

COMMENTS

Does a Prosocial–Selfish Distinction Help Explain the Biological Affects? Comment on Buck (1999)

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R. Buck (1999) argued that a conceptual distinction between prosocial and selfish motivation is necessary to understand the biological affects (consciously experienced feelings and desires having an innate neurochemical basis). However, at a biological level of analysis, a prosocial–selfish distinction is doubtful empirically and conceptually. For this reason, Buck's proposed typology of biological affects is unclear. Moreover, a prosocial–selfish distinction is not necessary to explain hemispheric differences in brain activity associated with affect. In contrast, an approach–withdrawal distinction explains some data uniquely well, although numerous exceptions imply that simple models are inadequate. To extend hemispheric models of experienced emotion, a prosocial–selfish distinction is unlikely to be explanatory, whereas an alternative account based on a distinction between verbal and nonverbal working memory may be useful.

The phenomenological experience of emotion can be subjectively dominating—for example, during a moment of road rage or can be far more subtle—for example, during the aesthetic appreciation of a humorous Shakespearean insult (Kraft, 1998). Moreover, people vary tremendously in what they find evocative and in how strongly they are moved by their feelings. Given such diversity, the neural mechanisms that support emotional states of consciousness are likely to be complex. Perhaps for this reason, associations between basic aspects of emotion and simple patterns of brain activity have attracted considerable attention. Clinical, behavioral, neuropsychological, neuroimaging, and electroencephalographic (EEG) studies have suggested an empirical association. On this basis, a model of lateralized emotion-related function is widely considered to be possible (Davidson, 1995; Fox, 1991; Heilman, 2000; Heller, 1990; Lane, 2000; Tucker, 1981). A model could be important in helping to understand not only the structure and functions of emotion but also high-level self-regulation in general, normal individual differences, and emotional disorders. However, in the face of numerous difficulties, both conceptual and methodological, models have been realized only in outline and apply only to some emotions. Most research has been directed to the foundations of a model: documenting the phenom-

ena that need to be explained. The mediating mechanisms have not been as widely investigated.

Many theorists subscribe, if only loosely, to a pleasant-versus-unpleasant or an approach-versus-withdrawal conception of left-versus-right hemispheric differences in experienced emotion for anterior regions of the human brain. Indeed, considerable evidence supports this view (Davidson, 1992; Fox, 1991). However, this widely accepted heuristic is hardly free of interpretive ambiguity or even active contention in light of numerous empirical exceptions and several competing interpretations (Canli, 1999; Chua, Krams, Toni, Passingham, & Dolan, 1999; Davidson, 1998b; Gainotti, Azzoni, Gasparini, Marra, & Razzano, 1997; Gainotti, Caltagirone, & Zoccolotti, 1993; Gotlib, Ranganath, & Rosenfeld, 1998; Hagemann, Nauman, Becker, Maier, & Bartussek, 1998; Heller & Nitschke, 1998; Kolb & Taylor, 2000; Luu, Tucker, & Derryberry, 1999; Reid, Duke, & Allen, 1998; Shin et al., 1997). In this context, Buck's (1999) hypothesis that a prosocial–selfish distinction is required and resolves some of the inconsistencies invites consideration.

In his broad theory of emotion, Buck (1999) proposed that a prosocial–selfish distinction is necessary to understand the biological bases of subjectively experienced feelings and desires, or *affect*, in his terms. A central claim was that a prosocial–selfish distinction characterizes a fundamental yet neglected dimension of motivation. The distinction held a key role in a proposed typology of biological affects (as distinct from cognitive, social, and moral affects). The prosocial biological affects included relaxation, courtship, pair bonding, lust, mating, and attachment; selfish biological affects included arousal, pain, approach–reward, withdrawal, and aggression (p. 323). The distinction was also held to help explain hemispheric differences in affect, a relatively minor aspect of the original article, yet considered important enough to be mentioned in the article's abstract.

I first present an overview of Buck's argument and then critique the prosocial–selfish conceptual distinction and the evidence cited

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Preparation of this article was supported in part by National Science Foundation Grant BCS 0001908 and by the McDonnell Center for Higher Brain Function, Washington University.

I gratefully acknowledge the unselfish comments of Ross Buck, Stephen M. Kosslyn, Randy Larsen, Jerome Kagan, Christopher F. Chabris, Mark Baxter, Daniel Weiss, David A. Gray, Todd S. Braver, Deanna M. Barch, and John M. Zelenski.

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for hemispheric differences in prosocial–selfish emotion. Finally, I suggest a more viable alternative interpretation of hemispheric differences in experienced emotion, emphasizing a possible role of functions mediating the cognitive control of behavior, as illustrated using the distinction between verbal and nonverbal working memory.

