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Is Appraisal 'Embodied' and 'Embedded'?

A Neurophilosophical Investigation of Emotions

Abstract: *Emotion theories in present philosophical discussion propose different models of relationship between feeling and appraisal. The multicomponent model considers appraisal as separate component and distinguishes it from feeling and physiological body changes thus presupposing what may be called 'disembodied' and 'disembodied' appraisal as representational. The recently emerged concept of enactment, in contrast, argues that appraisal is closely linked to feeling and physiological body changes presupposing what can be called 'embodied' and 'embedded' appraisal as relational. The aim of the paper is to investigate which concept of appraisal, the 'disembodied' or the 'embedded' one, is better compatible with current neuroimaging data on emotion processing and thus neurophilosophically more tenable. The 'disembodied' and 'disembodied' concept implies distinct and independent brain regions underlying feeling and appraisal whereas 'embodied' and 'embedded' appraisal implies overlapping and dependent brain regions. Recent neuroimaging studies demonstrate that medial and lateral prefrontal cortical regions are involved in both feeling and appraisal and that there seems to be reciprocal modulation between these regions. Though preliminary, these data suggest that feeling and appraisal are associated with different patterns of neural activity across overlapping and interdependent brain regions. I therefore conclude that current neuroscientific evidence is rather in favor of the 'embodied' and*

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'embedded' concept of appraisal as relational than the one of 'disembodied' and 'disembodied' appraisal as representational that is presupposed in current multicomponent theories of emotions.

Introduction

The concept of appraisal was introduced into psychology by M. Arnold (1960) who characterized it as the process that allows determining the meaning and personal significance of a situation for an individual. I only become anxious if I interpret and evaluate the respective situation as dangerous for me otherwise I would not feel anxious. It is this evaluative process that allows for the emotion to be meaningful, to be personally significant and to be about objects, events, or state of affairs in the world. Recent philosophical theories consider appraisal as one component of emotion besides feeling, physiological body changes, motivation, etc. (Scherer, 2000; Prinz, 2004; Frijda, 1986; Solomon, 2004; DeSousa, 1987). Although those theories consider body changes and feeling, appraisal is determined almost exclusively by higher-order cognitive functions which are supposed to constitute personal significance and meaning of emotions (see for instance Nussbaum, 2004). Consequently, multicomponent approaches associate appraisal with the head, e.g., the brain, and feeling with the body. Only the brain is considered to be able to constitute meaning and personal significance and thus to appraise emotion; appraisal becomes subsequently a purely cognitive and ultimately brainy matter while it is not bodily at all. While bodily processes like arousal including visceral and musculoskeletal changes are at best be considered secondary byproducts of appraisal thus remaining contingent and epiphenomenal. This has led Colombetti (2007) to speak of a so-called 'disembodied stance' on appraisal. 'Disembodiment' describes that the body is neither necessarily nor causally involved in constituting appraisal. Instead, the body is supposed to merely indicate the physiological or objective side of appraisal and is therefore considered only in Third-Person Perspective as mere 'objective index' of one's emotional state. In other terms, the body is treated as mere physical object or what has been called *Koerper* (Merleau-Ponty, 1962).

The body as mere physical and objective *Koerper* must be distinguished from the body which we experience subjectively and which is the subjective basis of all my experiences of both the environment and of myself. The subject of experience, our self or I, is situated within its body which constitutes the center of experience from which the

subject experiences and encounters the world, e.g., our environment, in First-Person Perspective. The body of our subjective experience is therefore experiential, e.g., phenomenal, and subjective and must consequently be distinguished from the physical and objective body. It is the body of our subjective experience in First-Person Perspective that has been characterized in phenomenological philosophy as the 'lived body' or 'Leib' (Merleau-Ponty, 1962; Gallagher, 2005) and by what Colombetti (2007) calls 'corporeal personalism' (as distinguished from the Koerper's 'corporeal impersonalism').

Once however the body is considered phenomenal, subjective and personal, e.g., as 'lived body' or Leib, rather than merely physical, objective and impersonal, e.g., as Koerper, appraisal can no longer be separated and cut off from the body. The body as 'lived body' or Leib is per definition subjective, personal and experiential which implies that it is involved in constituting meaning and personal significance and thus appraisal. Rather than merely indicating meaning and personal significance as an 'objective index', the body as 'lived body' is supposed to participate in constituting appraisal by itself. Meaning and personal significance can no longer be exclusively attributed to higher-order cognitive functions and thus to the head and the brain while, at the same time, excluding the body (as Koerper) and its relationship to the environment from their constitution. Instead, the body as 'lived body' and its relationship to the environment must be considered the necessary and constitutive basis of any kind of personal significance and meaning. The 'lived body' must thus be considered an integral and central part of appraisal rather than remaining either epiphenomenal as mere byproduct. The 'disembodied and 'disembedded' stance' on appraisal is thus to be replaced by an 'embodied and 'embedded' stance' and 'corporeal personalism' (see also Colombetti, 2007; Colombetti and Thompson, 2007). Accordingly, appraisal must be considered 'embodied' and 'embedded' and thus relational rather than remaining 'disembodied' and 'disembedded' and thus representational as assumed in multicomponent theories.

What remains however unclear is whether the concept of 'embodied' and 'embedded' appraisal is supported by empirical, i.e., neuroscientific, data of emotion processing or whether the data are rather in favour of the 'disembodied' and 'disembedded' concept of appraisal. In addition to animal studies (see Panksepp 1998 and 2005 as well as LeDoux 2002 for overviews), the newly emerged field of neuroimaging has created the opportunity to investigate neural activity and brain regions during emotion processing. Many imaging studies have been conducted while subjects performed some emotional tasks like

perceiving emotions, evaluating or judging emotions, or becoming aware of one's internal bodily changes (see Phan *et al.*, 2002; Heinzel *et al.*, 2005; Bermpohl *et al.*, 2006; Grimm *et al.*, 2006; Critchely *et al.*, 2004). Generally, brain imaging studies demonstrate that cortical regions like the ventromedial prefrontal cortex (VMPFC) and the medial orbitofrontal cortex (MOFC) as well as various subcortical regions like the amygdala and the Tectum/PAG seem to be crucially involved in processing emotions (see below for further details). The aim of this neurophilosophical paper is to investigate the two alternative concepts of appraisal in the light of recent neuroimaging findings during emotion processing. In a first step, I briefly discuss recent multicomponent approaches to appraisal and contrast them with the concept of 'embodied' and 'embedded' appraisal. This is followed by discussion of recent imaging data about emotional feeling, valence and judgment as distinct psychological components of emotion. In a third step, I investigate whether these neuroimaging data are better compatible with either the 'disembodied' and 'disembedded' concept of appraisal or the 'embodied' and 'embedded' appraisal. Finally, I will discuss some neurophilosophical implications of the concept of 'embodied' and 'embedded' appraisal for determining value, appraisal and their relationship to feeling and the body.

Concept of 'Embodied' and 'Embedded' Appraisal

Multicomponent theories and the concept of 'embodied' appraisal
Scherer (2000) as one of the main proponents of the multicomponent theory of emotion assumes different components in emotion (see Solomon, 2004; Frijda, 1987). The cognitive subsystem is responsible to appraise and evaluate environmental events, the autonomous nervous system accounts for the organisms' internal regulation and energy resources, the motor subsystem expresses emotions, the motivation system guides preparation and execution of associated actions, and the monitoring subsystem controls the systems and their possible interactions. In contrast to early cognitivist theories (Kenny, 1963; Solomon, 1976), feelings and physiological body changes are no longer neglected and excluded from emotions. Scherer assumes the distinct component to be subserved by different subsystems which, though they may modulate each other, remain principally modular, distinct and separate. For instance, the body as mere *Koerper* is not supposed to be involved in constituting personal significance and meaning which is completely delegated to higher-order cognitive functions, e.g., appraisal. It is however not enough to consider the

physiological body, e.g., the body as *Koerper*, as merely one component in emotions while, at the same time, separating and excluding it from higher-order cognitive functions and consecutively from appraisal. Accordingly, though multicomponent theories may consider the body in appraisal, they do not attribute a constitutive role to the body in appraisal. In other terms, appraisal remains essentially 'disembodied' (see also Colombetti, 2007) which can only be resolved by attributing the body, e.g., as 'lived body', a central role in constituting personal significance and meaning.

