yielded many causal neurochemical manipulations to be evaluated for their efficacy in modifying the human mental apparatus (Panksepp 1999; Panksepp & Harro 2004). Before we can grasp the global dynamics of entire systems in fragile butterfly nets of empirical measurements, a mountain of work remains to be done using more pedestrian linear approaches. I remain fond of Descartes' third rule of science: *to think in an orderly fashion when concerned with the search for truth, beginning with the things which were simplest and easiest to understand, and gradually and by degrees reaching toward more complex knowledge, even treating, as though ordered, materials which were not necessarily so* (see Williams 1972). Lewis shares a well-ordered image of complexity whose time will come. We will know that has transpired when caravans of relevant empirical findings appear on the horizon.

Not a bridge but an organismic (general and causal) neuropsychology should make a difference in emotion theory

Juan Pascual-Leone

Psychology Department, York University, Toronto, Ontario M3J 1P3, Canada.
juanpl@yorku.ca

Abstract: Does Lewis imply that brain processes might be used to replace an as-yet-unavailable substantive organismic neuropsychology? To counteract this reductionist idea I argue for distinguishing between affects and emotions, and discuss a real-life example of implicit emotional appraisal. Failure to use organismic units of processing such as schemes or schemas makes the bridging attempt fall under a reductionist "mereological fallacy."

This is a thoughtful target article that makes important points, but there are problems with its perhaps unintended theoretical reductionism. First, a dynamic-systems framework is not a substantive theory. Rather it is a metatheory, or epistemological stand, from which substantive theories must be constructed. For instance, the author, like many others, does not seem to distinguish between affects and emotions. Basic affects, however, may be innate organismic processes that assign organismic values ("good", "bad") and dispositions (conations) to both experience and organismic states. Emotions, in contrast, are acquired and situated feelings, more complex than affects, which usually combine affective and cognitive aspects (Pascual-Leone 1991; Pascual-Leone & Johnson 2004). Emotions cannot be purely innate, because they often involve an implicit reference to past experience. Failure to make this distinction complicates mapping onto brain processes.

Second, the author intends to advance neuropsychology, that is, a psychological "macro" theory interpretable within the brain. Hard neuroscience, a relatively "micro" theory (neurons, brain structures, networks) founded on neurology is less important for him. Lewis is aware of this problem of "macro" versus "micro" epistemological levels (epilevels), because he repeatedly states a need for more analytical psychological constructs and complains that common psychological terms are too global (cf. sect. 3.4 of the target article). Surprisingly, given these misgivings, the author does not adopt a functionalist construct such as schemes or schemas, which in the brain appear as distributed assemblies of neurons that are co-functional and often co-activated. Schemes and schemas (systems of schemes) are suitable macro-level units for expressing neuropsychological processes (Arbib et al. 1998), which also have a clear psychological formulation (Pascual-Leone 1995; 1996; Pascual-Leone & Johnson 1991; 2004; 2005). Schemes/schemas can be used to analyze psychologically acts, such as the affective appraisals, that involve emotional interpretations (sects. 2.1 and 3.3).

Consider an example from real life. A person suffers an accident as a passenger in a car. In the rain, the car leaves the road, skipping out of control onto wet sloping grass, speeding as it moves, and as it reaches the end of the hill at the river bank, becomes airborne 12 meters and falls into the river, where the passenger (A) and the driver (B) risked crashing into a huge rock. Although, surprisingly, they were unharmed, A kept for years a hard-to-control anxiety and fear reaction whenever she was in a car driven by B, and driving circumstances seemed dangerous (e.g., passing or coming close to another car). This real-life learned emotional reaction could be dismissed as an instance of one-trial classical conditioning (a descriptive label). This would, however, obscure the fact that emotionally colored thinking processes are involved, and the single experience has automatically synthesized within A's brain a complex schema (i.e., a superordinate scheme) that coordinates several other simpler schemes into an overpowering anticipation of danger. This schema might be symbolized as follows: WHENEVER [[A is driven in a car] AND [the driver is B] AND [present driving circumstances are actually dangerous]], ANTICIPATE THAT [a life-threatening car accident is about to happen to A and B]. In this symbolization the words in capital letters indicate the semantic-pragmatic framework introduced by the superordinate (overall) schema. This schema states that whenever the three stipulated cognitive schemes (which we demarcate with brackets [. . .] and describe in English, although they represent nonlinguistic pieces of knowledge) are coexisting together within the situation (i.e., are part of a synchronized collection of schemes currently dominant in A), the highly probable expectation is that a major accident is about to happen.

