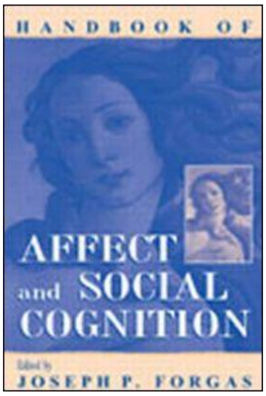

Handbook of Affect and Social Cognition

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Affect and Attitudes: A Social Neuroscience Approach

Publication details
https://www.routledgehandbooks.com/doi/10.4324/9781410606181.ch3
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Published online on: 01 Nov 2000

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Affect and Attitudes: A Social Neuroscience Approach

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Evaluative and affective reactions are a ubiquitous and important aspect of everyday experience. At the extreme end, they aid in survival by helping to determine which stimuli and environments should be avoided, and which

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should be approached. Even seemingly more mundane reactions, such as the pleasure experienced watching a puppy at play or the displeasure felt at the occurrence of an injustice, are important, because they infuse our lives with meaning. Affect can also have important influences on and be influenced by cognitive processes. For example, affective and emotional experiences may themselves arise from cognitive processes (Frijda, 1986; Ortony, Clore, & Collins, 1988; Scherer, 1984; Smith & Ellsworth, 1985), and cognitive processes such as decision making and memory are influenced by affective states (Forgas, 1995; Schwarz & Clore, 1983). Finally, affective states are also associated with a host of bodily changes that help meet current and expected metabolic demands (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000). A full understanding of the affect system therefore facilitates a more complete understanding of how we navigate in our social world.

In this chapter, we examine the affect system from a social neuroscience perspective. *Social neuroscience* refers to an integrative, multilevel analysis that extends from the neural to social level (Cacioppo & Berntson, 1992). Its goal is to broaden and stimulate research and theory through the application of findings at one level of analysis to inform, refine, and constrain inferences at another. This should not be interpreted as suggesting that research conducted within a single level of analysis is uninformative; nor are we implying that all research programs must span multiple levels of analysis. However, as we hope to illustrate in this chapter, we believe that insights can be gained through a consideration of findings and theories from other levels of analysis (see also Scherer, 1993). We focus in particular on two theoretical issues important to the study of affect and social cognition—the relation between positive and negative affect and the rerepresentation of evaluative mechanisms across different levels of the neuraxis.

WHY SOCIAL NEUROSCIENCE?

In addition to the possibility of new theoretical insights, a social neuroscience perspective is important in the context of current research emphasizing neural and genetic explanations. The growth of these disciplines appears to have encouraged reductionistic explanations by both scientists and the general public. People now talk about the "gene that causes" or the "gene for" depression, breast cancer, schizophrenia, homosexuality, and so on (for a discussion, see Anderson & Scott, 1999; Miller, 1996). Such discussions often imply that the identification of a genetic marker is equivalent to a complete understanding of the phenomenon. Genetic research is clearly informative, but phenotypic expression is influenced by both the genotype and the social environment (Gottleib, 1998). An overreliance on reductionistic approaches will likely obscure important information contained in other levels of analysis.

The potential benefits of a social neuroscience perspective are also suggested by the complexity of the phenomena that interest psychologists, such as affect and social cognition. Cacioppo and Berntson (1992) describe three specific organizing principles that address these complexities. The first is the principle of *multiple determinism,* which states that a target event at one level of analysis may have multiple antecedents within or across structural levels of organization. This suggests that a single affective response, such as a self-report that one feels happy, may have multiple antecedents both within and across such diverse levels as the immediate social context, the larger cultural context, the individual's personal history, and constraints of the relevant neurophysiological systems, to name just a few.

The second principle, that of *nonadditive determinism,* states that properties of the whole are not always predictable from properties of the individual parts until properties of the whole have been studied and understood across levels of organization. That is, a phenomenon may not be fully comprehensible until it is viewed across multiple levels of organization. The relation of positive and negative affect, as we illustrate in the next section, may represent an instance in which the order in the data is more clearly revealed when findings on subjective experience are combined with findings on the underlying neural mechanisms.

Finally, the principle of *reciprocal determinism* states that factors operating at different levels of analysis can mutually influence one another. Reciprocal determinism suggests, for example, that we should consider not only how the neurophysiological substrates of the affect system work to produce subjective experience, but also how prior experience and cognitive appraisals may influence specific neurophysiological mechanisms. Together, these three principles reinforce the importance of examining affect from multiple levels of organization.

THE SEPARABILITY OF POSITIVE AND NEGATIVE AFFECT

One of the more active areas of research on the affect system has concerned the structure of affective experience. Diener (1999) argues that this represents a fundamental question because its resolution has implications for such a wide range of issues, including the understanding of discrete emotions, personality, and cognition. At times, the discussion of the structure of affect has been viewed as a debate between psychologists who argue that affect is bipolar, and that positivity and negativity are reciprocally activated (e.g., Russell, 1979), and psychologists who argue that positivity and negativity are completely orthogonal factors (e.g., Diener & Emmons, 1985; Warr, Barter, & Brownbridge, 1983; Watson & Tellegen, 1985; Zevon & Tellegen, 1982). We believe that proponents on both sides of this debate are describing important but incomplete aspects of the affect system.

