Understanding emotion: Lessons from anxiety

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Abstract: We agree that conceptualisation is key in understanding the brain basis of emotion. We argue that by conflating facial emotion recognition with subjective emotion experience, Lindquist et al. understate the importance of biological predisposition in emotion. We use examples from the anxiety disorders to illustrate the distinction between these two phenomena, emphasising the importance of both emotional hardware and contextual learning.

Lindquist et al.'s meta-analysis convincingly disproves the strong locationist account of the brain basis of emotion. Yet, one needs look no further than the myriad different presentations of anxiety disorders to see that the experience of emotions such as fear is highly idiosyncratic. As behaviour originates in the brain, this idiosyncrasy must be reflected at the neural level, and we endorse Lindquist et al.'s emphasis on context and prior learning in shaping emotional experience. This process, referred to by Lindquist et al. as *conceptualisation*, has been described extensively in cognitive models of psychiatric disorder in terms of schema (e.g., Beck & Emery 1985). However, the universality of facial emotion recognition and the cross-cultural ubiquity of anxiety disorders, suggest that emotional hardware is more important than Lindquist et al. suggest.

We agree that the basic emotions as described by Lindquist et al. are unlikely to represent the most basic psychological emotional processes in the brain. However, by combining facial emotion recognition with subjective emotion experience, Lindquist et al. understate the importance of biological hardware in facial recognition. There is strong evidence that facial expressions are universal social signals, and reading emotion expressions in others is conserved across cultures (Ekman 1973), albeit with some cultural constraints (Elfenbein & Ambady 2002). Evidence suggests that humans are biologically prepared for facial expression recognition. Infants aged 5–7 months can reliably distinguish between most facial emotion expressions, and are beginning to show adult-like attentional preferences for threat emotions such as fear (for review, see Leppänen & Nelson 2009). Around this age infants also show increased startle responses to acoustic probes in the presence of angry, relative to happy, faces (Balaban 1995).

Research by Schofield et al. (2007) replicated by ourselves (i.e., Button et al., unpublished results) has found that social anxiety is not associated with differences in recognising facial expressions but is associated with differences in attributions of personal cost to those same expressions. Similar results have been found across anxiety disorders; emotion recognition does not vary as a function of anxiety, whereas other processes, such as attention, are selectively enhanced for threat emotions such as anger (for review, see Bar-Haim et al. 2007). These findings suggest that facial expression recognition is relatively robust to the influences of anxiety schema. Furthermore, they illustrate how different patterns of neural responses may arise during simple face emotion viewing tasks due to processes such as attribution and attention.

The universality of the clinical syndrome of anxiety disorders (e.g., Horwath & Weissman 2000) suggests that emotional hardware is also important in subjective emotion experience. Vulnerability to anxiety disorders is heritable (Hettema et al. 2001). Evidence that non-phobic individuals report as many aversive experiences with a fear-stimulus as do individuals who are phobic of that stimulus (Ehlers et al. 1994; Merckelbach et al. 1992) suggests that factors other than contextual learning are important in fear responses. However, compared to the relative robustness of facial emotion recognition, subjective emotions are strongly influenced by anxiety schema, as they have the broader function of guiding perceptions of, and responses to, the environment (Cosmides & Tooby 2000; Damasio 1996).

Variations in the physiological responses which characterise different anxiety disorders provide evidence for the influence of anxiety schema on subjective emotion experience. Specific phobias are characterised by relatively normal baseline autonomic activity, with strong elevations in autonomic activity in the presence of the phobic situation (e.g., Hofmann et al. 1995). This pattern of activation is consistent with the specificity of the phobic schema (e.g., spider fears) to the phobic stimulus (e.g., spiders).

By contrast, generalised anxiety and generalised social anxiety are associated with elaborate schemas involving excessive worry about worry and fears of social ridicule and rejection, respectively. As such, a much wider array of stimuli and ruminative thoughts can trigger anxiety, which is reflected in a generally elevated baseline arousal observed in the hypothalamic–pituitary–adrenal axis and sympathetic adrenal medullary activation (for review, see Craske 2003). This increased baseline arousal is associated with a hypervigilance for threat. However, responses to acute stressors in generalised anxiety do not reliably differ from controls, and chronic worriers actually show reduced variability in heart rate and skin conductance during psychological stress (Hoehnsaric et al. 1989; 1995).

McNeil et al. (1993) found that shame and embarrassment result in decreased cardiovascular activity, suggesting that during times of social fear the parasympathetic shame response competes with the sympathetic fearful response, resulting in an attenuated heart rate increases in persons with social phobias. These conflicting processes of shame and fear are likely to be reflected in patterns of brain activity, illustrating the complexity of subjective emotion experience.

Recognising facial expressions is highly conserved, and the influence of anxiety schema on this process is relatively subtle. By contrast, the experience of anxiety and fear is highly idiosyncratic, reflecting much greater influence of contextual learning and belief systems, referred to as *schema*. Given the idiosyncrasy of fear experiences, reflected in the diversity of physiological responses outlined above, we agree with Lindquist et al. that subjective emotional experience is likely to be highly socially constructed. However, the evidence does not support Lindquist et al.'s claim for the social construction of basic emotion recognition, suggesting instead that humans are biologically prepared for facial expression recognition.

The strong locationist model cannot account for the differences observed in emotion recognition and subjective experience. Neither can it account for the idiosyncrasy of emotional experience. We agree with Lindquist et al. on the need to identify the basic psychological processes underpinning emotion. However, in attempting to encompass all the complexity of human emotion into a single model, the result lacks predictive value. If we accept that subjective emotion is socially constructed, then models which address the question of what emotions are and how they are represented in the brain are unhelpful. A more fruitful approach to establishing the brain basis of emotion (and cognition in general) is perhaps to ask what a given brain region does, and why.