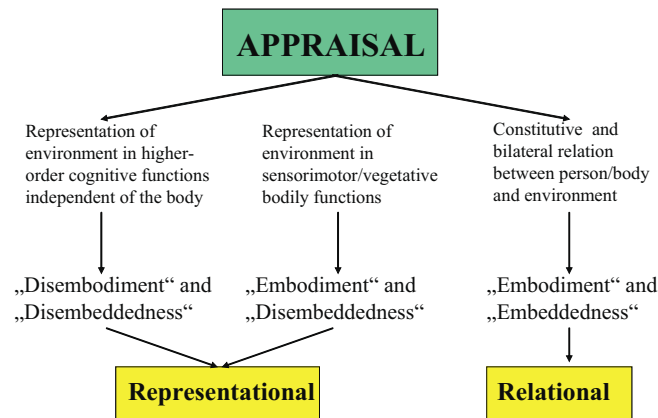
Once the body is attributed a constitutive role in personal significance and meaning, the respective environmental context must be considered too. It is neither the body as mere *Koerper* nor higher-order cognitive function that by themselves constitute personal significance and meaning of emotion but rather the relationship between body and environment. Since the body as 'lived body' allows for subjective experience of the environment in relation to one's body, constitution of meaning and personal significance and thus appraisal depends on the relationship between body and environment.¹ 'Embodiment' of appraisal consequently implies 'embeddedness' of appraisal. 'Embeddedness' of appraisal in this sense implies that the environment is involved in constituting meaning and personal significance in appraisal. Such constitutive role is characterized by direct impact of the environment on the body thereby establishing what I call constitutive relation. This constitutive relation allows for bilateral modulation between body and environment where both mutually shape and modulate each other. Such constitutive role of the environment must be distinguished from a representational one² where the environment is merely represented in body and/or higher-order cognitive functions. The environment is here only indirectly (via the body or cognitive functions) and unilaterally (from the environment to the body but not vice versa) involved in constituting personal significance and meaning — I call this relation a representational relation

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- [1] Similar to the concept of the 'lived body', the concept of environment may be considered subjective, experiential, e.g., phenomenal, and personal and may as such be distinguished from what may be called 'world' that can be described as objective, physical and impersonal.
- [2] The distinction between constitutive and representational relation mirrors the distinction between instrumental and non-instrumental relation as suggested by Hurley (1998, pp. 9–10, 341–2). The instrumental relation is only indirect where a factor *x* has an impact on another factor *y* via another medium *a* in the same way as the environment has an impact on emotional feelings only via its representation in the body. The non-instrumental relation, in contrast, assumes direct impact of factor *x* on factor *y* without mediation by medium *a* reflecting that the environment may have direct impact on emotional feelings without being mediated and represented in the body.

(see below for further discussion of the distinction between constitutive and representational relation). However, such causal representation of the environment in the body cannot be identified with what I call constitution. Representation is not constitution and appraisal is not mere representation of the environment but is bilaterally and thus constitutively dependent on it. Unlike in representational dependence that remains unilateral, constitutional dependence implicates bilateral dependence between body and environment; this implies that there would be no appraisal without environment as there would be no environment (for the experiencing subject) without appraisal. This contrasts with the rather unilateral approach in representation where appraisal remains constitutively independent of the environment. Even if it may assume embodiment, the representational approach cannot presuppose embeddedness. By assuming representation of the environment in the body, the former can no longer exert direct and thus constitutive effects on appraisal which then is possible only indirectly via the body (or higher-order cognitive functions as in disembodied approaches). Such dissociation between embodiment and embeddedness can, for instance, be observed in Lewis (2006). On the one hand, Lewis (2006) assumes separation between the distinct emotion components, e.g., between appraisal, feelings and physiological body changes which implies 'disembeddedness'. While on the other, Lewis (2006) claims that all components act interdependently in what he calls emotional interpretation as 'appraisal-emotion amalgam' mirroring 'embodiment' (see Lewis, 2006, as well as Colombetti and Thompson, 2005; Colombetti, 2007). Lewis neglects the intrinsic relationship between body and environment which must be considered constitutive for personal significance and meaning and thus for appraisal. Even if he considers the body in constituting personal significance and meaning, he neglects the constitutive role of the environment that results in embodied but disembedded appraisal (see also Figure 1 for the distinction between different forms of appraisal).

The distinction between a constitutive and representational role of the environment bears important implications for the relationship between embodiment and feeling and their relationship to appraisal. If the role of the environment is understood in a causal-representational sense, i.e., as represented by the body, embodiment is taken in a representational sense which does not include what I above called embeddedness. Feelings as subjective experience of emotions may be linked to the perception of bodily representations that reflect the representation of the environment in bodily functions. If the bodily representations are not perceived, there will be no feelings. This however

Figure 1 Different forms of appraisal



does not exclude that there may be higher-order cognitive evaluations of the bodily representation and thus what is called appraisal which is then characterized by higher-order cognitive functions. The representational sense of embodiment consequently allows for feeling and appraisal to dissociate from each other which are therefore at best extrinsically linked to each other. This however changes once one assumes a constitutional role of the environment implicating the constitution of a non-representational and thus direct and bilateral relation between body and environment and thus a constitutive (see above) sense of embodiment that includes what I above called embeddedness. . Feeling is then no longer associated with the perception of bodily representation of the environment but rather with the body–environment relation — feeling is nothing but this relation itself which therefore does not need to be perceived to induce feelings. This relation between body and environment is specific for the individual organism/person and implicates therefore what is called personal point of view (see below for further explanation). Once a personal point of view is implicated, the relation and thus feeling include a (e)valuative component and thus what I will call later low-level appraisal — this in turn implies that feeling and appraisal unavoidably co-occur with each other. Though the notions of personal point of view and lower-order appraisal need to be specified (see further

down), what is important at this point is that such constitutional sense of embodiment presupposes intrinsic linkage between appraisal and feeling which contrasts with the representational sense of embodiment where both are at best extrinsically linked. Most importantly, both sense of embodiment imply different neuroscientific predictions. If feelings and appraisal are inseparably linked to each other, as in the constitutional sense of embodiment, one would expect overlapping and mutually modulating neural regions during both processes. If, in contrast, feelings and appraisal are not inseparably linked, as in the representational sense of embodiment, one would expect different neural regions to be involved in feelings and appraisal. Taken together, the relationship between feeling and embodiment, more specifically the two distinct kinds of embodiment, i.e., constitutional and representational, has important implications for the way the neural relationship between appraisal and feeling is considered.

Objections against the concept of 'embodied' appraisal

One objection against a constitutive role of the body in appraisal is often supposed to be found in the Schacter/Singer (1962) experiments. They demonstrated that subjects with autonomous nervous system stimulation, as induced by a pharmacological agent, epinephrine, experienced the resulting arousal as either anger or euphoria in dependence on the respective context (they were placed in a room with either an angry or happy actor). The conclusion is often drawn that arousal indicating physiological bodily changes remains unspecific and cannot contribute to determine specific emotions (see also Colombetti, 2007, and Colombetti and Thompson, 2007, for a criticism of such interpretation of the Schacter/Singer experiments). Determination and distinction of specific emotions can consequently not be based upon feelings as perceptions of physiological bodily changes but must be found elsewhere as for instance in the cognitive domain and thus in appraisal. Bodily arousal remains non-specific for emotions while the specificity of emotion depends wholly on higher-order cognitive processes and thus on appraisal. Schacter/Singer observed also that those subjects who had been properly informed about the physiological effects of an adrenaline injection did not interpret their bodily arousal as a distinct and specific emotion. These results have often been interpreted as to provide support for the assumption that the body plays no constitutive role in appraising emotions which therefore is assumed to remain a purely cognitive process (see Colombetti and Thompson, 2007). The problem in interpreting

Schacter/Singer as support of a disembodied stance on appraisal lies in considering bodily arousal as isolated and independent from the respective environmental context thereby neglecting the body-environment relationship and thus 'embeddedness'. Once 'embeddedness' and the constitution of personal significance and meaning within the body-environment relationship are neglected, appraisal must be wholly attributed to higher-order cognitive processes and, at the same time, be isolated completely from the body as mere physical object (see below for further explanation). However, rather than supporting the assumption of appraisal as higher-order cognitive function, the Schacter/Singer experiments must be considered to lend strong support to the central role of the environmental context in constituting emotion and feelings. The Schacter/Singer results are thus well compatible with the 'embodied' and 'embedded' concept of appraisal rather than with 'disembodied'/'embodied' and 'disembedded' concepts of appraisal.³

