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Comment

The Quartet does not play alone
Comment on "The quartet theory of human emotions: An integrative and neurofunctional model" by S. Koelsch et al.

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The study of emotions has been an important topic in cognitive and affective neuroscience in the last decades. In the present manuscript, Koelsch et al. [1] propose a new neurobiological framework based on four emotional core systems (the Quartet), involved in different aspects of human emotion processing. This is an interesting theory that goes beyond classical emotion classification to describe the emotional experience based on four main cerebral components (brainstem, diencephalon, hippocampus, and orbitofrontal cortex). This approach allows the description of different classes of affects, including those that are unique in humans as emotional responses associated to abstract stimuli (for example, aesthetical stimuli such as art and music).

The theory extensively addresses the role of the different components of the Quartet in emotion processing, but it lacks of a proper integration with other fundamental systems, which play a critical role in the emotion experience. In concrete, an important aspect in emotion processing is the interaction between sensory and perceptual systems and the different core components of the emotional network. Indeed, although the relevance of these interactions is often underrepresented in the literature, the emotional experience does not only depend on the functioning of a few cerebral regions, but on a more extensive functional network, which implies, among others, the processing of sensory information. Indeed, humans can experience an enormous diversity of emotions from a broad range of stimuli. For example, in the auditory domain, emotions can be elicited either by basic sounds, such as the cry of a baby, or by very complex acoustic stimuli, such as a Mahler's symphony. Independently of the source and the complexity, all emotional stimuli might engage the four components proposed in the present framework. However, one might be more prone to emotionally react to certain stimulus than to others although all of them engage the same emotional network. In addition, different people might react very differently to a certain type of emotional stimulus (e.g., music), while presenting similar emotional response to another one (e.g., money) [2,3]. One potential mechanism to explain such large inter- and intra-individual differences is the interaction between the brain areas of the core emotional system and those involved in sensation and perception. Therefore, understanding how the sensory information reaches the different components of the Quartet might be a crucial aspect to provide an integrative theory of emotion processing.

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The only reference of the proposed theory to the processing of sensory information is the role of the Orbitofrontal Cortex in emotional appraisal through Stimulus Evaluation Checks [4]. However, the interaction between sensory information and the core areas of emotion processing is far more complex. The different components of the Quartet receive sensory information with different degrees of processing. For example, direct inputs from most of the sensory modalities are sent to the diencephalon (and specifically the thalamus) which, in turn, relies this information to the cortex. This information, with different levels of processing, is then sent to the OFC [5], and to the hippocampus through the entorhinal cortex [6]. The strength of these sensory-emotion interactions could provide an alternative biological explanation for the described emotion processing differences between and within individuals, rather than the inner functioning of the emotional system. For instance, studies of musical emotion have shown that music-induced emotion could be driven in part by the interaction between the ventral striatum and the auditory cortex [7]. In line with these results, Koelsch et al. [8] showed that the interaction between auditory cortex and amygdala plays an important role in music-evoked fear and joy. These two results highlight the relevance of auditory cortex in the experience of music emotion beyond classical limbic and cortical structures involved in emotional processing. Further, a recent study has also identified a group of healthy people who do not emotionally react to music but, in contrast, present standard emotional reaction to other types of rewards (specific music anhedonia [2,9]). This finding suggests that the selective engagement of the emotional circuits critically depends on the characteristic of the stimulus. In addition, lesion studies have also provided important insights in this topic. Within the last two decades, three case studies have been published reporting individuals that lost the capacity of feeling emotions from music after brain damage in different regions (temporal and parietal cortices, insula and amygdala), none of them being part of the Quartet [10–12]. Thus, although the Quartet might represent the ultimate stage of a hierarchical emotional processing, brain regions involved in sensory and perceptual integration might act as portal for the entrance of sensory information into the emotional system. Probably the Quartet is playing the main section in emotion processing, but it is not playing alone.

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