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Review article

Reconciling cognitive and affective neuroscience perspectives on the brain basis of emotional experience

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ABSTRACT

The "affective" and "cognitive" neuroscience approaches to understanding emotion (AN and CN, respectively) represent potentially synergistic, but as yet unreconciled, theoretical perspectives, which may in part stem from the methods that these distinct perspectives routinely employ—one focusing on animal brain emotional systems (AN) and one on diverse human experimental approaches (CN). Here we present an exchange in which each approach (1) describes its own theoretical perspective, (2) offers a critique of the other perspective, and then (3) responds to each other's critique. We end with a summary of points of agreement and disagreement, and describe possible future experiments that could help resolve the remaining controversies. Future work should (i) further characterize the structure/function of subcortical circuitry with respect to its role in generating emotion, and (ii) further investigate whether sub-neocortical activations alone are sufficient (as opposed to merely necessary) for affective experiences, or whether subsequent cortical representation of an emotional response is also required.

Contents

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1. Introduction

When surveying the neuroscientific literature on the topic of emotion, one broad distinction (both at the level of methodology and of conceptual/theoretical frameworks) might be made between the approaches of "affective neuroscience" (Panksepp and Biven, 2012; Panksepp, 2011a, 1998a, 1982, 1981) and the "cognitive neuroscience of emotion" (e.g., Lane and Nadel, 2000). The term "affective neuroscience" (AN) is associated with a broad family of approaches to understanding the neural basis of emotion within animal models and linking these to studies of human emotion. This approach enjoys significant advantages associated with the ability to manipulate and record neural activity through invasive techniques (e.g., deep brain stimulation [DBS], pharmacological manipulations, targeted brain lesions, genetic alterations, direct neurochemical measures, etc.). It also suffers from various weaknesses, especially in its applicability to understanding the neural mechanisms of human emotion, due to (for example) possible neurobiological differences between humans and other animals and to the impossibility of gathering verbal reports from non-human animals. In contrast, the term "cognitive neuroscience of emotion" (CN) is mainly associated with non-invasive approaches (e.g., functional magnetic resonance imaging [fMRI], positron emission tomography [PET], electroencephalography [EEG], etc.) for investigating the brain basis of emotion that are ethically appropriate in studying humans. Relative to more invasive methods, such procedures are limited in the inferences their results typically warrant.[1] However, they can examine the degree of agreement between verbal reports and nonverbal behavioral expressions of emotion. They also benefit from the ability to study the human nervous system directly.

Perhaps not surprisingly, given the differences in methodology, the researchers associated with these two different traditions have developed somewhat discordant conclusions regarding the neural basis of emotion—particularly with regard to the experienced "feeling" aspects of emotion. As the conscious/unconscious processing distinction in human emotion is thought by many to be of particular relevance to understanding psychopathology (e.g., Smith and Lane, 2016), greater consensus about how the neural basis of conscious affective states and related cognitive changes are instantiated is of considerable importance. This is especially true when one considers the critical role of conscious emotion in mental disorders and the maladaptive behaviors that can result from emotional reactions that are not consciously experienced or understood. However, for greater consensus to be achieved regarding emotional experience between the human and cross-species neurosciences, it will be necessary for researchers to first come to an agreement regarding the appropriate physiological and behavioral measures one can use to infer the presence of conscious feelings in humans and other animals.

Therefore, in the present article, we will attempt to first spell out where the theoretical differences lie between the AN and CN approaches on these issues. In doing so it is important to first highlight that there is also disagreement *within* each of these broad theoretical perspectives, and therefore not all of the arguments made here necessarily reflect the views of other researchers in each respective field. However, we believe there is significantly greater consensus within CN and AN than between them, and thus the views presented below will attempt to focus mainly on the areas of greatest disagreement. For instance, AN holds that higher-order cognitive experiences are next to impossible to study in animal models, and CN often advances the view that affective experiences require the cortical brain regions associated with higher cognition. There has been little discussion of how such problems can be empirically resolved, and this paper aims to begin such a conversation.

In what follows, Jaak Panksepp (JP) and Mark Solms (MS) will represent the AN view while Ryan Smith (RS) and Richard D. Lane (RDL) will represent the CN view. In Part 1 (Sections 2 and 3), each pair of authors will present an outline of their own view and the empirical evidence supporting it. In Part 2 (Sections 4 and 5), they will offer a critique of the opposing view, posing questions to which their protagonists are invited to provide clarifying answers. In Part 3 (Sections 6 and 7), each pair will offer responses to the other's critique and questions. Finally, in Part 4 (Section 8), the authors will review points of agreement/disagreement and suggest possible empirical routes toward resolution, and ultimately toward a more unified understanding of how emotional feelings are realized within the mammalian brain.

2. Presentation of the AN perspective (JP & MS)

2.1. Rationale and genesis of a cross-species affective neuroscience approach

A scientific understanding of the neural *constitution* of affect cannot be readily achieved by human research alone, since many of the necessary causal manipulations are not possible by the standard scientific methods used in human research. It seems reasonable to adopt the working hypothesis that affect is a more ancient property of the brain than, say, reflective cognition and language. Since animal brains with a simpler organization are also more accessible for causal experimentation, we concluded that it would be most useful to study homologous forms of affect across the mammalian series.[2] Against this background, it became increasingly clear, especially through radical neo-decortication studies, that most primary affects, at least in raw (unconditioned) form – whether they be *homeostatic* (e.g. hunger and thirst), *sensory* (e.g. pain and disgust) or *emotional* (e.g. fear and attachment)—are neurologically constituted at the level of subcortical brain regions, and not cortical ones (e.g., Panksepp et al., 1994). It became equally clear that the neural

[1] It should be acknowledged, however, that the CN approach also involves some methods for studying emotion in humans that do allow for stronger causal inferences (although in a somewhat diminished manner relative to AN approaches). These include pharmacological manipulations, DBS, transcranial magnetic stimulation (TMS), and transcranial direct current stimulation (tDCS), as well as research based on naturally occurring lesions, neurodegeneration, and genetic or acquired neurological conditions.

[2] Many of the issues discussed here have relevance for non-mammalian species too (for example, periaqueductal grey [PAG]—which plays such a central role in the AN conception of affectivity – is present in all vertebrates, and even invertebrates exhibit conditioned place preferences for drugs that mammals self-administer and get addicted to (Huber et al., 2011)). However, we will limit ourselves to the discussion of mammals, for the reason that they share more of the brain structures implicated in human emotion (especially at subcortical levels, where primal emotional circuits are situated).