Overview of Buck (1999)

The questions Buck (1999) dealt with are important and challenging. For example, consider moral affects, “some of the strongest and most persistent motivators of human behavior” (p. 326; cf. Kagan, 1998). It is unlikely that moral affects are completely innate (cf. Anderson, Bechara, Damasio, Tranel, & Damasio, 1999), and so the alternative is that they are partly acquired. One difficulty that an acquired hypothesis of moral affect must overcome is that consciousness cannot be observed directly in others. The intrinsic privateness of conscious states makes learning about them by mere observation difficult. How, then, are we to explain socially transmitted aspects of emotional consciousness such as moral affects in terms of neurobiology without explaining them away? Buck presented a metatheory of emotion, motivation, and cognition emphasizing the interacting roles of biological, cognitive, and social processes in human development. The potential value of such a metatheory is that by providing a broad yet unified conceptual context it might facilitate progress on such challenging issues, even if it is not directly testable in itself. The metatheory served as the basis for a typology of biological affects.

The Metatheory

Buck (1999) defined the term *affect* as subjectively experienced feelings and desires (p. 301; see also p. 306). The biological affects, although having an innate basis, are identified “operationally in terms of activities of specific neurochemical systems” (p. 307). That is, the biological affects are states of consciousness that can, in principle, be differentiated from one another neurochemically (cf. Panksepp, 1986, 1998; Zuckerman, 1995). Higher-level affects (social, cognitive, moral) are based on the biological affects hierarchically.

In the metatheory, *affect systems* are interoceptive perceptual systems that detect and amplify specific motivations. Such emotional perception concerns not only basic motivations, such as hunger, but higher-level motivations as well (social, cognitive, and moral). Affect systems broadcast their output neurochemically and thereby can simultaneously influence several relatively independent components of an emotional response: autonomic responses, expressive behaviors, and subjective experiences. One might add the possibility of yet other changes, for example, preparation for action (Frijda, 1986; Lang, 1995), memory consolidation (Cahill, Prins, Weber, & McGaugh, 1994), or biases on decision making (Gray, 1999a).

To understand affect, Buck (1999) argued that neurobiological and evolutionary constraints are necessary but not sufficient. Purely cognitive, topdown views of the antecedents of emotional experience have important strengths but are not complete. These include theories focusing on appraisal (e.g., Frijda, 1986; Lazarus, 1991) and goal interruption or frustration (e.g., Carver & Scheier, 1990; Simon, 1967). Biological constraints are also necessary (cf. Panksepp, 1992). Buck further argued that biology alone cannot be

sufficient (cf. Chalmers, 1996; Kagan, 1998). Higher order cognition and language are of critical importance in interaction with biological factors as (emotional) maturation unfolds developmentally.

Each of the various biological affects has a corresponding *prime* associated with it, a “phylogenetically structured (innate) primary motivational–emotional system” (p. 301). Primes include reflexes and instincts, which are relatively inflexible, and systems for signaling bodily needs, which are more flexible and closely associated with both specific neurochemical systems and biological affects. The social and cognitive affects are posited to be at a higher level of abstractness. These affects are learned through social interaction, especially, as more general psychological functions (conditioning, learning, language) interact with more specific ones (primes). The moral affects are at the highest level and depend in turn on the social and cognitive affects.

A hierarchy of affects is a reasonable simplification of a complex set of issues. It is parsimonious to postulate that affects of either genetic or nongenetic origin are mediated by the same set of neurochemical systems but in different degrees of complexity. For the biological affects, the evidence Buck (1999) discussed supported the idea of specific neurochemical systems associated with specific motivational–emotional functions. A neurochemical basis was less clear for social, cognitive, and moral affects, but these were not the focus of the article and were not posited to have simple relationships to neurochemical systems.

Some further consideration of the metaphor of levels might be useful. For example, it seems underspecified how the typology should handle evidence that monkeys can acquire conditioned fear responses by observing a conspecific reacting fearfully to a snake (Mineka & Cook, 1993). Does this mean such fear is therefore a cognitive or social affect (because it is learned) rather than a biological affect? Is there one affect, fear, but it is multileveled? Are there different kinds of fear at different levels? Differentiating between levels may not be straightforward. If the biological and social affects are not clearly separable, there is some doubt about whether a prosocial–selfish distinction can be adequately tested at the biological level at which it was specifically intended to apply. The distinction may only hold for social and moral affects.

There are several strengths of Buck’s (1999) conception. As he stated, it has the potential to ground the term emotion in a set of biological primitives associated with specific neurochemical systems (cf. Panksepp, 1986, 1998). This could make the study of affect more tractable, a challenging technical problem rather than a conceptual one. The emphasis on neuromodulators and emotional states is an interesting complement to the more prevalent current research emphasis on the perception and processing of stimuli that have emotional significance (e.g., LeDoux, 1996; Morris, Ohman, & Dolan, 1998). Buck emphasized that affects involve subjective experience (cf. Heilman, 2000; Lane, 2000), and moreover, that some of these states of consciousness might depend on socialization and communication. For emphasizing social processes as well, Buck’s metatheory provides a creative starting point for a number of research programs.

The Typology

On the basis of the metatheory, Buck (1999) promised to deliver a “comprehensive typology of biological affects” (p. 301), a ty-

pology “not logically organized, but . . . biologically organized” (p. 308). However, a typology was elusive despite consideration of relevant neuroanatomy (brainstem, hypothalamus, basal ganglia, limbic system and cerebral hemispheres) and neurochemistry (amine neurotransmitters and peptide hormones). Section headings, illustrative examples, and figures implied that there were not only prosocial and selfish classes of affect but still finer classes within these two. However, a typology proper was only hinted at, suggested to be possible on the basis of neurobiology.