Notice that the state of knowledge "A is being driven in a car" is also a complex schema involving appraisal of the situation. The state of knowledge "the driver is B" involves an equally complex process. The situational emotional appraisal "present driving circumstances are dangerous" is likely to involve some combination of the three circuits that Lewis outlines in diagram panels 1, 2, and 3 of Figure 3 in the target article. The three schemes just described must coexist, distinctly but simultaneously, within a synchronized field of activation in A's brain, to evoke the overpowering emotion of an impending car accident. They must coexist as dynamic conditions analogous to those of the prior accident experience (this experience is a fourth distinct scheme!).

This example illustrates that many mental-emotional processes involve the simultaneous synchronized activation of distinct schemes that are the basis (conditions) for transfer of the original emotional experience to the present. This is a distal transfer of learning because car, circumstances, road conditions, and so forth are all different: Transfer is mediated solely by the three schemes I mentioned, first coordinated by A during the original accident. The superordinate schema (i.e., WHENEVER [. . .] AND[. . .] AND[. . .], ANTICIPATE THAT[. . .]), was also implicitly formed during this original accident and included – functionally nested within it (this is the very important *nesting relation* among schemes) – the three initial schemes, which later serve as cues to elicit the schema.

This example also illustrates the idea that schemes emerge within levels of knowing (epilevels), and their heterarchical position within these levels can be appraised in terms of the functional, internally consistent, nesting relations that may hold among them. From this perspective of a repertoire such that schemes can be nested into context-sensitive heterarchies, we can define *low cognition or emotion* as the sub-repertoire in which schemes exhibit low epilevels and cannot have many other schemes functionally nested under them (e.g., in sensorial perception, simple conditioning learning, etc.). In contrast, *high cognition or emotion* is the sub-repertoire of schemes that exhibit high epilevels and can have many other schemes functionally nested under them (e.g., in intellective or intellectual schemes, affective or emotive feelings, representational processes, etc.). The (relative) distinction between affects and emotions I made before can now be clarified by saying that low states are motivated by affects or simple emotions, but high states are motivated by more elaborate emotions or feelings – when they are not affectively neutral.

Because the author's main interest is neuropsychological (i.e., mapping of affects and emotions onto the brain), he should not attempt (as he envisages at the end of section 4.4) to abandon explicit psychological definitions and replace them, perhaps in a piecemeal manner, with neurological structures and pathways, even if he uses the metatheory of dynamic systems. A piecemeal way of relating psychological to neurological processes is invalid and detrimental. This common error of directly imputing psychological meaning to discrete parts of the brain organization without passing by a theory of the psychological organism has been called a *mereological fallacy*, because it violates the logical relations of parts to wholes (Bennet & Hacker 2003).

What is needed is a neuropsychological substantive theory: an *organismic* (i.e., general, causal, and interpretable in the brain) *theory* defined at the macro-level of performance, which can facilitate process and task analysis. The author unwittingly is reinforcing the tendency of neuroscientists to work only with fragmented (i.e., regional, not organismic) theories, such as discrete theories of emotional appraisal, working memory, declarative memory, perception, learning, and so on. This is problematic because the brain works as an integrated totality constituted by subsystems that dynamically interact in complex ways.

ACKNOWLEDGMENTS
Preparation of this commentary was supported by a grant from the Social Sciences and Humanities Research Council of Canada. I thank Dr. Janice Johnson for her advice.

The role of frontocingulate pathways in the emotion-cognition interface: Emerging clues from depression

Diego A. Pizzagalli
Department of Psychology, Harvard University, Cambridge, MA 02138.
dap@wjh.harvard.edu http://www.wjh.harvard.edu/~daplab/

Abstract: By emphasizing nonlinear dynamics between appraisal and emotions, Lewis's model provides a valuable platform for integrating psychological and neural perspectives on the emotion-cognition interface. In this commentary, I discuss the role of neuroscience in shaping new conceptualizations of emotion and the putative role of theta oscillation within frontocingulate pathways in depression, a syndrome in which emotion-cognition relations are dysfunctional.

In the target article, Lewis provides a wide-ranging and timely theoretical formulation of emotion-cognition relations. By emphasizing (a) bidirectional interactions between appraisal and emotion; (b) lower-order psychological and neural constituents underlying the emergence of emotion–appraisal processes; and (c) large-scale functional coupling through oscillatory neurophysiological mechanisms, Lewis offers a multilevel account of appraisal-emotion interactions, fostering a better integration of emotion theory and neurobiology.

