt the great range of affective reactions reflected in human culture and yet could be readily replicated in other laboratories. Considering our motivational model, stimuli were not organized according to any list of specific emotions—already shown to relate poorly to emotion’s psychophysiology—rather, evaluative reports were based on the main factor analytic categories found consistently in studies of emotional language—hedonic valence (pleasant/unpleasant) and emotional arousal (Bradley & Lang, 1994; Lang, 1980). Our first effort was the International Affective Picture System (IAPS: Lang, Bradley, & Cuthbert,

2008), which currently includes over a thousand photographs covering a Cartesian space defined by ratings of pleasure and arousal, standardized on hundreds of participant evaluators. Subsequently, with National Institute of Mental Health support, we have expanded the available standardized media to non-linguistic sounds (IADS: Bradley & Lang, 1999b), single words (ANEW: Bradley & Lang, 1999a), and descriptive sentences (ANET: Bradley & Lang, 2007a).

Armed with these stimulus materials, we proceeded to measure reflex reactions, autonomic and somatic, during perceptual processing by healthy human participants. The assumption here was that a human being looking at an evocative picture is behaviorally similar to an animal—prey or predator—who is observing possible threats or rewards that appear in the distance. That is, the species-common reaction is to stop, look, and listen (e.g., orienting, enhanced vigilance, and information gathering) and, depending on the imminence and intensity of the cue (degree of danger; potential for or magnitude of reward), to mobilize the body for appetitive (charge and capture) or defensive (fight or flight) action (see, e.g., Löw, Lang, Smith, & Bradley, 2008).

The dependent variables studied in our research were the same as those used in animal experimentation to index significant brain structures and circuits evoked in the threat/reward context and are critical to reflex activation, including autonomic mediated cardiovascular and glandular changes and somatic muscle reactions that mediate initial orienting and attention and prepare the organism for action.

The research assessing these emotion measures with human participants has been reviewed comprehensively (Bradley & Lang, 2007b; Davis & Lang, 2003; Lang & Bradley, in press; Lang & Davis, 2006), and my comments here are brief. In the context of emotional perception (e.g., pictures and sounds), distinct autonomic and somatic reflex responses are observed, paralleling those found when animal subjects confront cues associated with threat or appetite; moreover, these measures are strongly related to standard ratings of hedonic valence and emotional arousal. Thus, for example, it has repeatedly been shown that unpleasant pictures prompt reflexive facial action (corrugator “frown” muscle). When a sudden loud noise is presented during viewing unpleasant—but not pleasant—pictures, the startle reflex is potentiated, as found for threatened animals (Davis, 2000). Viewing either pleasant or unpleasant pictures activates the autonomic system, prompting sweat gland increases and a widening of the pupil (Bradley, Miccoli, Escrig, & Lang, 2008) and both of these covary with standard arousal ratings. Unpleasant arousing pictures occasion strong heart rate deceleration, similar to the “fear bradycardia” found in prey animals orienting to a predator at a distance (Campbell, Wood, & McBride, 1997).

Brain-imaging research has shown that these emotional media (pictures, sounds, etc.) engage the same mediating neural structures (e.g., amygdala, striatum, sensory cortices) in humans that are activated in other mammals by survival cues. For example, the neural substrate of motivated orienting—enhanced attention to and vigilance for threat and reward—depends in non-human primates on re-entrant neural projections from the amygdala to sites in the visual cortex (Amaral et al., 1992).