Affective biology may well provide a basis for a typology of biological affect, but to establish a true typology of affect, further clarification is necessary on several interrelated points: (a) A prosocial–selfish dimension of affect was not adequately differentiated from two other dimensions that were acknowledged to be important. “At the base of the [affect] hierarchy, arousal and pleasant–unpleasant dimensions are, indeed, fundamental. . . . [but there is] another fundamental dimension of affect that is often overlooked,” a social–selfish dimension (p. 308). It was not clear what the arousal and pleasant–unpleasant dimensions fail to account for and why they fail, in the sense of being incomplete. (b) It was not specified how and where the prosocial–selfish distinction fit within the proposed typology of affect. It appeared to be the single most important distinction, forming the two major subclasses, with still finer subclasses within them. (c) The evocative terms prosocial and selfish lacked clear definition. For example, it was ambiguous why arousal should be considered a selfish affect (pp. 323–324) and panic a prosocial affect (p. 323, Figure 6). (d) The terms prosocial and selfish lacked the consistent usage required of a typology. For example, the distinction was alternatively: social versus selfish (p. 308), cooperative versus individualistic (p. 323), species versus individual genetic fitness (p. 308), and social versus primary emotion (p. 318). These various terms are not identical, and so further explanation is needed. (e) The prosocial–selfish distinction was not intended to be a dichotomy (R. Buck, personal communication, November 2, 2000), but this seems incompatible with their role in a typology: a structure consisting of types or kinds that are mutually exclusive at a given level of abstraction. (f) Finally, at a biological level of analysis, it is ambiguous to what extent the terms *prosocial* and *selfish* are able to refer to distinct motivations. I elaborate this concern in the next section, given its apparent centrality to the typology and its relevance to characterizing hemispheric differences in affect.

A Conceptual Issue: Prosocial Versus Selfish?

How distinct are the terms prosocial and selfish? It is typically ambiguous whether the apparently prosocial motivation behind a given behavior, cognition, or emotion is genuinely prosocial, a mixture of prosocial and selfish, or wholly selfish, in the sense of being Machiavellian. It is logically possible that all apparently cooperative, altruistic, or species-promoting behaviors are best interpreted as entirely self-serving (see, e.g., Trivers, 1985). For humans, at least, there are plausibly a number of situations in which prosocial motivation is reliably in conflict with selfish motivation (Kagan, 1998). However, and crucially, such conflict would seem to arise for social and moral affects and little if at all for biological affects.

Buck (1999) stated that “prosocial affects are not necessarily always conducive to the preservation of the individual, or even the

individual’s genes” (p. 324). To argue this point strongly suggests that the prosocial–selfish distinction was intended to be a conceptual one, not simply descriptive. However, the assertion is not persuasive. The prosocial affects included: sex reflexes, sex, courtship, lust, submission, relaxation response, parenting, attachment, and play (p. 323). The associated motivations are highly conducive to the preservation of the individual’s genes and are not at odds with selfish motivation. At best, prosocial motivation is in addition to selfish motivation, but it is also plausible that prosocial and selfish motivations are not discernable at a biological level. That is, there are various biological motivations, some of which involve other organisms and some of which do not, but prosocial-versus-selfish conflicts do not arise for organisms having only the biological affects. It is easy to engage in behaviors that serve prosocial and selfish biological motivations simultaneously and difficult not to. This conflation or lack of duality holds considerable explanatory force at a biological level of description (Trivers, 1985) although is dubious and potentially dangerous when applied uncritically to humans (Kagan, 1998).

For a prosocial–selfish distinction to hold conceptually, Buck’s (1999) hypothesis “requires that natural selection take place at the level of the group as well as that of the individual” (p. 324). The reason is so that group (prosocial) characteristics can be selected for even at a cost to individual (selfish) genes.¹ Laboratory evidence clearly suggests that selection can operate at a group level (see Goodnight & Stevens, 1997). However, this is through artificial selection and as such might be stable over generations in ways difficult to realize in nature (Maynard Smith, 1964; Simpson, 1994). Only a few examples of group selection have been found in the field (i.e., that occur by natural selection as opposed to artificial selection). Even optimistic reviews have concluded that it is logically possible but unknown whether group selection has had an important role in natural history (Bradley, 1999; Goodnight & Stevens, 1997) or whether it is needed to explain nonhuman primate behavior (Bradley, 1999). Further, the existence of group selection does not require that prosocial (group) motivation conflicts with selfish (individual) motivation. Individual fitness can be uninfluenced by, or even benefit from, selection at a group level (Wilson, 1997). For a prosocial–selfish distinction to be convincing, conflict between prosocial and selfish motivations must be demonstrated, ideally with specific reference to experienced emotion.