Any comprehensive theory of affect should be able to account for the large body of research showing that subjective affective experience and the language we use to describe our affective reactions can often be described by a single bipolar valence continuum, with high positive affect on one end and high negative affect on the other (e.g., Russell, 1979; Russell & Carroll, 1999; Russell & Feldman Barrett, 1999). In traditional bipolar models, positive and negative reactions are treated as operating in a reciprocal manner, such that increases in positivity are viewed as functionally equivalent to decreases in negativity, and vice versa. Most dimensional representations of subjective affective experience also include a second bipolar arousal or activation dimension, which refers to a subjective sense of mobilization or energy. Although researchers differ somewhat in the exact nature of the resulting valence×arousal circumplex (for reviews, see Larsen & Diener, 1992; Russell & Feldman Barrett, 1999), a bipolar valence dimension is common to all schemes.

At the same time, there is a large body of research suggesting that positive and negative affective reactions do not always operate in a reciprocal manner, and therefore can be separable. For example, reactions to political candidates reveal that disliking a candidate does not necessarily imply that the candidate is not also liked (Abelson, Kinder, Peters, & Fiske, 1982). Holbrook, Krosnick, Visser, Gardner, and Cacioppo (1999) analyzed cross-sectional (1972–1996) and longitudinal (1980–1996) National Election Study data. In both analyses, they found that the bipolar model (in which there is a single, linear valence dimension with positive and negative affect on opposite poles) did not provide a parsimonious account of voter sentiments or behavior. A study of undergraduate women's reactions to their dormitory roommates show similar results (Cacioppo, Gardner, & Berntson, 1997). Participants in this study rated how they felt toward their roommates using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), which provides separate self-report measures of positive and negative affective reactions. As with the reactions to political candidates, positivity and negativity elicited by the roommate were unrelated ($r = -.09$), suggesting stochastic independence. In addition, positivity and negativity appeared functionally independent; level of positivity but not negativity predicted the extent of friendship and amount of time spent with the roommate.

Separable motivational substrates have also been incorporated into a number of theories that deal with a range of affective and motivational issues. One example is work by Higgins and colleagues on regulatory focus, which suggests that behavior is guided by two motivational substrates labeled *promotion-focus* and *prevention-focus* (for a review, see Higgins, 1997). Chronic individual differences and situational fluctuations in these two motivations are thought to produce differences in sensitivity to positive and negative outcomes, with promotion-focus encouraging stronger approach than withdrawal motivations, and prevention-focus encouraging stronger withdrawal than approach motivations (Forster, Higgins, & Idson, 1998).

Separable positive and negative motivational substrates have also been observed or incorporated into explanations of phenomena as diverse as uplifts and hassles (Gannon, Vaux, Rhodes, & Luchetta, 1992; Zautra, Reich, & Gaurnaccia, 1990), self-knowledge (Showers, 1995; Showers & King, 1996), self-efficacy (Zautra, Hoffman, & Reich, 1997), personality processes (Costa & MacRae, 1980; Rusting & Larsen, 1998), achievement motivation (Elliot & Church, 1997; Elliot & Harackiewicz, 1996), organ donations (Cacioppo & Gardner, 1993), emotional expressivity (Gross & John, 1997), interpersonal relationships (Berry & Hansen, 1996), mood (Bradburn, 1969; Diener & Emmons, 1985; Goldstein & Strube, 1994; Warr, Barter, & Brownbridge, 1983; Watson & Tellegen, 1985; Zevon & Tellegen, 1982), and intergroup discrimination (Blanz, Mummendey, & Otten, 1997, Brewer, 1996; Katz & Hass, 1988).

The Evaluative Space Model

Cacioppo and colleagues (Cacioppo & Berntson, 1994; Cacioppo, Gardner, & Berntson, 1997) propose a general conceptual framework, termed the *evaluative space model* (ESM), within which to organize these divergent empirical findings. According to the ESM, a stimulus may simultaneously vary in terms of the strength of positive evaluative activation (i.e., positivity) and the strength of negative evaluative activation (i.e., negativity) it evokes. Thus, the activation of positivity and negativity at early stages of affective processing is conceptualized as potentially unfolding in parallel. The positive and negative activation functions are further conceived to be negatively accelerating functions with distinct coefficients, offsets, and exponents. Furthermore, although the consequences of positive and negative activation are generally antagonistic, a stimulus can evoke one of three modes of evaluative activation: (1) reciprocal activation, in which the same stimulus or environment has opposing effects on the activation of positivity and negativity; (2) uncoupled activation, in which the stimulus affects only positive or negative evaluative activation; and (3) coactivated or nonreciprocal activation, in which the same stimulus increases (or decreases) activation of both positivity and negativity. The three modes of activation are represented in the bivariate evaluative plane in Fig. 3.1.