Another objection against the concept of 'embodied' and 'embedded' appraisal may be the case of so-called 'brainy emotion' (Colombetti and Thompson, 2007). Damasio (1999) assumes that emotions can also be induced by what he calls 'as-if-body loops' that reflect brain mechanisms signalling physiological body changes when in fact there are no changes at all. Since Damasio identifies emotions with bodily changes, any signal of presumed bodily changes, as for instance through the 'as-if-body loops', is supposed to induce emotion. Does this mean that the body itself is not necessary for emotions? One should be careful. 'As-if-body loops' are possible only on the basis of 'real body loops' that signal real bodily changes since both loops may be regarded as distinct mechanisms that can modulate both internal bodily changes and the signalling of them. This implies a continuum or balance between 'real and as-if-body loops' that includes both extreme cases with either the 'real body loop' or the 'as-if body loop' predominating which respectively may result in what may be called 'bodily emotions' or 'brainy emotions'. 'Brainy emotions' as characterized by extreme predominance predominantly of the 'as-if-body loops' can then be considered an extreme case of

[3] To test this hypothesis one may suggest a reversed form of the Schacter/Singer experiments. One could expose subjects either to emotional situations so that they cannot avoid having and experiencing emotions or, as control, to situations that emotionally remain neutral if not indifferent. At the same time however one could give them pharmacological substances that block vegetative and physiological processing. This experiment could show the bodily dependence of environmentally or contextually induced emotions in the same way as the Schacter/Singer demonstrated the environmental or context dependence of bodily-induced emotions. I owe the basic idea of such experiment to Alexander Heinzl

constitutional bodily/brain dependence while the environment remains constitutionally rather in the background while the reverse may hold true in the case of ‘bodily emotions’. In other terms, the concept of ‘brainy emotion’ is intelligible only within the presupposed framework of embodiment and embeddedness as the default mode (see below for more extensive discussion).⁴

Imaging studies of emotions

Brain imaging of emotional feeling

Recent imaging studies investigated neural activity during interoceptive stimulus processing like evocation of blood pressure changes during isometric and mental tasks, heart beat changes and perception, anticipatory skin conductance during gambling, and heart rate modulation during presentation of emotional faces (Critchley, 2005, for a review; Pollatos *et al.*, 2006; 2007; Craig, 2002; 2003; 2004). These studies observed neural activity changes in the right insula, the anterior cingulate cortex extending from supragenual to dorsal regions (SACC/DACC), and the amygdala. This led to the assumption that specifically the right insula and the SACC/DACC integrally represent autonomic and visceral responses that are transferred from the spinal cord through the midbrain, the hypothalamus and the thalamocortical pathway to the right insular cortex (Craig, 2002; 2003; 2004; Critchley, 2005).

If these regions mediate interoceptive processing the question for their role in the subjective experience of bodily and thus interoceptive changes as the basis for emotional feeling arises. Critchley *et al.* (2004) led evaluate whether the own heart beat was synchronous or asynchronous with an auditory feedback note. As such they could compare interoceptive- and exteroceptive-directed attention. Interoceptive attention to the own heartbeat increased activity in the right insula (and the SACC/DACC and the somatomotor cortex) while exteroceptive attention to the tone suppressed activity in the very same region. Activity in the right insula also correlated with both the performance in the heartbeat detection task and subjective anxiety symptoms which also correlated with each other. These findings suggest close relationship between interoceptive awareness and

[4] See Colombetti and Thompson (2007) and Prinz (2004) for other objections against a constitutive role of the body that include the possibility of emotion in case of spinal cord injury, possible emotions without involving the body, possible body changes without emotions, and no one-to-one correspondence between the types of emotions and the types of bodily states.

emotional feeling. Other studies demonstrated the modulation of these interoceptive stimulus changes by exteroceptive stimuli. Critchley *et al.* (2005), for instance, investigated regional neural activity changes during presentation of happy, sad, angry and disgusted faces. They observed heart rate changes to be dependent upon the emotional category with sad and angry faces inducing the highest heart rate changes. Emotional face-responsive regions like the right (and left) insula, the SACC/DACC, the midbrain/brain stem and the right amygdala were also found to be correlating to heart rate magnitude changes. These results indicate that different emotions may be mediated by differential interoceptive response patterns which may be modulated by neural activity in the right insula, the SACC/DACC, the midbrain/brain stem, and the amygdala.

The group around Pollatos conducted a series of studies on heart-beat perception and emotional feeling. Pollatos *et al.* (2007) investigated attention towards heartbeats and cardiovascular arousal; regions implicated in both conditions included the right insula, the somatomotor cortex, the SACC/DACC, and the DMPFC. They observed activity in the right insula and the DACC to be correlating with the degree of interoceptive awareness while negative feelings correlated with the BOLD response of the interoceptive awareness condition in the DACC and DMPFC. Using EEG, they distinguished between good and poor heartbeat perceivers. Good heartbeat perceivers (Pollatos *et al.*, 2005; 2006; 2007) showed higher arousal ratings as well as higher P300 amplitudes and slow-wave latency ranges than poor heartbeat perceivers during presentation of emotional pictures. Taken together, these studies show behaviourally a close relationship between interoceptive awareness, arousal and emotional feeling while they do not observed relationship with emotional valence. While neuroanatomically, they confirm the involvement of the right insula, the SACC/DACC and the DMPFC in mediating the relationship between interoceptive awareness and emotional feeling.

Brain imaging of emotional valence

Emotions can be characterized by emotional valence, a psychological concept, that refers to their hedonic tone (i.e. pleasure versus displeasure) (see Feldmann-Barrett and Russell, 1999; Charland, 2005; and Colombetti, 2005, for an overview and see below for further discussion of the concept of valence). The hedonic tone is specific and private for a particular person who consequently experiences its emotional feelings as 'mine' and thus as subjective. Valence

understood in this sense comes close to what Colombetti (2005) and Charland (2005) described as ‘affect valence’ as distinguished from ‘emotion valence’ and ‘evaluation valence’. ‘Affect valence’ refers to the individual feelings or affects and can be characterized by subjective experience, meaning and personal significance thus reflecting a pretheoretical and pre-cognitive or pre-reflective phenomenal level. ‘Emotion valence’, in contrast, refers to the individual emotion (rather than to the individual feelings/affects as ‘affect valence’) and ‘evaluation valence’ points out the elicitation of emotions including feeling/affect by positive or negative evaluations (see also Ben-Ze’ev, 2000). The studies reported in the following refer mostly to what conceptually is described as ‘affect valence’ whereas they do not probe for ‘emotion and evaluation valence’.

Recent imaging studies incorporated individual subjects’ ratings of emotional valence as regressor in the analysis of functional activation data obtained during viewing of emotional pictures (Grimm *et al.*, 2006; Heinzl *et al.*, 2005). Regions specifically activated in relation to subjective ratings of emotional valence included the VMPFC and the DMPFC. In an earlier study, Lane *et al.* (1998) investigated regional cerebral blood flow (rCBF) changes during film- and recall-induced emotion; these were related to scores on the Levels of Emotional Awareness scale (LEAS), a measure of individual differences in the experience of emotion. Covariate analysis revealed activation in the PACC: The more activation was observed in PACC, the higher scores of emotional awareness were obtained. Grimm *et al.* (2006) included subjective ratings of emotional valence as regressors for both contrasts emotional picture perception, reflecting the affective component of emotion, and emotional judgment indicating the cognitive component of emotion. Interestingly, neural activity in VMPFC correlated with subjective ratings of emotional valence only during emotional picture perception but not during emotional judgment.