¹ The metaphor of the selfish gene (Dawkins, 1976) has proven slightly unfortunate, in that a misinterpretation of the theory behind the metaphor is easy to make. Genetic theory is not fundamentally concerned with the motivational states of organisms. In particular, it is agnostic about a possible genetic basis of prosocial motivation. (The misinterpretation is that the theory holds that all motivation is necessarily selfish.) Rather, genes are selfish in the following sense: Those DNA sequences that have self-stabilizing effects tend to become more frequent in the next generation. DNA sequences that do not promote their own stability in this way are less likely to increase in frequency. The metaphorical selfishness of genes should be understood as self-referential chemical stability, not as proscribing motivation. Selfish motivation is a potent pathway to greater chemical (genetic) stability, and so the metaphor is easily misread. However, there are several well-known mechanisms whereby self-stabilizing genes can generate prosocial motivation, for example; through kin selection and reciprocal altruism (see Trivers, 1985).

In sum, a prosocial–selfish distinction appears to depend on group-level selection reducing individual fitness by enhancing prosocial states of emotional consciousness. This is a logical possibility and if upheld an interesting one. However, an empirical basis for this hypothesis was not presented, and it appears difficult to test. Even if it were upheld, there is a further conceptual difficulty based on the possibility that a prosocial–selfish distinction might hold for social affects but not for biological affects. The distinction between the biological and social levels of affect would need to be more clear so that social interpretations of putatively biological affects could be ruled out. To evaluate whether a prosocial–selfish distinction holds for biological affects specifically, it must be clear that a given affect is truly a biological affect. In sum, a distinction between prosocial and selfish affect is doubtful at a biological level.

An Empirical Issue: Hemispheric Differences?

Buck (1999) held that the prosocial–selfish conception helps resolve inconsistencies in the literature on hemispheric differences in affect: “If the positive-negative distinction is replaced by a prosocial–selfish distinction, so that the LH [left hemisphere] is prosocial and the RH [right hemisphere] is selfish, a number of the inconsistent findings fall into place” (p. 317). The intended sense was that a positive–negative or related conception is incomplete (R. Buck, personal communication, November 2, 2000) therefore a prosocial–selfish distinction is necessary.

If a prosocial–selfish distinction can explain some evidence that other distinctions cannot explain well, then the prosocial–selfish distinction would be a useful contribution, assuming the conceptual concerns can be addressed. Distinctions that are conceptually robust, independently validated, and more specific in terms of information processing are, in general, preferable as explanations of psychological phenomena (Hellige, 1993; Kosslyn & Koenig, 1992). Interestingly, a number of hemispheric asymmetries are relatively well supported in the neuropsychological, cognitive neuroscience, and related literatures (Cabeza & Nyberg, 2000; Hellige, 1993). Importantly, many such distinctions have been established on the basis of evidence almost completely independent of hypotheses about affect.

In this section, I consider each argument Buck (1999) presented in favor of a prosocial–selfish account or against alternative accounts and view independently established distinctions as possible confounds. Such distinctions include verbal versus spatial working memory (D’Esposito et al., 1998; Smith & Jonides, 1999), retrieval of episodic memories (Tulving, Kapur, Craik, Moscovitch, & Houle, 1994), sustained attention (Cabeza & Nyberg, 2000; Pardo, Fox, & Raichle, 1991), and familiarity versus novelty processing (Berns, Cohen, & Mintun, 1997; Goldberg, Podell, & Lovell, 1994). In the next section, I suggest that some of these distinctions might contribute positively to an alternative account of hemispheric differences in experienced emotion. Many other such distinctions might simply be confounds.

Buck (1999) cited a clever study of nonverbal communication in patients with suspected left- or right-sided brain damage (Buck & Duffy, 1980) as evidence for a prosocial–selfish account of hemispheric differences. Some of the 37 male patients had suspected unilateral brain damage, and others were controls. All were shown emotional pictures while being videotaped surreptitiously. Under-

graduate raters then viewed the videos and were asked to infer the contents of the pictures that the patient had been viewing. The undergraduates’ accuracy at decoding facial expression was the measure of each patient’s ability to express emotion. Buck summarized the experiment as suggesting that the “RH [right hemisphere] might be associated with the spontaneous expression of emotion, whereas the LH [left hemisphere] is associated with learned rules and expectations about how and when emotions should be expressed” (p. 317). This means that the evidence does not clearly bear on subjectively experienced emotion (affect); rather, it concerns emotional expression, which depends on different neural systems (see Adolphs, Damasio, Tranel, & Damasio, 1996; Borod, Koff, Perlman Lorch, & Nicholas, 1986; Heller, 1990). There is another interpretive limitation: a confound of familiar–novel or pleasant–unpleasant with prosocial–selfish in the pictures that were presented to the patients. The pictures that Buck interpreted as eliciting prosocial responses were of familiar people (and presumably pleasant). Those eliciting selfish responses were unpleasant (and presumably novel). The left hemisphere is more involved in processing familiar information, whereas the right is more involved in processing novel information (see Berns et al., 1997; Goldberg et al., 1994). Familiar–novel and pleasant–unpleasant distinctions are better validated and more basic in terms of information processing, and so preferable to a prosocial–selfish distinction.