Whereas the presence of two separate evaluative channels suggests an efficient system in which positive and negative information is simultaneously processed by the positive and negative motivational substrates, respectively, the affect system evolved to ultimately provide situation-appropriate behavioral guides. Although it is possible to physically vacillate between approach and withdrawal, bivalent action tendencies are both the most efficient and adaptive. For this reason, stimulus processing continues after registration on the bivariate evaluative plane (Fig. 3.1) to include integration

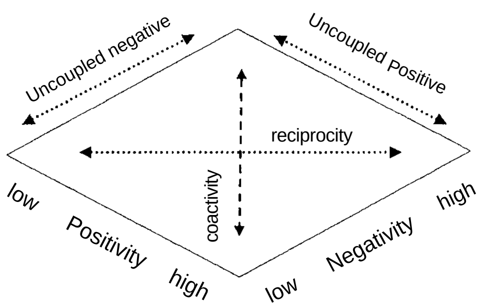

FIG. 3.1. The bivariate evaluative plane. The left axis represents the level of excitatory activation of positive evaluative processes (labeled "Positivity") and the right axis represents the level of excitatory negative evaluative processes (labeled "Negativity"). Along each axis, the level of activity increases with movement away from the front axis intersection. The dotted diagonal extending from the left to the right of the axis intersection depicts the diagonal of reciprocal control (labeled "Reciprocity"). The dashed diagonal extending from the back to the front axis intersection depicts the diagonal of nonrepirpocal control (labeled "Coactivity"). The arrows alongside the axes represent uncoupled changes in positive or negative evaluative processing. These diagonals and axes and vectors parallel to them illustrate major modes of evaluative activation. From "Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates," by J.T.Cacioppo & G.G.Berntson, 1994, *Psychological Bulletin, 115,* p. 402.

of the underlying evaluative substrates into a single net affective response or predisposition. Mapping of the underlying bivariate evaluative plane onto the associated net affective response surface is shown in Fig. 3.2. As noted previously, although positivity and negativity can be activated separately, they generally have antagonistic effects on response predispositions.

In addition to behavioral considerations, psychological factors also likely promote the integration of the two evaluative channels into a single, bipolar net affective response predisposition. When assigning psychological meaning, bipolar representations tend to be most stable and harmonious. For instance, the coactivation of positivity and negativity aroused by choosing between two equally desirable alternatives is often resolved

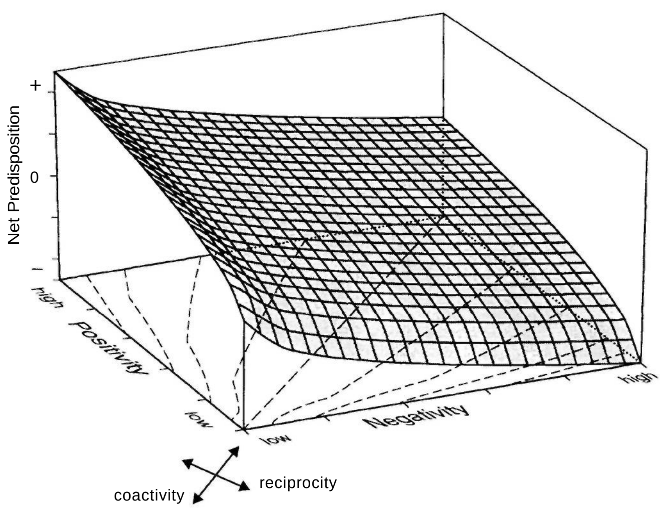

FIG. 3.2. The bivariate evaluative plane and its associated affective response surface. The surface represents the net affective predisposition of an individual toward (+) or away from (−) the target stimulus. Net predisposition is expressed in relative units. The point on the surface overlying the left axis intersection represents the maximally positive predisposition evoked by the target stimulus, and the point on the surface overlying the right axis intersection represents the maximally negative predisposition toward the target stimulus. The point on the surface overlying the left axis intersection represents the maximally positive disposition evoked by the target stimulus, and the point on the surface overlying the right axis intersection represents the maximally negative disposition toward the target stimulus. From "Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates," by J.T.Cacioppo & G.G.Berntson, 1994, *Psychological Bulletin, 115,* p. 412.

though an exaggeration of the positive features of the chosen alternative and of the negative features of the unchosen alternative (Brehm, 1956; Schultz, Leveille, & Lepper, 1999).

The bipolar nature of the net affective response surface may account for the large number of findings suggesting that affective experience is bipolar; measures of subjective affective experience typically sample the net affective response predisposition surface. However, it is important to note that the affective response surface in Fig. 3.2 represents a behavioral or psychological endpoint, and not necessarily the underlying affective process. The ESM highlights the importance of distinguishing behavioral and psychological endpoints from the bivariate evaluative mechanisms that give rise to such endpoints.

Neural Substrates

Although the ESM is a model of the psychological operation of the affect system, these psychological processes are nevertheless ultimately achieved through the operation of underlying neurophysiological mechanisms. Research on the neural mechanisms associated with affect and emotion may therefore prove informative to psychological theories of affect. A review of neurochemical and neuroanatomic research reveals that separable positive and negative motivational substrates observed at the psychological level are likely the result of separable underlying positive and negative evaluative substrates at the neural level (cf. Lang, Bradley, & Cuthbert, 1990).