Using functional magnetic resonance imaging (fMRI) to study humans, we found that activation of the amygdala and of the ventral object-recognition region of the visual system (inferior temporal cortex) are highly correlated during picture viewing, and that activation increases in both neural structures as pleasant and unpleasant images are rated as more arousing (Sabatinelli, Bradley, Fitzsimmons, & Lang, 2005). Consistent with this amygdalofugal hypothesis, the initiating amygdala activation temporally precedes that of the visual system (Sabatinelli, Lang, Costa, Bradley, & Keil, 2009). Interestingly, this motive circuit activation also shows expected individual differences, as participants viewing pictures of snakes who report high fear show coordinate increased activation in both structures—not found in non-fearful participants. Furthermore, it is already clear that reading or hearing language descriptions of emotional events prompts a reflex physiology that parallels that observed for perceived emotion cues (Cuthbert et al., 2003; McTeague et al., 2009, 2010), and activation of the same motivational neural circuitry when processing emotional pictures or texts (Costa, Lang, Sabatinelli, Bradley, & Versace, in press; Sabatinelli, Lang, Bradley, & Flaisch, 2006).²

A Natural Science of Emotion

It was proposed at the outset that a science of emotion has three objective data streams— affective language, emotional behavior, and a reflex physiology—all observable events available to scientific scrutiny. It was noted that in human folk culture these responses are presumed to reflect an integrating state of mind, an experience of emotion, conscious, or somehow the same but unconscious, that can sometimes be tapped by verbal report. It is proposed here that as a scientific hypothesis or research theme, this view is not heuristic. It has failed to find significant experimental support despite more than a century of scientific study. Thus, the mammalian brain model, developed using studies of animal subjects and now providing human data at an accelerating pace, may more usefully serve a more modern integrating role. Although the effort to make scientific sense of emotion may continue to be difficult, its aims need not be “fuzzy”. Furthermore, this neuroscience model is certainly no less universal than the theme of mental states: the ubiquity of reported emotions and the centrality of emotion in our lives exist because of emotion’s firm evolutionary base in the brain of every human being.

It is proposed that as we proceed to build a more coherent basic science of emotion (and thus a more effective translational base for addressing practical social and clinical needs), we build from a brain-based blueprint. In this effort we will be following of course a moving target—as new genetic, anatomical, and neurochemical findings emerge. Unlike our stable understanding of human mental experience, unchanged at least since Descartes, Kant, and Spinoza, understanding of the emotional brain is very much a work in progress. Nevertheless, I have tried to show that there are already useful bricks that could support what could be the foundation of an objective emotion science structure. Thus, we might be able to agree that emotions reflect the activation of fundamental motivational circuits

in the brain founded broadly on survival goals—appetitive and life-sustaining; defensive and protective. We might also be able to agree that emotional language, expression, and reported affects show a factorial organization that is consistent with a biphasic motivational structure, appetitive/pleasant and defensive/unpleasant, both of which vary in their vigor or arousal.

LeDoux (1996) has wisely said that it is not necessary to understand consciousness in order to productively study emotion. To this I would add a further caution—that it is misleading to assume we know what consciousness is, or that our introspective grasp of this small part of the formidable quantity of information processing going on continuously in the brain is a guide to understanding the whole. There will be, of course, greater complexities to surmount as research increasingly addresses the higher intellectual functions of humans. There are signs, nevertheless, that we could already be moving toward a general consensus on emotion’s motivational foundation. I suggest—considering both its constraints and powerful heuristics—that this brain-based model, clearly grounded on animal research and focused on a motivational base, is the surest current guide for the future of emotion science.

Notes

- 1 Correlations between evaluative reports of specific emotions and physiological measures have seldom accounted for more than 9% of experimental variance. Such reports are, of course, either retrospective or constitute a dual-task situation for the participant (serving both as experiencer and observer). These distancing features of the introspective method, as well as individual differences in the interpretation of emotion labels, all contribute to the unreliability of the obtained data. Interestingly, *expressive* emotional language, analogous to screams and cries in non-human animals seems to yield better covariation, e.g., in an early study, Mandler, Mandler, Kremen, & Sholiton (1961) found correlations as high as .75, but only for spontaneous, expressive emotional language (e.g., “That’s horrible!”) and autonomic reactivity.
- 2 Human neural imaging methods increasingly permit researchers to directly assess leads uncovered in animal research in studies of human participants. However, it is important to keep in mind also that these tools (fMRI; positron emission tomography (PET); high-density electroencephalography (EEG)) are still blunt instruments when compared to the refined technologies that can be employed in animal research. Thus, for example, we can grossly image the region of the amygdala or the nucleus accumbens, but functional imaging cannot yet discriminate the many individual nuclei within these structures or determine their connections, which the neuroscience research suggests function importantly in determining different valence and arousal-related output patterns. In effect, translating many important animal findings to the human depends on major further advances in imaging and related technologies.