In the next study Buck (1999) cited, 10 patients with severe epilepsy were asked to retrieve an emotional memory and describe it while undergoing transient inactivation of the right hemisphere by anesthesia (Ross, Homan, & Buck, 1994). They were also asked to retrieve and describe the same memory under conditions of no anesthesia. Eight patients showed a reduction in the verbal expression of primary (selfish) emotion during right-hemisphere anesthesia as compared with the control condition. The data are consistent with a prosocial–selfish interpretation, but more recent evidence suggests two alternative interpretations. A reduction of primary emotion is likely to reflect lower emotional arousal resulting from the simultaneous anesthetization of right posterior areas that are critical for emotional arousal (Heller & Nitschke, 1998; Heller, Nitschke, & Lindsay, 1997). Further, the result may also reflect a failure to retrieve the target memories completely during right-hemisphere inactivation, because episodic retrieval processes depend in part on right prefrontal cortex (Cabeza & Nyberg, 2000; Tulving et al., 1994). Both arousal and episodic retrieval are more basic and better validated than a prosocial–selfish distinction for interpreting the results of Ross et al. (1994).

Buck (1999) held that lateralized activation in limbic cortices as studied by positron emission tomography (Gur et al., 1995) supported his hypothesis, emphasizing a cingulate (prosocial, left lateralized) versus noncingulate (selfish, right lateralized) distinction. However, the cingulate is a large and functionally heterogeneous area, and not all of it is involved in affect (Devinsky, Morrell, & Vogt, 1995). In the Gur et al. (1995) study, there was no specificity of the lateralized activity to the affective subregions. Moreover, under a prosocial interpretation of cingulate function, it is unclear why areas involved in the conscious experience of pain (Rainville, Duncan, Price, Carrier, & Bushnell, 1997) should have left-lateralized activity (Gur et al., 1995, Figure 2). For noncingulate (selfish) limbic regions, it is unclear why only two of the six areas should have more metabolic activity on the right. The lack of

specificity undermines the inference that asymmetric limbic activity during resting conditions reflects hemispheric specialization for prosocial–selfish affect.

Buck (1999) stated that, “the fact that NE [norepinephrine] and the MFB [medial forebrain bundle] reward system are right-lateralized does not fit the notion that the RH [right hemisphere] is associated only with negative affects” (p. 317). Evidence that the MFB is right lateralized would be interesting and very telling if completely right lateralized, but no evidence was cited. NE does appear to be relatively right lateralized (for reviews, see Tucker & Williamson, 1984; Wittling, 1995). Yet, it is essential to show that there is some right lateralized, specific association of NE with positive aspects of emotion. (Without specificity, positive aspects of NE could be left lateralized and negative aspects right lateralized.) However, no evidence for the implied specificity was presented, yet the inference against a positive–negative account depends on it.

The next point was that “most of the selfish emotions (fear, anger, disgust) are considered to be negative” (p. 317). However, selfishness is associated not only with negative affects but also with positive affects such as craving, greed, and lust. The positive–selfish association greatly undermines the specificity of the negative–selfish association. Without specificity, a negative–selfish association is not problematic for a positive–negative account of hemispheric differences.

An obscure point was that “it can be argued that language is not in itself unemotional” (p. 317), because people derive pleasure from using language successfully and frustration when language is misused. However, the point is nonspecific: If language is intrinsically emotional, then virtually everything in human experience is as well.

Finally, a study appearing after Buck’s (1999) review deserves mention, as evidence that is clearly consistent with a prosocial–selfish hypothesis. The frontal EEG asymmetry was investigated in shy and sociable undergraduate women (Schmidt, 1999). High-shy participants had relatively greater right than left neural activity over frontal areas. High-sociable participants had relatively greater left frontal activity. These data are consistent with a prosocial–selfish hypothesis but do not require it. Schmidt (1999) interpreted the EEG asymmetry as reflecting a predisposition to experience positive versus negative affect, and shy versus sociable behavior as an approach–avoidance disposition revealed in social contexts.

In summary none of the evidence, presented in support of a prosocial–selfish account of hemispheric differences in affect or against other accounts, is compelling given a lack of specificity or confounds with more basic information processing functions. A prosocial–selfish distinction does not appear to be necessary.

Is There an Alternative?

As noted, Buck (1999) considered emotional arousal and pleasantness–unpleasantness to be dimensions of motivation that are fundamental but incomplete. Regarding hemispheric differences, Buck’s argument was based on valid concerns about whether these two simple dimensions could explain all the data. However, Buck’s exposition of the relevant evidence was too brief to serve as a guide to whether a prosocial–selfish distinction might be a useful supplement. This section first provides more background. Although highly selective, the overview is sufficient to

suggest both that an approach–withdrawal distinction is necessary to explain some evidence and that this distinction does not succeed as a complete account—confirming the basis of Buck’s position on these two points. However, for introducing a greater complexity into neurobiological models of experienced emotion, distinctions drawn from the cognitive neuroscience and related literatures appear to hold more potential than a prosocial–selfish distinction.

An Approach-Versus-Withdrawal Distinction?