An approach/reward system has been associated with mesolimbic dopamine pathways, which originate in the ventral tegmentum and project to the nucleus accumbens. Research supporting this conclusion indicates that (1) animals self-stimulate to this pathway in proportion to the density of dopamine receptors surrounding the simulating electrode tip, (2) dopamine metabolism is also increased after such stimulation, and (3) dopamine antagonists decrease self-stimulation (Fibiger & Phillips, 1988; Fiorini, Coury, Fibiger, & Phillips, 1993; Wise & Rompre, 1989). In addition, the rewarding properties of some addictive drugs, such as cocaine and amphetamines, have been explained via their action in this pathway (Fibiger & Phillips, 1988; Hoebel, Herndandex, Mark, & Pothos, 1992; Wise, 1996; Wise & Rompre, 1989). Available human data is also consistent with the rewarding properties of the dopamine pathway. Trait levels of positivity are related to functional activity in dopamine systems, such that higher trait positivity has been associated with greater dopamine agonist reactivity, as measured by decreased prolactin secretion (Depue, Luciana, Arbisi, Collins, & Leon, 1994).

Whereas a dopaminergic system is implicated in appetitive motivation, an amygdala substrate has been implicated in aversion. In animals, lesions to the amygdala attenuate reactions to conditioned aversive stimuli (Davis, 1992a, 1992b; Hitchcock & Davis, 1986; LeDoux, Cicchetti, Xagoraris, & Romanski, 1990), and stimulation of the amygdala produces punishment effects (Halgran, 1982). In humans, functional neuroimaging reveals activation of the amygdala during the presentation of negative stimuli (Irwin et al., 1996; Whalen et al., 1998). There is also evidence that bilateral damage to the amygdala selectively impairs the ability to recognize facial expressions of fear and decreases perceptions their intensity (Adolphs, Tranel, Damasio, & Damasio, 1994, 1995).

Central nervous system mechanisms associated with the affect system are no doubt complex, and their full explication will likely reveal the involvement of other structures and neurochemical systems. Nevertheless, the extant neurochemical and neuroanatomic research is consistent with the separability of positive and negative motivational substrates at the psychological level. In addition to complementing analyses at more psychological levels of the affect system, neurophysiological analyses also provide insights that are not always possible with self-report data. Whereas self-reported affective experiences are particularly useful in describing conscious, subjective experience, they may not be the best indicators of the process or operations of the affect system. Direct measurements of physiological processes associated with the operation of the affect system can provide important insights into processes not unambiguously revealed in self-report data.

Negativity Bias

The complementary nature of self-report and neurophysiological assessments is illustrated by research on the negativity bias. A greater sensitivity to negative than to comparably extreme positive information has been demonstrated in a range of situations, including impression formation (Anderson, 1965; Fiske, 1980; Skowronski & Carlston, 1989) and risk-taking (Kahneman & Tversky, 1984). What is unclear from this corpus of self-reported reactions is the stage at which the negativity bias is introduced. To the extent that the negativity bias is an inherent property of the underlying affect system itself, as opposed to some form of response bias, it should be present early in evaluative processing. In order to assess this, Ito, Larsen, Smith, and Cacioppo (1998) recorded event-related brain potentials (ERPs) as participants made evaluations of a range of stimuli. A particular potential of the ERP, the late-positive potential (LPP), is sensitive to evaluative categorization processes but is relatively insensitive to response output operations (Cacioppo, Crites, Berntson, & Coles, 1993; Cacioppo, Crites, Gardner, & Berntson, 1994; Crites, Cacioppo, Gardner, & Berntson, 1995). In particular, the size of the LPP increases in response to changes in evaluation. For example, a positive stimulus embedded within a context of negative items (evaluative inconsistency) produces a larger LPP than a negative item in a negative context (evaluative consistency). Evidence of the negativity bias in the ERP responses would therefore suggest that it is introduced early in evaluative processing.

ERPs were recorded as participants viewed positive, negative, and neutral pictures embedded within sequences of other neutral pictures. Consistent with prior research showing the LPP's sensitivity to evaluative categorization processes, stimuli that were evaluatively inconsistent with the more frequently presented neutral stimuli were associated with larger LPPs. That is, both positive and negative stimuli were associated with larger LPPs than were evaluatively consistent neutral stimuli. However, the evaluative categorization of negative stimuli was associated with a larger amplitude LPP than was the evaluative categorization of positive stimuli, even though both were equally probable, evaluatively extreme, and arousing. These results suggest that the negativity bias is introduced early in evaluative processing. They also demonstrate how physiological measures can be used to assess the operation of psychological processes that would not be easily revealed with more traditional self-report measures.

Summary

This review of the structure of the affect system suggests a flexible and functionally adaptive system. At the level of underlying evaluative substrates, the presence of two separate channels allows for efficient parallel processing of both relevant safety- and threat-related cues. The system also accommodates important behavioral and psychological considerations through the integration of the bivariate evaluative plane into a single net affective response predisposition (Fig. 3.2). We should note that the net affective response surface represents only one of the two instances of bipolarity in the ESM. Bipolarity may also occur at the level of the underlying bivariate evaluative plane in the form of the reciprocal mode of evaluative activation. The presence of separable motivational substrates is therefore not inconsistent with demonstrations of bipolarity. Bipolarity is obtained from sampling the net affective response predisposition surface and/or sampling an instance in which reciprocal activation is occurring.