References

- Amaral, D. G., Price, J. L., Pitkanen, A., & Carmichael, S. T. (1992). Anatomical organization of the primate amygdaloid complex. In J. P. Aggleton (Ed.), *The amygdala: Neurobiological aspects of emotion, memory and mental dysfunction*. New York: John Wiley & Sons, Inc, pp. 1–66.
- Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: SAM and the semantic differential. *Journal of Experimental Psychiatry & Behavior Therapy*, 25, 49–59.
- Bradley, M. M., & Lang, P. J. (1999a). *Affective norms for English words (ANEW): Stimuli, instruction manual and affective ratings*. Technical

- Report C-1, Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.
- Bradley, M. M., & Lang, P. J. (1999b). *International affective digitized sounds (IADS): Stimuli, instruction manual and affective ratings*. Technical Report No. B-2. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.
- Bradley, M. M., & Lang, P. J. (2007a). *Affective norms for English text (ANET): Affective ratings of text and instruction manual*. Technical Report No. D-1. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.
- Bradley, M. M., & Lang, P. J. (2007b). Emotion and motivation. In J. T. Cacioppo, L. G. Tassinary & G. Berntson (Eds.), *Handbook of psychophysiology* (3rd ed., pp. 581–607). New York: Cambridge University Press.
- Bradley, M. M., Miccoli, L., Escrig, M. A., & Lang, P. J. (2008). The pupil as a measure of emotional arousal and autonomic activation. *Psychophysiology*, *45*, 602–607.
- Campbell, B. A., Wood, G., & McBride, T. (1997). Origins of orienting and defense responses: An evolutionary perspective. In P. J. Lang, R. F. Simmons & M. T. Balaban (Eds.), *Attention and orienting: Sensory and motivational processes* (pp. 41–67). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Costa, V. D., Lang, P. J., Sabatinelli, D., Bradley, M. M., & Versace, F. (in press). Emotional imagery: Assessing pleasure and arousal in the brain's reward circuitry. *Human Brain Mapping*.
- Cuthbert, B. N., Lang, P. J., Strauss, C., Drobles, D., Patrick, C., & Bradley, M. M. (2003). The psychophysiology of anxiety disorder: Fear memory imagery. *Psychophysiology*, *40*, 407–422.
- Davis, M. (2000). The role of the amygdala in conditioned and unconditioned fear and anxiety. In J. P. Aggleton (Ed.), *The amygdala* (Vol. 2, pp. 213–287). Oxford: Oxford University Press.
- Davis, M., & Lang, P. J. (2003). Emotion. In M. Gallagher & R. J. Nelson (Eds.), *Handbook of psychology, Vol. 3: Biological psychology* (pp. 405–439). New York: Wiley.
- Dickinson, A., & Dearing, F. (1979). Appetitive-aversive interactions between appetitive and aversive stimuli. *Psychological Bulletin*, *84*, 690–711.
- Fanselow, M. S. (1994). Neural organization of the defensive behavior system responsible for fear. *Psychonomic Bulletin & Review*, *1*, 429–438.
- Frijda, N. H. (2007). *The laws of emotion*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Frijda, N. H., & Scherer, K. R. (2009). Emotion definitions (psychological perspectives). In D. Sander & K. R. Scherer (Eds.), *Oxford companion to emotion and the affective sciences*. New York: Oxford University Press.
- Hebb, D. O. (1949). *The organization of behavior: A neuropsychological theory*. New York: Wiley.
- James, W. (1890). *The principles of psychology* (Vols. 1 & 2). New York: Holt.
- James, W. (1894). The physical bases of emotion. *Psychological Review*, *101*, 205–210.