The studies reported so far relied on visual emotional stimulation, i.e., visually-induced feeling. Other studies inducing feeling in different sensory modalities using non-visual tasks revealed more or less similar regions with predominant involvement of the MOFC and the VMPFC. In a gustatory whole-food experiment Kringelbach *et al.* (2003) determined the subjective pleasantness ratings when a liquid food was eaten to satiety. These ratings mirroring the feeling of satiety correlated with the activation of a region in the left mediolateral orbitofrontal cortex. Small *et al.* (2003) demonstrated regional association of subjective affective valence with the MOFC during presentation of unpleasant and pleasant taste in fMRI. In contrast neural

activity in subcortical regions including the amygdala, pons and cerebellum correlated with intensity irrespective of valence. An analogous result was obtained in the case of olfaction. Anderson *et al.* (2003) observed activity in orbitofrontal cortical regions to be related to valence independent of intensity. In contrast, Anders *et al.* (2004) observed no correlation of neural activity in the anterior medial cortical regions like the VMPFC, the so-called aCMS, with emotional valence. They recorded startle reflex modulation and skin conductance responses in healthy volunteers during fMRI while they viewed a set of emotional pictures and took verbal ratings of the emotional valence and arousal of each picture after scanning. The discrepancy of their results compared to those of the other studies appears difficult to account for since they used the same stimuli applying a similar paradigm. It may be speculated that there is a relation to the application of the startle reflex recording, which may interact with the neural activity in aCMS. However, due to the lack of empirical data this remains unclear.

Some indirect support for the association of affective valence with neural activity in aCMS is coming from patients with lesions in these regions. Among other parameters, the group of Rolls (Hornak *et al.*, 2003) investigated feeling with a subjective emotional change questionnaire in patients with lesions in (medial) orbitofrontal cortex (OFC), anterior cingulate/medial prefrontal cortex (ACC/MPFC), or dorsolateral prefrontal cortex (DLPFC). Patients with lesions involving the medial OFC or ACC/MPFC showed strong changes in subjective experience of affective valence (see also Rolls, 2004; Berlin *et al.*, 2004; and Damasio, 1999). The intensity and frequency of their emotions increased and they became hypersensitive especially to sad events resulting in a far more emotional state. In contrast, patients with DLPFC lesions showed no changes in subjective emotional experience. Finally, patients with subcortical lesions like, for example, in the amygdala as in Urbach Wiethe disease show changes in affective processing (e.g. Siebert *et al.*, 2003). Unfortunately, valence and intensity ratings were not obtained in either group of patients. Taken together with the imaging findings in healthy subjects, one could hypothesize that neural activity in anterior aCMS contributes to what is described as 'affect valence' irrespective of intensity.

Finally, one should consider interaction between these regions, the anterior cortical midline structures (aCMS), and subcortical regions. The aCMS may directly interact with subcortical midline regions like the hypothalamus, PAG, the stria terminalis, the preoptic areas, and the dorsomedial thalamus. Following Panksepp (1998; 2005),

different subcortical regions may be involved in generating different types of feelings like fear, anger/rage, sex/lust, panic, and joy (see also Winkielman and Berridge, 2005, who also point out the importance of subcortical regions in generating distinct types of emotion). We therefore assume that the interaction between neural activity in aCMS and emotion generation in subcortical midline regions may give rise to the distinct types of feelings in humans; the type of feeling may then depend on which subcortical midline region the aCMS predominantly interacts with.

Brain imaging of emotional judgment

Most of the above reported studies focused on emotion perception thus excluding (as much as possible) cognitive components. Other studies, in contrast, focused more on the cognitive components of emotion processing by, for instance, including a judgment (Grimm *et al.*, 2006; Taylor *et al.*, 2003) of or attention (Berpohl *et al.*, 2006) to emotions. This implicates that the focus is no longer on subjective experience itself and thus on what above is described as ‘affect valence’ but rather on ‘evaluation valence’ as the elicitation (or possible modulation) of emotional feelings by positive or negative judgments. The distinction between different types of valence, ‘affect valence’ and ‘evaluation valence’, raises the question for their neural relationship.

Interestingly, recent studies demonstrate neural segregation between both components (Northoff *et al.*, 2004; Grimm *et al.*, 2006). The affective component correlated with neural activity in aCMS during mere emotional picture viewing whereas the evaluative component was related to activation in lateral prefrontal cortex (LPFC) during judgment of emotional pictures (see also Dolcos *et al.*, 2004). These results lend strong support to the psychological distinction between the affective and evaluative components of valence in neural respect thus mirroring what conceptually has been distinguished as ‘affect valence’ and ‘evaluation valence’. Furthermore, they support our assumption of the crucial involvement of aCMS in the affective component of valence thus what Charland (2005) and Colombetti (2005) call ‘affect valence’. This must be distinguished from the evaluative component of valence and thus ‘evaluation valence’ that may rather indicate associated cognitive processing; this is further supported by association with the LPFC that has been closely linked with reflective processes in general (Duncan and Owen, 2000) and in emotions in particular (Northoff *et al.*, 2004; LeDoux, 2002).

Most importantly, we observed a converse correlation pattern in VMPFC and DLPFC. The VMPFC showed a positive relationship to valence whereas neural activity in the DLPFC correlated rather negatively. The more positive emotional pictures (including positive and negative ones) were rated, the less activation (or even more deactivation) was observed in bilateral DLPFC. This converse correlation pattern between VMPFC and DLPFC strongly agrees with the observation of reciprocal modulation between medial and lateral prefrontal cortex during emotional-cognitive interaction. Reciprocal modulation can be defined by signal changes in opposite directions (i.e. signal increases and decreases) in different regions. This has been demonstrated in recent studies on emotional-cognitive interaction. Emotion processing is known to lead to signal increases in the VMPFC (and DMPFC) and concurrent signal decreases in the DLPFC (and VLPFC). In contrast, cognitive tasks induce the reverse pattern with signal increases in lateral prefrontal cortex and signal decreases in medial prefrontal cortex. Our finding of a converse correlation pattern specifies the functional mechanisms of reciprocal modulation with respect to valence. Both VMPFC and DLPFC are apparently sensitive to modulation by valence, but to distinct aspects of it, i.e., affective and evaluative aspects which seem to be modulated in reciprocal ways.

Neurophilosophical Implications

Appraisal and medial-lateral prefrontal reciprocal modulation and attenuation

Multicomponent models consider emotions to consist of separate and distinct components including both feelings and appraisal which are supposed to interact or co-occur with each other. However, feelings and appraisal are considered separate components with appraisal alone allowing for constituting personal significance and meaning. This approach considers appraisal to be a distinct, separate and independent module as distinguished from emotional feeling which conceptually corresponds to what I described above as 'disembodied' and 'disembedded' appraisal. Neuroscientifically, such modular approach implies that appraisal and feeling as distinct and separate components are mediated by different brain regions. While the alternative concept, 'embodied' and 'embedded' appraisal, implies the converse, e.g., that appraisal and feeling as intrinsically linked aspects of emotions are mediated by at least overlapping brain regions. I assume that the aCMS reflect these overlapping brain regions that allow for the co-occurrence of feelings and appraisal as low-level appraisal (see below).

Most importantly, multicomponent models associate appraisal with predominantly higher-order cognitive function and determine such cognitive involvement to be necessary for constituting personal significance and meaning of emotion. If however the modular distinction and separation between feeling and appraisal is no longer empirically plausible, as indicated above, the role of higher-order cognitive function in appraisal must be questioned. Empirically, this raises the question for what is really measured in the imaging experiments in psychological regard when subjects for instance make emotional judgments (see above). The multicomponent proponent of ‘disembodied’ and ‘disembedded’ appraisal would probably argue that emotional judgment reflects exactly those higher-order cognitive functions that are necessary to constitute personal meaning and significance of emotions. In other terms, he would probably associate the psychological function of emotional judgment with his concept of appraisal as distinct and separate component. This would fit at least superficially nicely with neuroimaging data reported above. Emotional judgment involves signal changes in lateral prefrontal cortical regions like the DLPFC and the VLPFC (see above) that are distinct from those associated with emotional feeling (medial prefrontal cortex) and have indeed been associated with higher-order cognitive functions like working memory and executive functions. Though preliminary it seems as if the neuroimaging data lend support to both presuppositions made by the multicomponent approach, (i) appraisal is a distinct and separate component when compared to feeling; (ii) appraisal is determined by higher-order cognitive functions. Do the neuroimaging data thus support the ‘disembodied’ and ‘disembedded’ concept of appraisal?

