cortical midline regions in emotion (Heinzel et al. 2004), social interaction (Iacoboni et al. 2004), and autobiographical memory (see Fink et al. 1996). All of the different tasks involved self-referential processing, which may account for involvement of CMS. Another mechanism for distinguishing the CMS as a functional unit from other regions is the pattern of neural activity. The CMS regions show coactivation among themselves. By contrast, they do not show coactivation with other regions, such as lateral prefrontal regions. Instead, opposite patterns of activity – concurrent activation and deactivation – have been described between these regions (see Bush et al. 2000; Drevets & Raichle 1998; Goel & Dolan 2003; Northoff et al. 2004). Future research may reveal further details about dynamic mechanisms for integrating CMS regions into a functional unit and, at the same time, distinguishing them from other regions.

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## Emotional dynamics of the organism and its parts

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**Abstract**: Emotion-science without basic brain-science is only superficially satisfying. Dynamic systems approaches to emotions presently provide a compelling metaphor that raises more difficult empirical questions than substantive scientific answers. How might we close the gap between theory and empirical observations? Such theoretical views still need to be guided by linear cross-species experimental approaches more easily implement in the laboratory.

Credibly "docking" psychological states in neural processes remains a great challenge for psychobiology. In conceptualizing affective states, dynamic systems analysis should be more productive than telephone switchboard and computer models of the past (Ciompi & Panksepp 2004). As I have previously noted (Panksepp 1998a, p. 3), we "look forward to a day when" such topics

> can be encompassed within the conceptual schemes of sophisticated dynamic approaches. The basic emotional systems may act as "attractors" within widespread neural networks that exert a type of "neurogravitational force" on many ongoing activities of the brain, from physiological to cognitive. Unfortunately, at present we can utilize such dynamic concepts only in vague and metaphoric ways.

As Lewis recognizes in this seminal vision set forth in the target article, such compelling conceptual metaphors must now be cashed out empirically. To the degree that Lewis's synthesis generates many falsifiable predictions and supportive new findings, it will have served us well.

Despite advances in human brain imaging, the underlying neural details upon which Lewis builds his theorizing remain largely inaccessible in human brain research. In contrast, animal investigations allow sufficiently detailed access to homologous brain mechanisms, concentrated sub-neocortically, which are essential for emotional feelings (Panksepp 1998a; 2000). However, here is the rub: Cognitive-appraisals, so evident in human emotional mentation, are not readily deciphered through animal models. With as little association cortex as most other animals have, we can question whether their sensory-perceptual abilities can lead to cognitive activity that would resemble human thought. Therefore, how might we dock the human-type cognitive appraisals, which motivate Lewis's analysis, with the type of basic neuro-emotional mechanisms that can only be detailed in animal models?

Lewis proposes five lines of research to evaluate his overarching theory. Might he flesh out his "novel predictions" with the eight foundational principles of self-organization he describes in section 3.2 of the target article?

1. Cortical theta band activity seems to be quite sensitive to both cognitive and emotional processing in both adults (e.g., Klimesch 1999; Krause et al. 2000) and infants (Maulsby 1971), but what might the time-locked indicators of "emotional relevance" be in such studies? Can theta discriminate positive and negative affective relevance? Subcortical theta, which is so important in the overall functions of extended, hippocampus-centered, limbic networks that promote emotional information processing (Buzsaki 2002; Vertes & Kocsis 1997), may not be the same theta that is evident on the human cortical surface (Buzaki & Draguhn 2004; Sederberg et al. 2003).

2. A study of correlations among various brain and peripheral physiologies is a valuable empirical pursuit. What aspects of multidimensional scaling might confirm or disconfirm dynamic system viewpoints?

3. "Vertical integration" is probably best studied in animal models. What criteria would one use to identify recording sites, and what types of prototypic emotions would one seek to contrast? Where does Lewis stand on the issue of emotional "primes"? Affective processes are treated rather globally in the target article. What measures, within dynamic systems schemes, might distinguish one type of emotional response from another?

4. How might we validate that event-related potential changes shortly after perceptual events have any causal relations to thoughtful appraisal processes? If an unconsciously initiated "appraisal" response to a briefly presented stimulus does not exhibit certain event-related potential (ERP) components, would Lewis predict that there will be no resulting consciously perceived attributional process? If so, what neural changes might indicate specific psychological changes?

5. The temporal analysis of emotional episodes is much understudied. It would be stupendous if early childhood ERPs could predict trajectories of the multi-dimensional aspects of affective personality development (Davis et al. 2003), but how might we study the temporal dynamics of such diverse emotional tendencies in the EEG laboratory? At present we do not have compelling data about the natural time courses of emotional episodes.

Clearly, the devil dwells in the methodological and empirical details. It is understandable that impressive unifying visions such as this are bound to be short on such critical dimensions initially, but how do we move from a mere correlational toward a causal analysis? Brain correlates and theoretical functional decompositions, important as they are, will not give us much causal satisfaction (Schutter et al. 2004). How might causal experiments capitalize on the conceptual wealth of dynamic systems approaches, or must we still rely on simpler one-way linear models? If so, how can the analytic and synthetic perspectives be fruitfully merged?

Reductionistic-dissective analyses give us the components that need to be dynamically reconstructed into the whole, but, so far, that can only be achieved in our imagination (Panksepp 2000). When we dissect the many "organs" of the brain-mind, we see that cognitions (the partitioning of external differences) are vastly different species of brain activities than emotions (which "energetically" valuate perceptions and actions; Ciompi & Panksepp 2004). Only when we consider the intact organism, working as a whole, can we claim "that cognition and emotion were never two distinct systems at all." In fact, they can be scientifically distinguished (Panksepp 2003). Even though the liver and kidneys rely on each other completely, if we do not conceptualize their parts well, we cannot learn much about their more holistic, emergence-producing interactions. How might a synthetic dynamic view help us to analyze the necessary parts?

Lewis is correct in his view that a deep scientific understanding of human emotions cannot be achieved without neuroscience. However, a great deal of that understanding must still be reached using traditional parametric approaches that have sustained mind-brain science for more than a century. Such approaches have


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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

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**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.



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