The challenge before us, as we see it, is to better understand what determines the underlying mode of activation. Also important is understanding consistency motives that work to produce bipolar psychological endpoints and instances in which inconsistency is not resolved to a bipolar endpoint. Such a state corresponds to ambivalence, and there are instances in which coactivation of positivity and negativity are maintained rather that resolved to a bipolar framework (Abelson et al., 1982; Bell & Esses, 1997; Katz & Hass, 1988; MacDonald & Zanna, 1998; Priester& Petty, 1996; Thompson, Zanna, & Griffin, 1995). The three modes of evaluative activation also have implications for understanding interactions among affective and cognitive processes, reminding us that positive and negative affective states should not necessarily be expected to produce reciprocal effects on cognition; the separability of positive and negative affective substrates indicates that each may be associated with distinguishable effects on cognition. To the extent that positive and negative affect operate in either an uncoupled of nonreciprocal mode, the effects of positive and negative affect on cognition should not be expected to mirror one another.

REREPRESENTATION OF EVALUATIVE PROCESSES ACROSS THE NEURAXIS

Research reviewed in the previous section suggests that the affect system is composed of separable positive and negative evaluative substrates. In this section, we discuss research suggesting that these evaluative mechanisms are rerepresented at different levels of the neuraxis. Stated differently, the ability to perform positive and negative evaluative categorizations is distributed across all levels of neural organization, from the spinal cord to higher cortical functions. This implies that both evaluations of the same stimulus or event and interactions among evaluative and cognitive processes can unfold simultaneously at multiple levels of the neuraxis.

The greatest flexibility and variability in evaluative mechanisms is shown at the highest levels of the central nervous system. Nevertheless, elementary evaluative mechanisms are present in the spinal cord, as seen in simple approach-withdrawal reflexes in animals and humans with spinal cord injuries (Grill & Berridge, 1985; Steiner, 1979). Although reflexive responses at this level can be modified via conditioning (Grill & Berridge, 1985; Berridge, 1991), a wider range of behavior, decreased stimulus dependence, and greater contextual sensitivity in evaluative mechanisms is observed at higher levels of the neuraxis. To illustrate, an animal with a lesion separating the brain from the spinal cord may show limb withdrawal from an aversive stimulus, but an intact animal may also display global escape behavior, vocalizations, or aggression. In addition, the behaviors may persist long after the limb is removed from the noxious stimulus in the form of agitation or escape attempts (see review by Berntson, Boysen, & Cacioppo, 1993).

Berntson et al. (1993) note that this rerepresentation of evaluative mechanisms results in three important features. First, evaluative dispositions that arise from different levels of the neuraxis may be sensitive to only partially overlapping features of the environment. Thus, rather than representing an inefficient redundancy, the multiplicity of evaluative mechanisms produces a system in which lower-level processors are capable of responding to important classes of stimuli without intervention from higher-level functions. Whereas these low-level evaluative mechanisms may be relatively inflexible, they are efficient and place few burdens on higher-level processing operations. Pain processing provides an example of the efficiency of these lower-level mechanisms. In response to a painful stimulus, lowerlevel processing may predominate and produce a stereotyped yet efficient withdrawal of the limb. Involvement of higher levels of processing at this point is not necessary, and might serve only to delay the critical response.

A second important consequence of the rerepresentation of evaluative mechanisms is that evaluative processing at different levels of the neuraxis may influence different aspects of behavior. This suggests that different evaluative mechanisms may be best indexed by different types of measures. Returning to the example of pain perception, immediate limb response and later vocalizations are different behaviors that may derive from different evaluative mechanisms. In addition, these different aspects of behavior may be associated with differences in awareness of the source of an affective state. The relatively efficient and stereotypical processing of lower level evaluative mechanisms may allow them to operate largely outside of conscious awareness. Affective dispositions derived from lower evaluative mechanisms may therefore be consciously experienced, but their (true) source may not be appreciated (see also Gazzaniga & LeDoux, 1978; Nisbett & Wilson, 1977). Accurate awareness of the stimuli that elicit an affective reaction may be more likely with higher-level evaluative mechanisms.

Additional behavioral differences may also result through the use of diverging neural mechanisms at different neuraxial levels. This is seen in the control of facial musculature, where volitionally induced expressions are conveyed via the pyramidal tracts, whereas spontaneous emotional expressions use a separate, phylogenically older, extrapyramidal system (Rinn, 1984). Interesting behavioral dissociations are associated with damage to one but not the other pathway. Brain lesions that affect the extrapyramidal system compromise the ability to display spontaneous emotional facial responses but leave intact the ability to move facial muscles in response to verbal commands. Lesions to areas associated with the pyramidal tract can leave patients unable to voluntarily move the face on the side contralateral to the lesion. Contractions on this contralateral side will occur, however, in response to emotionally evocative stimulation (for a review, see Rinn, 1984).