Before answering this question I want to focus on a particular pattern of neural activity that has been observed in neuroimaging studies of emotion, the reciprocal modulation and attenuation between medial and lateral prefrontal cortical regions. Based on the above-mentioned findings, I hypothesize ‘reciprocal modulation and attenuation’ of neural activity in medial and lateral prefrontal cortical regions. ‘Reciprocal modulation’ can be defined by signal changes in opposite directions (i.e. signal increases and decreases) in different regions. Whereas emotional processing like emotional feeling and perception is known to lead to signal increases in medial prefrontal cortical regions and concurrent signal decreases in lateral prefrontal cortex, cognitive tasks like judgment may induce the reverse pattern with signal increases in lateral prefrontal cortex and signal decreases in medial prefrontal cortex. Emotional-cognitive interaction might then

be associated with the functional mechanism of 'reciprocal attenuation': Inclusion of an emotional component into a cognitive task might lead to smaller signal decreases in medial prefrontal cortical regions and, at the same time, smaller signal increases in lateral prefrontal cortical regions; this means that in the emotional condition the signals might be closer to baseline in both medial and lateral prefrontal cortical regions which shall be called 'attenuation' in the following. Since 'attenuation' concerns both medial and lateral prefrontal cortical regions in opposite directions (i.e. smaller signal decreases/increases respectively), one may speak of 'reciprocal attenuation'. Our own (Grimm *et al.*, 2006; Northoff *et al.*, 2004) and others' (Goel *et al.*, 2003) studies lend strong empirical support to the assumption of 'reciprocal modulation and attenuation' in medial and lateral prefrontal cortex during processing of affective and cognitive components of emotions.

Why is this prefrontal cortical pattern of reciprocal modulation and attenuation difficult to explain for the proponent of the multicomponent approach? The proponent might argue that this pattern reflects only an interaction between feeling and appraisal which he allows to be possible. The brain regions mediating appraisal might for instance modulate those associated with emotional feeling in the form that the lateral prefrontal cortex top-down modulates the medial prefrontal cortex which indeed has been shown (see Ochsner *et al.*, 2004; 2005). Or conversely, the medial prefrontal cortex might bottom-up modulate the lateral prefrontal cortex. These kinds of modulation are unilateral in that x modulates y without x being modulated by itself during its modulation of y which implies that the constitution of x remains independent of its modulation of y (the reverse is true, of course, for y as well). Such unilateral interaction is well compatible with the multicomponent approach where appraisal and feeling are supposed to remain constitutionally independent while interacting with each other. The problem however arises in that moment where x that modulates y becomes modulated by itself when modulating y. Thus modulation of y by x implies not only modulation of y but also co-occurrent modulation of x itself. The unilateral interaction is here replaced by bilateral interaction between x and y which implies that the constitution of x can no longer be considered to be independent of the constitution of y and vice versa. Such model of bilateral interaction seems to be suggested by the observed pattern of reciprocal modulation and attenuation in medial and lateral prefrontal cortex. Considering reciprocal modulation and attenuation, the proponent will have difficulties maintaining his claim of constitutional

independence between feeling and appraisal since such bilateral interaction implies constitutional dependence rather than independence. This however puts the multicomponent approach into doubt because it is based per definition on constitutional independence of appraisal. Accordingly, the empirical observation of reciprocal modulation is better compatible with the assumption of intrinsic linkage between feeling and appraisal which in turn presupposes embodiment in a constitutional sense (see above for details) thus implicating what I called embeddedness. Whereas reciprocal modulation is not compatible with separation and independence between feeling and appraisal as in multicomponent approaches which (at best) presuppose embodiment in a representational sense thus implicating what I called disembeddedness. To put it more directly, reciprocal modulation supports the concept of a constitutional sense of embodiment and thus embeddedness rather than the representational sense of embodiment that goes hand in hand with disembeddedness (see above). I therefore conclude that the empirical observation of reciprocal modulation and attenuation is better compatible with the ‘embodied’ (in a constitutional sense) and ‘embedded’ concept of appraisal rather than the ‘embodied (in a representational sense)’ and ‘disembedded’ concept of appraisal.

Appraisal, cognitive function and value

The ‘embodied’ and ‘embedded’ approach is confronted with a problem when interpreting the empirical data. This approach assumes feeling and appraisal to be no longer separate and distinct components which though preliminary is in accordance with the observed overlap between emotional feeling and valence in anterior cortical midline structures (see above). This raises the question for the relationship between the psychological function of emotional judgment and the philosophical concept of appraisal, e.g., whether they correspond to each other or not. The multicomponent theorists is here at ease in associating emotional judgment with appraisal after he separated the latter from feelings. If, in contrast, feeling and appraisal are no longer separated from each other, it becomes unclear to which philosophical concept emotional judgment and other supposedly higher-order cognitive functions correspond if not appraisal. Current neuroscientific theories of emotion (LeDoux, 2002; Damasio, 1999; Rolls, 1999) often distinguish between ‘having an emotion’ and ‘feeling an emotion’. There is however, as Bennett and Hacker (2003, pp. 210–14) argue, no principal distinction between ‘having an emotion’ and ‘feeling an emotion’

since the having of an emotion is to be identified with the feeling of that emotion. Either we have an emotion and subjectively experience or feel the emotion or we do not feel any emotion and then we have no emotion at all. 'Having an emotion' is consequently to be identified with 'feeling an emotion' while their distinction remains untenable and implausible. According to Bennett and Hacker (2003, p. 214), the main difference should instead be drawn between 'feeling an emotion', as being the same as 'having an emotion', and 'realizing what emotion one feels'. This is well compatible with the 'embodied' and 'embedded' concept of appraisal. Appraisal is here supposed to be already implicated in 'having an emotion' and thus in 'feeling an emotion'. Whereas this basic pre-cognitive sense of appraisal (see below for further discussion) must be distinguished from 'realizing what emotion one feels'. The latter may empirically correspond to emotional judgment where one becomes aware and realizes whether the experienced and felt emotion was either positive or negative. Higher-order cognitive functions are thus associated no longer with appraisal but rather with the reflection and realization of one's emotion and thus with what has been called reflective consciousness (see below for further discussion).

If appraisal is intrinsically linked to feeling on the one hand and no longer predominantly determined by higher-order cognitive functions on the other, the exact nature and determination of appraisal remains unclear. Rather than consisting in a reflective judgment, appraisal may then be considered a more basic function that is no longer predominantly determined by higher-order cognitive function. What however is this more basic function that constitutes appraisal in a non-cognitive form remains unclear. One could, for instance, assume causal representation (in the sense of Dretske) of the environment and its relationship to the organism by the body which then constitutes personal significance and meaning. However, his sense of embodiment is not the same sense of embodiment presupposed in the concept of 'embodied' and 'embedded' appraisal. This is so because constitutional interdependence between feeling and appraisal is not the same as causal representation. Causal representation is well compatible with constitutional independence between feeling and appraisal and ultimately with independence from the environmental context. One might consequently distinguish between two distinct senses of embodied appraisal. Appraisal might be considered 'embodied' only in a representational sense, e.g., as 'embodied-r', but not as 'embodied' in a constitutional sense, e.g., as 'embodied-c'. (If in the following I speak of embodiment without referring to either the

representational or constitutional sense, I imply the latter to hold.). The distinction between the representational and constitutional sense of embodiment implies a crucial difference with regard to embeddedness. Whereas the constitutional sense of embodiment implies embeddedness (see above), the representational sense does not since the body may well remain independent and thus constitutionally isolated from the environment. Accordingly, the concept of ‘embodied-r’ appraisal goes hand in hand with ‘disembeddedness’ (see above).