Overcoming the emotion experience/expression dichotomy

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Abstract: We challenge the classic experience/expression dichotomous account of emotions, according to which experiencing and expressing an emotion are two independent processes. By endorsing Dewey's and Mead's accounts of emotions, and capitalizing upon recent empirical findings, we propose that expression is part of the emotional experience. This proposal partly challenges the purely constructivist approach endorsed by the authors of the target article.

An essential aspect of Lindquist et al.'s proposal in the target article concerns the attack on the classic attempt to functionally parcellate the brain, according to which, given a linguistically described mental process, a specific brain area underpinning it can be found. From the experimental point of view, the endorsement of such a "one word-one area" account of the mental domain has already shown its limits in the case of the classic cognitivist description of the mental processes underlying social cognition. According to this view, specific brain sites have been postulated to underpin the attribution of mental states to others by means of linguistic-like propositional attitudes, stimulating the search for a theory of mind reading brain modules. We do agree with the authors that such a transposition from language to brain sites could hinder our understanding of the brain, and we fully appreciate their view that words are "essence placeholders" (target article, sect. 3, see "Definitions"), helping to create categories in the absence of strong statistical regularities. The fact that different words designate different emotional states does not necessarily imply that such states can be directly mapped within specific brain locations.

Lindquist et al. frame this criticism within the locationist–constructionist debate, supporting the view that single emotions are not represented in specific brain regions, but rather are constituted by basic psychological operations common across different emotional domains. Despite the intriguing view they propose, however, the authors fail to describe what, according to a locationist approach, a cortical site for a given emotion is supposed to represent. This omission weakens the locationist approach, making it easier to criticize it. Consider the case of the insula. The authors claim that a locationist approach describes the insula as a region where disgust is processed; this view is then compared to a constructionist approach, according to which the insula is involved in "representing core affective feelings in awareness" (sect. 5.2., para. 2). Whereas the constructionist proposal is clearly explained, it is not as comprehensible what, according to the locationist approach, the insula is supposed to process ("perceiving instances of *disgust*," sect. 5.2., para. 1, italics in original).

In our view, this uncertainty is connected to the perspective that having an emotion is a "perceptual act" (see sect. 3, para. 2) during which the emotion "emerges in consciousness." According to the classic perspective the authors seem to endorse, experiencing a given emotion is similar to having a sensation, that is, it means feeling something. However, in their view, differently from sensations, emotions depend upon the "internal" world or, to use the authors' description, "core affect." It follows that experiencing and expressing a given emotion are two different and independent processes. The view that feeling emotions is a sensory activity, totally independent from their motor expression, is an old idea among scholars of emotions. In his seminal work, Darwin (1872) considered the emotion as a feeling preceding the emotional expression, whereas James (1884) considered the emotion as a feeling consequent to the emotional expression. In both cases, the motor output is not considered to be part of the emotion itself. The heritage of Darwin's and James's views strongly influenced contemporary neuroscientists, who mostly accept the experience/expression dichotomy, considering the emotional experience as a specific type of sensory activity (Craig 2002; Critchley et al. 2004; Damasio 1999). This perspective is clearly endorsed also by the authors of the target article.

An alternative perspective was offered, however, by Dewey (1894) and Mead (1895; 1934). Both Dewey and Mead explicitly criticized the experience/expression dichotomy by stressing the lack of any proof of the previous existence of the emotions with respect to the emotional response. In contrast, they suggested that the behavior connected to a specific emotion is part of the emotion itself. The sensory patterns directly trigger the motor representations associated with that specific emotion and this sensory–motor match *is* the emotion. The link between experience and expression has been partially recognized by recent neuroscientific studies. Botox injection in facial muscles decreases the strength of emotional experience (Davis et al. 2010). Activity in the left amygdala and in the brainstem is reduced during imitation of angry facial expression, if Botox is injected into the frown muscles (Hennenlotter et al. 2009). This effect likely reduces both the sensory input and the visceromotor output controlled by these structures. Even inducing the production of an emotional expression, or posture, enhances the correspondent emotional experience and influences the normal processing of the emotional information (Niedenthal 2007).

Even more dramatic is the case of the insula, described by Lindquist et al. as a region involved in the mental representation of bodily sensations. Recently, we showed that two different emotional behaviors can be evoked by the intracortical microstimulation (ICMS) of two different sectors of the macaque monkey insula (Caruana et al. 2011). ICMS of the anterior sector of the insula evokes a complex disgust-related behavior, characterized by a motor component (grimace of disgust) and a complex context-dependent behavior (refusal of food during stimulation). ICMS applied to a more posterior sector of the insula produces an affiliative behavior (lip-smacking).

Given the correlative nature of brain imaging, this approach hardly elucidates the possible causal role of a brain region in a specific emotional behavior. The choice of the authors to restrict their analysis only to neuroimaging, although done for practical reasons, weakens the result of their proposal. In fact, past electrophysiological studies showed that the stimulation of different emotion-related brain regions produces different behaviors related to specific emotions (for review, see Frijda 1986). It is not clear how a purely constructivist perspective could account for these data.

The locationist/constructionist debate could greatly benefit from overcoming the emotion experience/expression distinction, as has already happened in other fields of cognitive neuroscience, such as in the case of the perceptual experience of objects, space, and actions (see Gallese & Sinigaglia, in press). If a specific sensory pattern directly matches with a motor output (facial expression, visceromotor reaction), it makes sense to predict the existence of specific brain sensory-motor representations related to different emotional states. Is this locationist or constructivist?

A constructionist account of emotional disorders

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