The third implication of the rerepresented evaluative system is the potential for interactions among the mechanisms. Such interactions can be seen in an experiment in which evaluative preferences (attitudes) were created through classical conditioning (Cacioppo, Marshall-Goodell, Tassinary, & Petty, 1992). Familiar words and novel nonwords, matched for physical attributes and affective tone, served as stimuli. Electric shock was paired with either the words, nonwords, or with both words and nonwords. In a second block, the shocks were removed and participants rated their liking for all stimuli. A separate sample of participants received only a description of the experimental paradigm and were asked to predict their liking for the stimuli. These simulation participants predicted a simple conditioning effect in which stimuli that had been paired with shocks, whether they were words or nonwords, were disliked the most. By contrast, results from the main experiment revealed stronger conditioned negative reactions to non-words than words. These results suggest that the evaluative dispositions previously associated with the words, and likely represented at higher levels of the neuraxis, attenuated conditioning effects operating at lower levels of the neuraxis.

Biasing effects of higher evaluative processes can also be seen in affective startle eyeblink modification. The eyeblink is one of the most reliable components of the startle response, which occurs following the presentation of intense and, unexpected stimuli. Although the eyeblink is a relatively obligatory aspect of the startle response, the intensity of the reflex can nevertheless be modified by higher-level evaluative processing. In particular, the size of the eyeblink varies as a function of one's current affective state. Presentation of startle probes to participants as they view positive, negative, and neutral pictures reveals that negative states potentiate and positive states inhibit startle eyeblink relative to neutral states (Lang, Bradley, & Cuthbert, 1990, 1992; Lang, 1995).

Startle eyeblink modification following the presentation of hedonically toned stimuli has been explained by differential priming of the two motivational systems (Lang et al., 1990, 1992; Lang, 1995), which is thought to increase the likelihood and potential strength of responding of the activated system while simultaneously decreasing the likelihood and potential strength of responding for the nonengaged system. A negative stimulus that precedes a startle probe is therefore thought to activate the aversive system. The subsequent match between the already primed aversive system and the defensive startle reflex elicited by a startling stimulus results in potentiation of startle eyeblinks (reflex-affect match). By contrast, a positive affective foreground results in a mismatch between the valence of the affective foreground and the reflexive response, resulting in inhibition of startle eyeblinks (a reflex-affect mismatch).

Finally, although speculative, there are also implications of the rerepresentation of evaluative mechanisms for interactions between affect and cognition, suggesting that such interactions may occur at multiple levels of the neuraxis and with differing levels of awareness. Functionally, the multiple opportunities for affect and cognition to interact should maximally tune cognitive processes to the evaluative implications of the surrounding environment.

Feeling without Knowing

As we have noted, a theoretical implication of the multiplicity of evaluative mechanisms is that an individual may come to feel something without fully comprehending the source of those feelings. This was suggested in the conditioning experiment described above by the difference between expectations in the simulation experiment and actual results (Cacioppo et al., 1992). There have also been numerous other demonstrations of evaluative and affective processing outside of conscious awareness (e.g., Bargh, Chaiken, Govender, & Pratto, 1992; Fazio, Jackson, Dunton, & Williams, 1995; Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Murphy & Zajonc, 1993; Wittenbrink, Judd, & Park, 1997; for a review, see Bargh, 1996; Wegner & Bargh, 1998).

Automatic affective and evaluative effects suggest that lower-level evaluative mechanisms automatically process stimuli and environmental contexts, even when we do not have an explicit evaluation goal. Consistent with this hypothesis, we obtained ERP (event-related brain potential) evidence of implicit evaluative categorizations (Ito & Cacioppo, in press). Recall that the LPP (late positive potential) is sensitive to changes in evaluative categorization. This same potential is also sensitive to changes in nonevaluative categorizations, such as the pitch of an auditory stimulus (Donchin, 1981; Donchin & Coles, 1988). Categorically inconsistent stimuli, such as a high-pitched tone embedded within a series of low-pitched tones, elicit a larger LPP than categorically consistent ones.

In order to assess implicit evaluative categorization processes, Ito and Cacioppo (in press) recorded ERPs as participants viewed photographs of stimuli that simultaneously varied both in valence (i.e., an evaluative categorization) and along a people-animal/objects dimension (i.e., a nonevaluative categorization). All participants viewed the same stimuli, but half were instructed to perform an evaluative categorization task by classifying stimuli as positive or negative. The other half of the participants performed a nonevaluative categorization task by classifying stimuli as showing people or animals and objects. No explicit mention was made of differences along the non-task-relevant dimension (e.g., differences along the people-animal/objects dimension were not mentioned to participants performing the evaluative categorization task).

Prior results led us to predict variations in the size of the LPP as a function of both the *explicit* evaluative and nonevaluative classifications, which were obtained. Among participants performing evaluative classifications, evaluatively inconsistent stimuli (e.g., a positive picture embedded within negative pictures) produced larger LPPs than evaluatively consistent stimuli (e.g., a positive picture embedded within positive pictures). Similarly, among participants performing nonevaluative classifications, nonevaluatively inconsistent stimuli (e.g., a picture with a person embedded within animal/object pictures) produced larger LPPs than nonevaluatively consistent stimuli (e.g., a picture with a person embedded within people pictures). However, we also obtained evidence of *implicit* evaluative categorization. Among participants explicitly instructed to categorize the stimuli along the people-animal/object dimension, the LPP was nevertheless sensitive to changes along the evaluative dimension.[1] These results suggest that lower-level evaluative mechanisms automatically