What do the different concepts of appraisal imply for interpreting the function of the anterior cortical midline structures? Proponents of what I called the concept of ‘embodied-r’ and ‘disembedded’ appraisal would probably argue that the anterior cortical midline structures are crucially involved in causally representing those ‘organism-environment relations that bear on well-being’ by means of which personal significance and meaning are constituted. Due to convergence between intero- and exteroceptive afferent inputs into anterior cortical midline structures as so-called ‘convergence zone’ (Rolls, 1999), the assumption of a role of these regions in causally representing ‘organism-environment relations’ might at least be plausible. This however becomes relativized once one considers the fact that many other brain regions including subcortical ones like the PAG, the tectum and the colliculi (see Panksepp, 1998; 2005) show the very same kind of strong intero-exteroceptive convergence. The question remains however what is so special about the anterior cortical midline structures that they are so strongly involved in neuroimaging studies on emotional feeling and valence. While the proponent of ‘embodied-c’ and ‘embedded’ appraisal might postulate that the anterior cortical midline structures are crucially involved in constituting some basic non-cognitive form of value which empirically may correspond to reward (see below for further explanation).⁵ There is indeed some empirical support for the assumption of the involvement of anterior cortical midline structures in some basic non-cognitive form of value which, as I assume, is closely linked to what empirically is described

[5] Appraisal is thus understood in a constitutional sense (see Ben-Ze’ev, 2000, p. 72) where it is considered a crucial component of emotion while not necessarily being involved in the cause of that emotion which the proponent of ‘embodied-c’ appraisal traces back to the intrinsic organism-environment relationship than to appraisal itself. In contrast, Prinz seems to assume a concept of ‘embodied-r’ appraisal in a more causal sense (see Ben-Ze’ev, 2000, p. 72) since appraisal is supposedly implicated in the cause of emotion by representing the ‘organism-environment relation that bears on well-being’. The cause of emotion is thus shifted from the intrinsic organism-environment relationship to appraisal itself which in turn implies a shift from ‘embodied-c’ to ‘embodied-r’ appraisal.

as reward. Reward is determined as an immediate form of value for the organism (Montague *et al.*, 2002; 2006). Several studies on reward demonstrated indeed involvement of anterior cortical midline structures and subcortical regions like the Nucleus accumbens (NAcc) and the ventral tegmental area (VTA) (Montague *et al.*, 2002; 2006). If this is true, one would assume close association of reward with emotional feeling and appraisal which as some authors argue (Rolls, 1999) is the case and is further supported by involvement of the very same regions in emotion processing (Phan *et al.*, 2002; Northoff *et al.*, 2004; Heinzl *et al.*, 2005). However, the exact psychological and neuronal relationship between reward and value on the one hand and emotional feeling and appraisal on the other remains to be investigated. While conceptually value may be assumed to be constituted by the individual's relation to the environment thus reflecting what Lazarus (1991) calls 'core relational themes' (see also deSousa 1987). Since it is constituted within and by the individual's relation to the environment, the constitution of value co-occurs with the constitution of what is called a personal point of view, i.e., the perspective from which the respective person subjectively experiences the environment in terms of value and emotional feelings. In other terms, the process of relating the person/organism to the environment includes the constitution of a personal point of view that co-occurs with emotional feeling and valuing i.e., (low-level) appraisal. One may consequently also characterize the here advanced embodied and embedded low-level form of appraisal as relational thus implying what I call a relational concept of appraisal.

I so far characterized the basic and non-cognitive form of appraisal by value which empirically I traced back to reward and conceptually associated with the basic relation between organism/body and environment. What does this imply for the concept of appraisal? Several authors in the recent philosophical discussion about emotion claim for a non-cognitive form of appraisal. Ben-Ze'ev (2000, pp. 57–60; see also Ben-Ze'ev, 1993, pp. 117–33) for instance distinguishes between schematic and deliberative evaluation. Schematic evaluation is spontaneous, tacit, fast, unconscious, automatic, more basic and evolutionary-based, and strongly modulated by social and biographical history whereas deliberative evaluation is rather slow, conscious, voluntarily controlled, higher-order and cognitively dominated, and modulates and transcends social and biographical history. He assumes that emotions are predominantly constituted by schematic evaluation rather than deliberative evaluation which though may have some role in especially preparatory emotional responses. What he calls

schematic evaluation may be well compatible with the here advanced basic and non-cognitive concept of appraisal. Griffith (2004, pp. 246–7) also speaks of ‘low-level appraisal’ which according to him involves predominant action-based representation and focuses on what he calls ‘ecological significance of the environment to the organism’ rather than on cognitive content as cognitively-dominated ‘high-level appraisal’. However, one should also exclude that even if ‘high-level appraisal’ is rejected, the significance of the environment might still be considered in a purely representational sense in ‘low-level appraisal’ rather than in a constitutional sense (see above). Such ‘low-level appraisal’ remains representational which distinguishes it from the here advanced concept of ‘embodied’ and ‘embedded’ appraisal where the relationship between body and environmental is rather constitutional than representational. Finally, Robinson (2004, pp. 32–6) assumes ‘affective or non-cognitive appraisal that concerns things that matter to the organism’ which is fast, automatic and below the threshold of awareness. Such ‘affective appraisal’ may be a ‘primitive’ type of evaluation which allows to appraise the environment in terms of survival and well-being thereby singling out what matters and concerns the organism and what is of significance to it, e.g., ‘what is at stake for the wants and interests of organism in this particular encounter with the environment’ (Robinson, 2004, pp. 34–5). It is more than apparent that Robinson’s concept of ‘affective, non-cognitive appraisal’ comes very close to the here advanced concept of appraisal. Taken together, my neurophilosophical claim of a more basic and non-cognitive form of appraisal, i.e., low-level embodied and embedded appraisal with value as its core nucleus, is well compatible with and extends (with regard to the characterization by valuation as distinct from evaluation) analogous suggestions for a more basic form of appraisal in recent philosophical emotion theories.

‘Embodied’ appraisal and feeling

The framework of ‘embodiment’ and ‘embeddedness’ presupposes that appraisal cannot be identified with reflective consciousness either since the latter allows us to become aware and realize what kind of appraisal our emotions implicated. Once appraisal is not exclusively associated with higher-order cognitive function, it can no longer be sharply and exclusively distinguished from feeling. Feeling and appraisal must then be considered integral aspects (rather than components) of emotions which are intrinsically linked to each other. This

implies that any kind of appraisal is accompanied by feelings which has been described as 'feelings of appraisal' (Frijda, 1986; Colombetti and Thompson, 2005). Even stronger, the constitution of appraisal should be dependent on feelings. Appraisal is here determined as value for a specific organism or person which empirically may correspond to reward (See above); value is subjective and presupposes therefore a personal point of view that is constituted by the individual subject's/person's relation to the environment. Such personal point of view may be realized and expressed in feelings that can preliminarily be defined as subjective experience of emotion (see Goldie, 2000).⁶ Constitution of value by appraisal may consequently be impossible without the involvement of feelings and the respectively implicated personal point of view. Conversely, feelings may also constitutionally be dependent upon appraisal. Appraisal allows to constitute value as for instance positive or negative value, e.g., reward or punishment (see Rolls, 1999). Feelings reflect the subjective experience of that value implying that appraisal is integral in feelings. Both feeling and appraisal are consequently constitutively interdependent on each other. If there is no value and thus no appraisal, feelings remain impossible since the absence of emotion implies the absence of feelings. While the converse holds true, the absence of feeling implies the absence of appraisal since without subjective experience from a personal point of view value and appraisal remain impossible too.

Such intrinsic linkage and constitutional dependence implies that appraisal and feeling always already and necessarily co-occur with each other as integral aspects of emotion. The intrinsic linkage between feeling and appraisal may correspond to what I above described as affective and evaluative components of valence (see above) though in a modified version. Feeling allows for subjective experience and may thus mirror the affective aspect of valence. While the here advanced basic and non-cognitive form of appraisal seems to concern the evaluative aspect. One should however differentiate between valuation and e-valuation. Valuation is considered a basic and non-cognitive form of appraisal whereas e-valuation rather implicates reflective and thus higher-order cognitive functions. E-valuation may correspond to what in imaging is tested for as emotional judgment. Whereas valuation may already be implicated in mere emotional perception and feeling. Taken together, I 'complexify' (see Colombetti, 2005, for this expression) the concept of emotional

[6] A full account and definition of feeling is beyond the scope of this paper and will therefore be dealt with elsewhere.

valence, i.e., ‘affect valence’, in three regards. First, I distinguish distinct aspects, affective and valuative aspects, which must be considered integral and mutually inherent to each other. Second, I consider these aspects to be basic and non-cognitive. I distinguish these aspects from higher-order cognitive more reflective components like e-valuation and emotional judgment. Third, affective and valuative aspects of ‘affect valence’ are inherently relational, i.e., can be constituted only within and by the relation between organism and environment thus presupposing what conceptually can be described as ‘embodiment’ and ‘embeddedness’. Since it presupposes ‘embodiment’ and ‘embeddedness’, I call the integral aspects of affectivity and valuation in a non-cognitive and basic form of ‘affect valence’ the concept of ‘embodied’ and ‘embedded affect valence’.