A duality between approach and withdrawal behavior can readily be inferred: It is effectively impossible to approach something and simultaneously withdraw from or otherwise avoid it. This in no way precludes the simultaneous motivation to approach and withdraw, but what is critical is that such states intrinsically involve conflict (Miller, 1944). The problem of the control of approach and withdrawal behavior is pervasive phylogenetically, suggesting considerable evolutionary selection pressure (Lima & Dill, 1990; Schneirla, 1959). How an approach–withdrawal distinction might ramify in models of human self-regulation is important but beyond the scope of this critique (see Cacioppo & Berntson, 1994; Carver & Scheier, 1990; Carver & White, 1994; Gray, 2001; Gray & Braver, 2002; Higgins, 1987; Larsen & Ketelaar, 1991; Miller, 1944).

As applied to emotion (Davidson, 1992; Fox, 1991), the approach–withdrawal distinction concerns goal-directed emotions motivated by cues of impending reward or threat, respectively. Approach-related emotions include desire, interest, enthusiasm, and craving. Withdrawal-related emotions include disgust, fear, and anxious arousal. The approach–withdrawal distinction does not apply to all emotions, and in particular is agnostic about postgoal attainment (or nonattainment) emotions (Davidson, 1998a). Some emotions that are pleasant, such as satiation, are not approach related, and some that are unpleasant, such as disappointment, regret, or sadness are not withdrawal related. Anger may include a strong approach component (Harmon-Jones & Sigelman, 2001; Heller & Nitschke, 1998). Postgoal-attainment states typically lack the urgency associated with goal-oriented (approach–withdrawal) states.

As applied to hemispheric differences in emotion, the approach–withdrawal hypothesis is a refinement of a pleasant–unpleasant hypothesis (Davidson & Fox, 1982; Flor-Henry, 1979; Gainotti, 1972; Goldstein, 1952; Heller, 1990; Lang, Bradley, & Cuthbert, 1990; Tucker, 1981). Specific pleasant–unpleasant hypotheses vary in detail (e.g., in the interpretation of relative vs. absolute levels of brain activity), but generally posit that greater left-sided anterior activity is more associated with pleasant emotion, whereas right-sided anterior activity is more associated with unpleasant emotion. Approach–withdrawal hypotheses posit that these relations hold for only a subset of pleasant and unpleasant emotions: those emotions that are goal related, especially in a prospective or anticipatory sense, rather than retrospectively. The emphasis on goals is potentially important because, as briefly elaborated below, emotional states that are goal directed might be expected to influence neural systems responsible for goal-directed behavior (Gray, 1999b; Gray, 2001; Gray & Braver, 2002; Tomarken & Keener, 1998).

Diverse evidence supports an approach–withdrawal hypothesis of anterior hemispheric differences in experienced emotion: pa-

tients with brain damage (Gainotti, 1972; Robinson, Kubos, Starr, Rao, & Price, 1984); EEG in neonates (Fox & Davidson, 1986), 10-month old infants (Davidson & Fox, 1982), normal adults (Sutton & Davidson, 1997), adult clinical populations (see Davidson, 1992; Heller & Nitschke, 1997), and rhesus monkeys (Davidson, Kalin, & Shelton, 1992; Kalin, Larson, Shelton, & Davidson, 1998). The data from neonates and monkeys suggest an innate basis. A functional magnetic resonance imaging study that controlled for individual differences in arousal predicted and found the asymmetry (Canli, Desmond, Zhao, Glover, & Gabrieli, 1998), albeit without a strongly interpretable (anatomically localized) pattern of activation. Many of these data also support a pleasant-unpleasant hypothesis, but other evidence argues in favor of approach-withdrawal specifically. For example, the anterior EEG asymmetry correlates (Harmon-Jones & Allen, 1997; Sutton & Davidson, 1997) with personality measures that assess trait sensitivity to cues of threat and reward (the behavioral inhibition system [BIS]-behavioral activation system [BAS] scales; Carver & White, 1994). In Sutton and Davidson's (1997) study, the anterior asymmetry did not correlate significantly with measures of trait positive and negative affect (Watson, Clark, & Tellegen, 1988), suggesting specificity to approach-withdrawal (Harmon-Jones & Siegelman, 2001).

The approach-withdrawal distinction is sometimes upheld in absolute terms. Depression is associated with low approach motivation and left anterior hypoactivation (Henriques & Davidson, 1990, 1991), whereas anxious arousal is associated with high withdrawal motivation and right anterior hyperactivation (Heller, Nitschke, Etienne, & Miller, 1997; Heller, Nitschke, & Lindsay, 1997). As another example, an asymmetry in absolute terms was revealed in EEG by cues of impending reward and punishment (Sobotka, Davidson, & Senulis, 1992). Reward cues lead to greater left neural activation. Punishment cues lead to greater right neural activation.