[1] There was also evidence of implicit nonevaluative categorization, such that the LPP was sensitive to variations in the people-animal/object dimension even among participants who were explicitly categorizing along the evaluative dimension

process the environment in terms of its affective significance, even when higher-order processing goals are directing attention to other stimulus features. The implicit evaluative categorization even revealed evidence of a negativity bias, such that negative stimuli spontaneously received greater processing resources than positive ones. Coupled with the results of Ito et al. (1998), these results suggest that the negativity bias occurs early in evaluative processing, both when participants explicitly intend to evaluate stimuli in their environment and when evaluative categorizations occur more spontaneously. Such spontaneous dedication of greater processing resources to negative information (see also Pratto & John, 1991) may in turn help contribute to the more systematic, bottom-up processing that has been associated with negative affective states (Forgas, 1992, 1998; Schwarz, 1990).

Applications to Implicit and Explicit Prejudice

Implicit evaluative processes and the implications of multiple evaluative mechanisms may be especially relevant to issues of stereotyping and prejudice, and to research on implicit and explicit forms of prejudice in particular. Interest in implicit and explicit prejudice was stimulated by Devine (1989), who argued that an outgroup member can automatically activate negative, culturally transmitted stereotypical beliefs. At the same time, she noted, an individual may possess personal beliefs that are inconsistent with the negative stereotype. Devine suggested that these personal beliefs can result in inhibition of the negative automatic responses and initiation of new responses. Although inhibited from explicit expression, the automatically activated negative responses may nevertheless be detected on more automatic or implicit measures.

Cacioppo et al. (1992) elaborated on this theme by specifying a mechanism by which implicit negative associations with the outgroup could occur, and linking the maintenance of such associations in the face of more egalitarian personal beliefs to the rerepresentation of evaluative mechanisms. Their theorizing is based on their classical conditioning results, which, as previously discussed, revealed stronger conditioned affective associations to unfamiliar (nonword) than familiar (word) stimuli. In the domain of intergroup relations, racial outgroup members are typically less familiar than ingroup members (Linville, Fischer, & Salovey, 1989). These unfamiliar outgroup members may also be occasionally paired with negative or aversive cues such as a stereotypical negative portrayal in a movie. Even though ingroup members may also occasionally be paired with negative cues, the effects of familiarity on conditioning suggest that negative reactions are more likely to become associated with the racial outgroup members.

The inability of simulation participants in the Cacioppo et al. (1992) study to predict this familiarity effect suggests that differential racial conditioning could easily go unnoticed. Moreover, research on feelings without awareness indicates that individuals may confabulate reasons for affective arousal if the true source is unclear (Gazzaniga & LeDoux, 1978; Nisbett & Wilson, 1977). In the domain of prejudice, this suggests that we might construct rationalizations for classically conditioned prejudice, further obscuring the true source of the negative associations.

Like Devine (1989), Cacioppo et al. (1992) assume that individuals may develop more egalitarian personal beliefs that motivate them to control prejudiced responses. The most optimistic proposition is that the newer, more egalitarian personal beliefs and affective reactions will replace the older, negative beliefs and affective reactions. Behavior would then be influenced by only our more egalitarian beliefs. However, the multiplicity of evaluative mechanisms suggests that egalitarian personal beliefs and classically conditioned (negative) evaluative dispositions could easily coexist because they might operate at different levels of the neuraxis (Cacioppo et al., 1992).

Theorizing about implicit and explicit aspects of prejudice spurred the development of measures that are designed to assess the more automatic, implicit processes (e.g., Fazio et al., 1995; Wittenbrink et al., 1997). Comparisons between these and more traditional explicit measures (e.g., questionnaires) have yielded inconsistent results, with some studies reporting a dissociation between implicit and explicit measures (e.g., Banaji & Hardin, 1996; Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997, studies 1 and 3; Fazio et al., 1995, Study 3; Greenwald, McGhee, & Schwartz, 1998, Study 3; Vanman, Paul, Ito, & Miller, 1997, studies 1 and 2) and others reporting associations between the two (e.g., Greenwald et al., 1998, Study 2; Dovidio et al., 1997, Study 2; Vanman et al., 1997, Study 3; Wittenbrink et al., 1997). On the surface, such inconsistencies are troubling. However, the first two features of a rerepresented evaluative system previously discussed—that different mechanisms may be sensitive to different stimulus features, and that different measures may index different mechanisms— anticipates this situation. The implicit and explicit measures may be indexing different evaluative mechanisms that are sensitive to different types of information.

The multiplicity of evaluative mechanisms suggests that we may therefore wish to recast our question from "Are implicit and explicit measures related?" to "*When* should we expect implicit and explicit measures to be related?" That is, when should we expect evaluative operations at different levels of the neuraxis to produce similar results and when should we expect divergence between the mechanisms? The answer to this question may depend on the types of measures being used, characteristics of the person, and features of the situation. In addition, as the number of different implicit measures increases, the issue of how different implicit measures relate to each other is increasingly raised. Just as implicit and explicit measures may index different levels of evaluative processing, so too may different implicit measures. Consequently, we should not necessarily expect relations between implicit measures, but we should make an effort to better understand what each is measuring.

Different Evaluative Mechanisms or Decreased Activation with Practice?