This concept of ‘embodied’ and ‘embedded’ affect valence’ implies that feeling can not be dissociated from appraisal and emotions. This is, for instance, presupposed in recent neuroscientific theories that seem to exclude emotional feeling from the core of emotions by associating emotional feeling with metarepresentation and higher-order processing of emotions. For example, Rolls (1999; 2000) assumes that higher-order linguistic thought processing is essential for the occurrence of consciousness and consequently for the emergence of feelings. LeDoux (1996; 2002) considers working memory to be crucial for consciousness, which in turn allows for feelings to occur. Analogously, Damasio (1999) characterizes consciousness by meta- or second-order representation of contents; he considers the distinct types of emotions as contents that can be represented on a higher level, i.e., meta-represented which in turn induces feeling. Though these approaches differ in various aspects, they all have in common that they account for emotional feeling by higher-order cognitive processing. Emotions as lower-order (and unconscious)⁷ processes are

[7] I do not want to get into the discussion of unconscious versus conscious emotion here. Analogous to implicit memory and implicit perception, Kihlstrom has suggested ‘emotional unconscious’ and ‘implicit emotion’ as corresponding labels for unconscious affective reactions. ‘Explicit emotion’ refers to the person’s conscious awareness of an emotion, feeling, or mood state. Whereas ‘implicit emotion’ refers to changes in action and behaviour that are attributable to one’s emotional state, independent of her or his subjective experience of that state (Kihlstrom, 1999; Kihlstrom *et al.*, 2000). Berridge and Winkielman (2003) argue that a truly unconscious (or implicit) emotion requires not only unconsciousness of the stimulus that is eliciting an emotion (see for example Zajonc 2000, Oehmann *et al.*, 2000) but, even stronger, an unconscious and thus unfelt emotion. In this case emotions have an impact only on perception, action, i.e., on behaviour, accounting for the unconscious emotional reaction (Berridge & Winkielman, 2003; Ekman, 1999; Frijda, 1999; Lang, 1993; Oehman & Soares, 1998; Zajonc, 1998). The possibility of unconscious emotions is further supported by recent developments in affective

supposed to be represented on a higher level on second- or even third order that makes us conscious of them in the form of emotional feelings. Emotional feelings are thus associated with what has been described as reflective, higher-order, or secondary consciousness (LeDoux, 1996; 2002; Rolls, 1999; 2000; Damasio, 1999; Panksepp, 1998; 2005; Edelman, 2003; Metzinger, 2003; Chalmers, 1995; Lycan, 1995; 2001; Rosenthal, 1986; 1997; Block, 1996; Crick and Koch, 2003; Gray, 2004; Northoff, 2003). In contrast to these approaches, the concept of 'embodied' and 'embedded affect valence' considers feeling to be crucial and a 'core component' of emotion. Rather than associating feeling with reflective consciousness, the basic and non-cognitive character of the concept of 'embodied' and 'embedded' affectvalence characterizes feelings by what is called phenomenal consciousness.

How can we characterize the relationship between feeling and appraisal on this basic and non- or pre-cognitive level? I assume dynamic balance between feeling and appraisal as distinct aspects of valence. One aspect may be stronger than the other with for instance subjective experience or feelings predominating as figure while value and appraisal remain in the background (and conversely). It is this balance between feeling and appraisal which may differ in different cases and may also account for those cases of emotions that do not seem to require the body. Damasio (1999; 2003), for instance, assumes so-called 'as-if-body loops' and associates them with brain mechanisms that makes one believe that the body is undergoing changes when in fact it is not (see also above). How are such 'brainy emotions' possible? Does their possibility argue rather in favour of the multicomponent model than the 'embodied-c' concept of appraisal? Such 'as-if-body loops' may represent an extremely one-sided balance between appraisal and feeling with the former predominating the latter. One may go even one step further, as Colombetti and Thompson (2005) do, and argue that such one-sided balance and any other possible balances are possible only on the basis that embodiment and embeddedness are the default-mode. Imagine, for instance, the case where embodiment is still given while there is no longer

neuroscience. Relying on behavioural reactions, the neural correlates of unconscious fear processes (LeDoux, 1996; 2002; Phillips *et al.*, 2004; Williams *et al.*, 2004), unconscious pleasure (Berridge, 2003), and other unconscious emotions such as disgust (Davidson, 2000; 2003; Rolls, 1999; Damasio, 1999) have been demonstrated. Unconscious emotion are often related to subcortical regions like the PAG, superior colliculi, pons, reticular formation, nucleus basalis meynert, raphe nuclei, hypothalamus, and amygdala (LeDoux, 1996; 2002; Damasio, 1999; Panksepp, 1998; Davidson, 2000; Rolls, 1999; Berridge and Winkielman, 2004).

embeddedness with the organism remaining isolated from the environment. In this case, feeling would indeed be restricted to perception of bodily changes independent of the respective environmental context. Most importantly, feeling and appraisal would no longer be constitutively dependent on each other since personal point of view and value, e.g., feeling and appraisal, would dissociate from each other. Feeling would concern the body but no real value while appraisal, which then would degenerate into higher-order cognitive function, would constitute meaning and personal significance independent from feelings and the respective environmental context. Appraisal would no longer be felt and feelings would no longer concern value. In other terms, both the James-Lange theory and multicomponent models of emotions would probably hold true in the case of ‘embodied-r’ or ‘disembodied’ and ‘disembedded’ appraisal. One may finally imagine the case of total (constitutional) isolation from both body and environment, i.e., disembodiment and disembeddedness. In this case, feeling would probably be impossible and emotions would solely and exclusively be defined by appraisal. This may come close to the early cognitivist theories of emotion (Kenny, 1963; Lyons, 1980; Solomon, 1976) that determined emotions predominantly by appraisal while attributing no significance (or even no existence) to feeling. Since however, as demonstrated, both multicomponent and cognitivist theories of emotions do not seem to be compatible with current neuroscientific findings, their assumptions of disembodiment and disembeddedness remain rather implausible and thus not tenable from a neurophilosophical point of view.

How could cognitivist and multicomponent approaches neglect feeling and the inherent constitutive bodily component in their concepts of appraisal? One main issue seems to be that the body is considered only in an objective way as mere physiological object, as *Koerper*, which as such must principally be distinguished from any cognitive activities that generate meaning and personal significance. The body as *Koerper* is considered as the objective and physiological manifestation of the cognitive activities that allow for appraisal; it can consequently be only instrumentally related to appraisal whereas it is not involved in constituting it — body as *Koerper* and appraisal show mere instrumental relationship rather than constitutional interdependence (see Colombetti, 2007, for the both forms of relations). This however changes once the body is not only considered merely objective as *Koerper* but also as ‘lived body’ and thus as *Leib*. Once the body is considered as ‘lived body’ or *Leib*, the crucial role of the body in constituting personal significance and meaning (by means of its

intrinsic relation to the respective environmental context) becomes apparent. The mere instrumental relationship between body and appraisal is replaced by constitutional interdependence with appraisal being necessarily dependent upon the body, as 'lived body', and its intrinsic relation to the respective environmental context.. Appraisal is consequently not mere higher-order cognitive e-valuation of already given environmental (personally insignificant and meaningless) events but is implicated in constituting specific body-environment relationships by valuing them which ultimately results in the constitution of meaningful and personally significant events. Accordingly, appraisal of personal significance and meaning of emotion can no longer be regarded as disembodied *cognitive e-valuation about already given environmental events* but rather as embodied *valuation of specific body-environment relationships* with the consecutive constitution of the emotional and thus valued event itself.⁸

Conclusion

Multicomponent theories of emotion that consider feeling and appraisal as distinct and separate components have recently been challenged by the concept of 'embodied' and 'embedded' appraisal. The aim of this neurophilosophical paper was to investigate whether recent neuroimaging data on emotion are better compatible with the multicomponent approach to appraisal as representational or the concept of 'embodied' and 'embedded' appraisal as relational. Neuroimaging data indicate involvement of anterior cortical midline structures in both emotional feelings and appraisal which argues against their conceptualization as distinct and separate components as in multicomponent theories of emotion. Furthermore neuroimaging data demonstrate reciprocal modulation and attenuation between medial and lateral prefrontal cortical regions during feeling/appraisal and emotional judgment. Conceptually, the concept of 'embodied' and 'embedded' appraisal implies a basic non-cognitive form of appraisal allowing for 'having and feeling an emotion' which should not be confused with higher-order cognitive functions that rather allow us to 'realize what emotion we feel'. I conclude that recent neuroimaging data on emotion are better compatible with the concept

[8] This is well in accordance with Ben-Ze'ev's (1993, p. 8) assumption that there is no meaningless and personally insignificant stage of processing with a gap between passive 'contentless, meaningless stage (sensation, which is devoid of active mental contribution) and (an active) contentful, meaningful stage (perception, which is laden with such contributions)' the latter becoming possible only by higher-order cognitive functions and thus by appraisal.

of ‘embodied’ and ‘embedded’ appraisal as relational than with multicomponent approaches where appraisal remains essentially ‘disembodied’ and ‘disembedded’ and thus representational. This bears important neurophilosophical implications that concern the determination of appraisal and its relationship to both feeling and body.