Although these and other data support an approach-withdrawal distinction there is also considerable evidence that does not support it (Canli, 1999; Heller & Nitschke, 1998). For example, behavioral evidence suggests a left-side locus of trait anxiety (Tucker, Antes, Stenslie, & Barnhardt, 1978). Many and perhaps most neuroimaging studies in normal participants have found little or no evidence for hemispheric asymmetries in experienced emotion (e.g., Lane, Reiman, Ahern, Schwartz, & Davidson, 1997; Lane, Reiman, Bradley, et al., 1997). Some neuroimaging studies report an asymmetry in the opposite direction (i.e., greater left activity in withdrawal states; e.g., Chua et al., 1999; Shin et al., 1997). There have been failures to find an asymmetry in EEG in healthy (Hagemann et al., 1998) and depressed (Reid et al., 1998) participants. EEG asymmetries in the opposite direction have been reported in trait anxiety (left activity greater than right; e.g., Carter, Johnson, & Borkovec, 1986). A study of 149 patients with brain damage found no association between mood and lesion location when using both verbal and nonverbal measures of mood (Gainotti et al., 1997).

These and other exceptions may be more important than widely assumed. The most negative interpretation is that they reject the very idea of a prefrontal asymmetry in experienced emotion. However, this would completely ignore the evidence for asymmetries under certain conditions (e.g., Davidson, 1998b; Davidson & Fox, 1982; Davidson et al., 2000; Fox & Davidson, 1986; Kalin et al., 1998; Schmidt, 1999; Sutton & Davidson, 1997). Dismissing these data effectively assumes that all positive findings are due to

chance, methodological artifact, or investigator bias—possible but unlikely explanations.

A more plausible interpretation is that simple hemispheric models of experienced emotion are inadequate, as emphasized by several investigators. Heller and Nitschke (1998) addressed this possibility directly. They suggested that for understanding prefrontal asymmetries in depression and anxiety, comorbidities and subtypes are critical to consider, focusing on a difference between anxious apprehension and anxious arousal. They made compelling use of otherwise anomalous data to support this point. Tucker, Gainotti, and their respective colleagues (e.g., Gainotti et al., 1993; Liotti & Tucker, 1995) have emphasized the complexity of both emotion and the brain, for example, noting possible contributions of subcortical structures to cortical asymmetries and that asymmetries may partly reflect inhibitory processes involved in the regulation or control of emotion (see also Tomarken & Keener, 1998). Davidson (1992; 1998b) has emphasized a number of conceptual and methodological caveats. For example, lower left-frontal activity may be best conceptualized as a vulnerability to depression rather than an indicator of current depressed affect. This is relevant for understanding the relationship between stroke and depression. Left prefrontal damage may only lead to depression after sufficient exposure to stressors, rather than immediately.

A selective review shows that the biological bases of experienced emotion are complex. An approach-withdrawal distinction is conceptually sound, and some evidence is explained uniquely well by this distinction. Associations of left-pleasant-approach and right-unpleasant-withdrawal sometimes hold (Canli et al., 1998; Sutton & Davidson, 1997); sometimes they do not hold (Canli, 1999; Heller & Nitschke, 1998). The question appears to be why do they hold when they do (Hagemann et al., 1998; Heller & Nitschke, 1998; Reid et al., 1998). Conceptual and empirical concerns about the prosocial-selfish distinction suggest that it will not be useful in this regard.

Is There a Better Alternative?

The point of this final section is to suggest that there is an alternative to a prosocial-selfish distinction for introducing a supplementary complexity into current models of experienced emotion. The possibility that neuropsychological, cognitive neuroscience, and cognitive distinctions might be relevant to hemispheric asymmetries in emotion has often been noted (e.g., Bartolic, Basso, Schefft, Glauser, & Titanic-Schefft, 1999; Gray, 2001; Heller, 1990; Heller & Nitschke, 1998; Hoptman & Davidson, 1998; Liotti & Tucker, 1995; Sutton & Davidson, 1997; Tucker, 1981). As an example, goal-directed emotions (i.e., approach or withdrawal states) might adaptively modulate the neural systems that mediate the cognitive control² of behavior by active

² As used here, the word *cognitive* in cognitive control or cognitive neuroscience is a technical term. Cognitive control refers to the control of behavior by actively maintained internal representations such as goals or context information, which can be emotional or unemotional. In discussions of emotion, cognitive can carry an unfortunate connotation of its nontechnical meaning, namely, as denoting aspects of mental life that are not emotion related. In this article, the cognitive control of behavior is intended to contrast with stimulus-based (external) control and not to contrast with the control of behavior by emotion. Part of the argument is that the control of behavior by emotion may be mediated by cognitive control mechanisms (Gray, 2001).

goals (Gray, 2001; Gray & Braver, 2002; Tomarken & Keener, 1998). To suggest that there is a better alternative to a prosocial–selfish account, this section illustrates the minimal plausibility of hybrid models incorporating cognitive control functions. For empirical clarity, the discussion focuses on the nonobvious possibility of interactions between emotional states and verbal versus nonverbal spatial cognition.

It is at least logically possible that some emotion-related hemispheric asymmetries are mediated indirectly by cognitive processes. If experienced emotional states can influence cognitive processes that are lateralized in prefrontal cortex, then frontal asymmetries in brain activity associated with experienced emotion might partly reflect cognitive contributions. A verbal–spatial distinction is extremely well documented in diverse literatures and holds robustly within the domain of working memory (Baddeley, 1986). Working memory and prefrontal cortex are critical for the active maintenance and manipulation of information and for coordinating complex, goal-directed activity (see Baddeley, 1986; Braver & Cohen, 2000; Miyake & Shah, 1999; Smith & Jonides, 1999). In neuroimaging studies, verbal and spatial working memory tasks tend to differentially activate left and right prefrontal cortex, respectively (D’Esposito et al., 1998; Smith & Jonides, 1999).