Our discussion of multiple evaluative mechanisms has suggested that implicit and explicit evaluative responses to outgroup members may represent evaluative mechanisms operating at different level of the neuraxis. Before leaving this topic, we should note an additional way in which implicit and explicit processes may differ. This suggestion comes from recent neuroimaging research investigating semantic repetition priming. In these studies, participants are required to retrieve certain semantic information multiple times, whereas other similar information is retrieved only once. For example, participants may be asked to judge whether words and pictures represent something that is living or nonliving, with some stimuli repeated multiple times and other stimuli presented only once (Wagner, Desmond, Demb, Glover, & Gabrieli, 1997). Behaviorally, repetition priming facilitates semantic encoding, as seen in faster decision times. Neurophysiologically, positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) reveal a decrease in the activation of process-specific brain areas. Areas activated in initial task performance show a decrease in activation for repeated but not novel stimuli (Buckner, Raichle, Miezen, & Petersen, 1996; Gabrieli et al., 1996; Wagner et al., 1997). Such decreased activation suggests that repeated semantic processing of the same stimulus results in more efficient processing of that stimulus, achieved possibly through decreases in the duration and/or intensity of activity, compared to initial semantic encoding (Wagner et al., 1997).

These experiments used relatively simply semantic decisions (e.g., living/nonliving, abstract/concrete) and simple stimuli (e.g., words, line drawings) and examined repetition effects over relatively short retention intervals (e.g., minutes, days). Nevertheless, they suggest that repeated semantic associations produce changes in neurophysiological activation. To the extent that implicit and explicit prejudice differ in how well practiced they are (Devine, 1989), we might expect these processes to show similar differences in neurophysiological activation. These differences in activation could occur in addition to, or instead of, the differences in evaluative mechanisms suggested previously. It is clearly too early to determine the relative contribution of changes in neurophysiological activation and the rerepresentation of evaluative mechanisms to implicit and explicit prejudice, but this review does suggest future avenues for research. In addition, although we use prejudice as the specific example, the issues we discuss could apply more broadly to implicit and explicit evaluations in other domains.

Summary

The rerepresentation of evaluative mechanisms across levels of the neuraxis is a fundamental neurobehavioral organizing principle that also has important psychological consequences. One implication we discuss is that the same environment or stimulus may invoke different evaluative dispositions at different levels of the neuraxis. This is what may be occurring in studies of prejudice that reveal dissociations between implicit and explicit measures. In one such example, Vanman et al. (1997) had White participants imagine themselves in cooperative interactions with Black and White partners. Participants reported liking the Black partners more than the White partners, but facial electromyography revealed patterns of covert facial muscle activity indicative of greater negative affect toward Blacks than Whites. At first glance, these results seem inconsistent—how can the participants both like and dislike Black partners? The rerepresentation of evaluative mechanisms suggests that the measures may reflect different evaluative mechanisms and that, rather than thinking of a stimulus as producing a single affective response, it will be informative to study how evaluations of the same stimulus operate simultaneously across the neuraxis. An appreciation of the rerepresentation of evaluative mechanisms may also prove useful in understanding interactions between affect and cognition, suggesting that cognition may be influenced by multiple evaluative processes operating with differing levels of awareness at multiple neuraxial levels.

CONCLUSION

In our approach to the study of affect, we use findings from more biological approaches to understand the operation of the affect system at the psychological level. This application of a social neuroscience perspective both provides useful insight and highlights potential important avenues for future research. When we look across levels of analysis, both psychological and more biological approaches converge in suggesting that separable positive and negative evaluative substrates underlie the affect system. It is important to distinguish these structural and functional aspects from behavioral and psychological endpoints. The latter are an important topic in their own right, but the structure of behavioral and psychological output does not unambiguously inform us about the structure and function of the system that produces them. The affect system has evolved to produce bipolar endpoints because they provide both clear bivalent action tendencies and harmonious and stable subjective experiences. This bipolar endpoint, however, is derived from the activation of two intervening evaluative substrates that can operate in one of three different modes of evaluative activation: reciprocal, uncoupled, and coactivated. Measurement of the bipolar, net affective response carries important information but fails to reveal the relationship between the underlying evaluative substrates. Moreover, sampling of only the affective endpoints does not allow us to address important issues about the bivariate evaluative activation, such as the antecedents and consequences of the different modes of activation. It may be especially informative to attend to how both the bipolar psychological and behavioral endpoints and the underlying bivariate activation impact on cognitive processing.

The rerepresentation of evaluative mechanisms across levels of the neuraxis provides a second reason for greater attention to the structure and function of the affect system. Because evaluative dispositions that arise from different levels of the neuraxis may (a) be sensitive to only partially overlapping features of the environment, (b) influence different aspects of behavior, and (c) interact across levels of the neuraxis, the affect system is unlikely to be fully appreciated from measures that sample only a single endpoint. Advances in recording and measurement techniques, such as neuroimaging and reaction time-based implicit evaluation measures, should allow us greater insight into the multiple evaluative mechanisms, and in so doing foster a greater understanding of their interactions. As we more fully understand this multilevel system, we may also more fully appreciate the multiple levels at which interactions between affective and cognitive processing can occur.

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