- Kapp, B. S., Wilson, A., Pascoe, J. P., Supple, W. F., & Whalen, P. J. (1990). A neuroanatomical systems analysis of conditioned bradycardia in the rabbit. In M. Gabriel & J. Moore (Eds.), *Neurocomputation and learning: Foundations of adaptive networks* (pp. 55–90). New York: Bradford Books.
- Konorski, J. (1967). Some new ideas concerning the physiological mechanisms of perception. *Acta Biologicae Experimentalis*, *27*, 147–161.
- Lang, P. J. (1980). Behavioral treatment and bio-behavioral assessment: Computer applications. In J. B. Sidowski, J. H. Johnson & T. A. Williams (Eds.), *Technology in mental health care delivery systems* (pp. 119–137). Norwood, NJ: Ablex Publishing.
- Lang, P. J. (1988). What are the data of emotion? In V. Hamilton, G. H. Bower & N. Frijda (Eds.), *Cognitive perspectives on emotion and motivation*. Amsterdam: Martinus Nijhoff Publishers.
- Lang, P. J. (1994). The varieties of emotional experience: A meditation on James–Lange theory. *Psychological Review*, *101*, 211–221.
- Lang, P. J., & Bradley, M. M. (in press). Emotion and the motivational brain. *Biological Psychology*.
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual*. Technical Report A-8. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.
- Lang, P. J., & Davis, M. (2006). Emotion, motivation, and the brain: Reflex foundations in animal and human research. *Progress in Brain Research*, *156*, 3–29.
- LeDoux, J. (1996). *The emotional brain*. New York: Simon & Schuster.
- LeDoux, J. E., Iwata, J., Cicchetti, P., & Reis, D. J. (1988) Different projections of the central amygdalaoid nucleus mediate autonomic and behavioral correlates of conditioned fear. *Journal of Neuroscience*, *8*, 2517–2529.
- Löw, A., Lang, P. J., Smith, J. C., & Bradley, M. M. (2008). Both predator and prey: Emotional arousal in threat and reward. *Psychological Science*, *19*, 865–873.
- Mandler, G., Mandler, J. M., Kremen, I., & Sholiton, R. (1961). The response to threat: Relations among verbal and physiological indices. *Psychological Monographs*, *75*, Whole No. 513.
- McTeague, L. M., Lang, P. J., Laplante, M.-C., Cuthbert, B. N., Shumen, J. R., & Bradley, M. M. (2010). Aversive imagery in PTSD: trauma recurrence, comorbidity, and physiological reactivity. *Biological Psychiatry*, *67*, 346–356.
- McTeague, L. M., Lang, P. J., Laplante, M.-C., Cuthbert, B. N., Strauss, C. C., & Bradley, M. M. (2009). Fearful imagery in social phobia: Generalization, comorbidity, and physiological reactivity. *Biological Psychiatry*, *65*, 378–382.
- Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning*. Chicago: University of Illinois Press.
- Russell, J. A., & Feldman Barrett, L. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology*, *76*, 805–819.
- Russell, J. A., & Mehrabian, A. (1977). Evidence for a three-factor theory of emotions. *Journal of Research in Personality*, *11*, 273–294.
- Sabatinelli, D., Bradley, M. M., Fitzsimmons, J. R., & Lang, P. J. (2005). Parallel amygdala and inferotemporal activation reflect emotional intensity and fear relevance. *NeuroImage*, *24*, 1265–1270.
- Sabatinelli, D., Lang, P. J., Bradley, M. M., & Flaisch, T. (2006). The neural basis of narrative imagery: Emotion and action. *Progress in Brain Research*, *156*, 97–106.
- Sabatinelli, D., Lang, P. J., Costa, V. D., Bradley, M. M., & Keil, A. (2009). The timing of emotional discrimination in human amygdala and ventral visual cortex. *Journal of Neuroscience*, *29*, 14864–14868.