Behavioral evidence suggests that verbal and nonverbal working memory are influenced by approach–withdrawal states. To show a selective effect of emotion on cognitive control, we used induced emotional states to dissociate verbal from nonverbal working memory performance on psychometrically matched tasks (Gray, 1999b, 2001; Gray, Braver, & Raichle, 2002). Undergraduates saw short videos that induced approach, neutral, and withdrawal emotional states, as verified by a specific association of trait emotion (BIS-BAS scores: Carver & White, 1994) with emotional reactivity (cf. Larsen & Ketelaar, 1991). Performance on the spatial task was enhanced by a withdrawal state and impaired by an approach state. The opposite pattern held for performance on the verbal task. The double dissociation was stronger for threat-sensitive participants (high BIS) after horror videos but stronger for reward-sensitive participants (high BAS) after comedy videos. For these participants, the respective emotional states were not simply stronger but were stronger along the approach–withdrawal dimensions specifically. This specificity did not hold when the same participants were classified in terms of their extraversion and neuroticism scores (which assess trait sociability and emotional instability, respectively, Eysenck, Eysenck, & Barrett, 1985). For present purposes, the point is that because emotional states can selectively influence cognitive processes that depend asymmetrically on prefrontal cortex, hemispheric differences associated with emotion cannot be assumed to be purely affective (see also Bartolic et al., 1999; Heller, 1990; Heller & Nitschke, 1997; Hoptman & Davidson, 1998). Cognitive distinctions may be required in models of emotion, suggesting the plausibility of a hybrid model.

A further question is whether a hybrid model could resolve some of the inconsistencies, for example, the left-sided activation found in both approach-related states (e.g., Sobotka et al., 1992) and anxious apprehension (e.g., Carter et al., 1986). The verbal–nonverbal distinction might also help explain this apparent contradiction. Anxious apprehension motivates the processing of potential problems (Luu et al., 1999) and manifests subjectively as worry. Worry tends to be mediated verbally, for example, as shown by an increase in the ratio of verbal thoughts to visual

mental images during active worrying (Borkovec & Inz, 1990). Thus during worry, verbal processes are likely to be actively engaged. These verbal processes are likely to produce left-sided activation (see Hellige, 1993; Smith & Jonides, 1999) that has little to do with emotion specifically, despite being caused by anxiety. A simple test of whether multiple mechanisms can mediate left-sided activation by different emotions would be to probe verbal working memory. Anxious apprehension or worry states often impair verbal working memory (e.g., Darke, 1988), whereas approach states facilitate it (e.g., Gray, 2001; Gray et al., 2002). This behavioral divergence suggests that apparently similar hemispheric asymmetries might arise from fundamentally different mechanisms. The existence of multiple mechanisms might help explain some of the otherwise inconsistent results.

Thus it is minimally plausible that approach and withdrawal emotional states might activate networks that subservise cognitive control and that such activation could be responsible for some of the observed hemispheric asymmetries. Beyond a verbal–nonverbal distinction, there are many other candidate distinctions related to cognitive control that might be functionally related to both emotion and hemispheric differences (see Gray, 2001; Gray & Braver, 2002; Tomarken & Keener, 1998). For extending simple hemispheric models of experienced emotion—which many have suggested is necessary (Davidson, 1992; Gainotti et al., 1993; Heller & Nitschke, 1998; Liotti & Tucker, 1995; Reid et al., 1998; Tomarken & Keener, 1998)—there is an alternative explanation more attractive than a prosocial–selfish distinction. The verbal versus nonverbal distinction appears to be useful and suggests that other distinctions related to cognitive control might be worth considering.

Conclusion

Buck (1999) presented a metatheory of motivation, emotion, and cognition that was intended to stimulate progress on a very wide range of difficult issues. Buck clearly distrusted simple explanations of the biological bases of emotional consciousness and put forth a creative alternative hypothesis. However, a prosocial–selfish distinction is not currently warranted for biological affects, nor necessary for explaining hemispheric differences in affect. In contrast, an approach–withdrawal distinction is likely to be necessary for frontal regions, although, as suggested by numerous empirical exceptions, simple hemispheric models fail. Such models have been invaluable for focusing research efforts and for providing a conceptual and empirical foundation on which to build. For introducing further complexity, other distinctions hold more potential than a prosocial–selfish distinction. Functions related to the cognitive control of behavior by active goals or context information, such as working memory, may have particular promise.

On the basis of this critique, it would be a mistake to reject any possibility of a prosocial–selfish distinction. Even if the distinction is of doubtful relevance to the biological affects, it is evocative and might be needed for social and moral affects. Similarly, the typology of the biological affects was under specified, yet Buck’s (1999) emphasis on communication in affect is interesting and possibly important. Clarifying the distinction, the metatheory, and the typology may well prove useful.

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Received August 26, 1999

Revision received April 6, 2001

Accepted April 8, 2001 ■