In this commentary, I elaborate on two important points raised in the target article. First, I emphasize how a brain-based approach to emotion and appraisal can uniquely inform and constrain theoretical models of these complex constructs. Second, I comment on Lewis's assertion that "phase synchrony in the theta range may underpin the functional integration of systems mediating appraisal–emotion processes" (sect. 5.4). To this end, I review recent event-related potential (ERP) findings of action monitoring (Luu et al. 2004) and electroencephalographic (EEG) findings highlighting disrupted functional connectivity within frontocingulate pathways in depression (Pizzagalli et al. 2003a).

With respect to brain-based approaches to emotion and appraisal, Lewis discusses definitional problems that have hindered the development of comprehensive theories of emotion. Here, I would like to emphasize two points. First, as Lewis argues, definitions of "appraisal" and "emotion" often overlap substantially, causing formidable conundrums to theoretical approaches based on the assumption that these two constructs have distinct functions and are governed by simple, linear, and unidirectional causal processes (e.g., appraisal as a temporal and causal antecedent of emotion; Roseman & Smith 2001). Second, and more important, the definitional overlap between emotion and appraisal mirrors substantial anatomical and functional overlap among brain regions subserving affective and cognitive processes (see Davidson 2003b, for an extended discussion). That is, many brain regions subserving appraisal processes also participate in emotional functions, and vice versa. This evidence forcefully contradicts assertions that affect and cognition are subserved by separate and independent neural circuits, and speaks against the notion that affect and appraisal are subcortically and cortically mediated, respectively (e.g., Panksepp 2003). As suggested by Lewis and others (e.g., Davidson 2003b; Pizzagalli et al. 2003b), emotion is not a monolithic process but comprises different subcomponents encompassing a distributed network of cortical and subcortical systems. Acknowledging empirical data consistent with this assertion (Phan et al. 2002) has important theoretical consequences, because, as appropriately stated by Lewis, "brain function prohibits any real independence between appraisal and emotion" (sect. 5). In sum, although Lewis's overview of neural substrates underlying appraisal and emotional processes is neither comprehensive nor new, a reconceptualization of these substrates in terms of dynamic systems is indeed useful for stressing that the brain's anatomy places important constraints upon psychological theories of emotion and its relations to cognition. Emerging brain-based approaches to the study of depression have similarly underscored not only the synergy between emotional and appraisal processes, but also the utility of a neurobiological framework to parsing the clinical heterogeneity of the disorder (Davidson et al. 2002; Pizzagalli et al. 2004).

My second set of comments pertains to the hypothesis that phase synchrony in the theta range may play a critical role in the functional integration of appraisal–emotion processes. Specifically, Lewis predicts that theta synchronization across the amygdala, hippocampus, anterior cingulate (ACC), orbitofrontal (OFC), and prefrontal (PFC) cortices may "underpin the functional integration of systems mediating appraisal–emotion processes" (sect. 5.4). In humans, empirical evidence for this hypothesis is very limited, but recent findings provide promising support. First, a recent ERP study has shown that the error-related negativity (ERN) – an ERP peak occurring 50–100 msec after the commission of an error – was largely explained by transient phase-locking of midline theta activity to the error responses within distinct frontocingulate regions (Luu et al. 2004). This finding replicated and extended a prior report that error monitoring and evaluative feedback engaged dorsal and rostral ACC sources oscillating within the theta range (Luu et al. 2003). As Luu et al. (2003) proposed, these findings indicate that action regulation mediated by the ACC is associated with entrainment of frontocingulate pathways, consistent with the general framework of Lewis's model.

A second, albeit more indirect, line of evidence suggesting that large-scale corticolimbic synchronization is crucially involved in the emergence of emotion-appraisal processes can be derived from recent findings in major depression, a clinical condition in which coordination of these states is dysfunctional (Mineka et al. 2003). In a recent study, Pizzagalli et al. (2003a) found that baseline theta activity within ACC and PFC/OFC regions was functionally coupled for control, but not depressed, subjects. In healthy controls, this functional connectivity within frontocingulate pathways is in line with anatomical data suggesting that the ACC has reciprocal connections with the dorsolateral PFC and OFC (Barbas 1992; Petrides & Pandya 1999). Disrupted functional connectivity within frontocingulate networks in depression is intriguing, particularly in light of evidence reviewed in the target article and elsewhere (Bush et al. 2000) indicating that the ACC is critically implicated in monitoring conflicting response de-