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References

- Anderson, A.K., Christoff, K., Stappen, I., Panitz, D., Ghahremani, D.G., Glover, G., Gabrieli, J.D. and Sobel, N. (2003), ‘Dissociated neural representations of intensity and valence in human olfaction’, *Nat Neurosci*, **6**(2), pp. 196–202.
- Arnold, M. (1960), *Emotion and Personality* (New York: Columbia University Press).
- Bennett, M.R. and Hacker, P. (2003), *Philosophical Foundations of Neuroscience* (Oxford: Blackwell).
- Ben-Ze’ev, A. (1993), *The Perceptual System: A Philosophical and Psychological Perspective* (New York: Peter Lang Publishing Inc.).
- Ben-Ze’ev, A. (2000), *The Subtlety of Emotions* (Cambridge, MA: MIT Press).
- Berlin, H.A., Rolls, E.T. and Kischka, U. (2004), ‘Impulsivity, time perception, emotion and reinforcement sensitivity in patients with orbitofrontal cortex lesions’, *Brain*, **127**, pp. 1108–26.
- Bermpohl, F., Fregni, F., Boggio, P.S., Thut, G., Northoff, G., Otachi, P.T.M., Rigonatti, S., Marcolun, M.A. and Pascual-Leone, A. (2006), ‘Dissociable networks for the expectancy and perception of emotional stimuli in the human brain’, *Neuroimage*, **30**(2), pp. 588–600. Epub 2005 Nov 7 PMID: 16275018.
- Berridge, K.C. (2003), ‘Pleasures of the brain’, *Brain Cogn.*, **52**(1), pp. 106–28.
- Berridge, K.C. and Winkelman, P. (2003), ‘What is an unconscious emotion? (The case for unconscious “liking”’, *Cognition and Emotion*, **17** (2), pp. 181–211.
- Block, N. (1996), ‘How can we find the neural correlate of consciousness?’, *Trends in Neurosciences*, **19** (11), pp. 456–9.
- Chalmers, D.J. (1995), ‘The puzzle of conscious experience’, *Scientific American*, **273**(6), pp. 80–6.
- Charland, L.C. (2005), ‘Emotion, experience, and the indeterminacy of valence’, in *Emotion and Consciousness*, ed. L.F. Barrett, P. Niedenthal, and P. Winkelman (New York: Guilford Press) pp. 231–54.
- Charland, L.C. (2005), ‘The heat of emotion: Valence and the demarcation problem’, *Journal of Consciousness Studies*, **12** (8–10), pp. 82–102.
- Colombetti, G. (2005), ‘Appraising valence’, *Journal of Consciousness Studies*, **12** (8–10), pp. 103–26.
- Colombetti, G. (2007), ‘Enactive appraisal’, *Phenomenology and the Cognitive Sciences*, **6**(4).
- Colombetti, G. and Thompson, E. (2007), ‘The feeling body: Towards an enactive approach to emotion’, in *Body in Mind, Mind in Body: Developmental Perspectives on Embodiment and Consciousness*, ed. W.F. Overton, U. Müller and J. Newman (Hillsdale, NJ: Lawrence Erlbaum)

- Colombetti, G. and Thompson, E. (2005), 'Enacting emotional interpretations with feeling', *Behavioral and Brain Sciences*, **28** (2), pp. 200–201.
- Craig, A.D. (2002), 'How do you feel? Interoception: the sense of the physiological condition of the body', *Nat Rev*, **3**, pp. 656–66.
- Craig, A.D. (2003), 'Interoception: The sense of the physiological condition of the body', *Curr Opin Neurobiol*, **13**, pp. 500–505.
- Craig, A.D. (2004), 'Human feelings: Why are some more aware than others?', *Trends Cog Sci*, **8** (6), pp. 239–41.
- Crick, F. and Koch, C. (2003), 'A framework for consciousness', *Nature Neuroscience*, **6** (2), pp. 119–26.
- Critchley, H.D. (2005), 'Neural mechanisms of autonomic, affective, and cognitive intergration', *J Comp Neur*, **493**, pp. 154–66.
- Critchley, H.D., Wiems, S.W., Rotshtein, P., Oehman, A. and Dolan, R.J. (2004), 'Neural systems supporting interoceptive awareness', *Nature Neuroscience*, **7** (2), pp. 189–95.
- Damasio, A.R. (1999), *The Feeling of What Happens: Body and Emotion in the Making of Consciousness* (New York, Harcourt Brace).
- Damasio, A. (2003), 'Mental self: The person within', *Nature*, **423** (6937), p. 227.
- Davidson, R.J. (2000), 'Emotion, plasticity, context, and regulation: Perspectives from affective neuro-science', *Psychological Bulletin*, **126**, pp. 890–909.
- Davidson, R.J. (2003), 'Affective neuroscience and psychophysiology: Toward a synthesis', *Psychophysiology*, **40**(5), pp. 655–65.
- De Sousa, R. (1987), *The Rationality of Emotion* (Cambridge, MA: MIT Press).
- Dolcos, F., LaBar, K.S. and Cabeza, R. (2004), 'Dissociable effects of arousal and valence on prefrontal activity indexing emotional evaluation and subsequent memory: An event-related fMRI study', *Neuroimage*, **23**(1), pp. 64–74.
- Duncan, J. and Owen, A.M. (2000), 'Common regions of the human frontal lobe recruited by diverse cognitive demands', *Trends Neurosci*, **23**(10), pp. 475–83.
- Edelman, G.M. (2003), 'Naturalizing consciousness: A theoretical framework', *Proc Natl Acad Sci USA*, **100** (9), pp. 5520–4.
- Ekman, P. (1999), *Handbook of Cognition and Emotion* (Chichester: John Wiley & Sons, Ltd.).
- Feldmann-Barrett, L. and Russell, J.A. (1999), 'The structure of current affect: Controversies and emerging consensus', *Current Directions in Psychological Science*, **8** (1), pp. 10–14.
- Frijda, N. (1986), *The Emotions* (Cambridge: Cambridge University Press).
- Frijda, N.H. (1999), 'Emotions and hedonic experience', in *Well-being: The Foundations of Hedonic Psychology*, ed. D. Kahneman, E. Diener & N. Schwarz (New York: Russell Sage Foundation), pp. 190–210.
- Gallagher, S. (2005), *How the Body Shapes the Mind* (Oxford: Oxford University Press).
- Grimm, S., Schmidt, C.F., Bermpohl, F., Heinzel, A., Dahlem, Y., Wyss, M., Hell, D., Boesiger, P., Boeker, H. and Northoff, G. (2006), 'Segregated neural representation of distinct emotion dimensions in the prefrontal cortex: An fMRI study', *Neuroimage*, **30**(1), pp. 325–40.
- Goel, V. and Dolan, R.J. (2003a), 'Explaining modulation of reasoning by belief', *Cognition*, **87**(1), pp. B11–22.
- Goel, V. and Dolan, R.J. (2003b), 'Reciprocal neural response within lateral and ventral medial prefrontal cortex during hot and cold reasoning', *Neuroimage*, **20**(4), pp. 2314–21.
- Goldie, P. (2000), *The Emotions: A Philosophical Exploration* (Oxford: Oxford University Press).

- Goldie, P. (2002), 'Emotions, feelings and intentionality', *Phenomenology and the Cognitive Sciences*, **1**, pp. 235–54.
- Gray, J.A. (2004), *Consciousness: Creeping up on the Hard Problem* (Oxford University Press).
- Griffiths, P.E. (2004), 'Is emotion a natural kind?', in *Thinking about Feeling: Contemporary Philosophers on Emotions*, ed. R.C. Solomon (Oxford University Press), pp. 233–49.
- Heinzl, A., Bermpohl, F., Niese, R., Pfennig, A., Pascual-Leone, A., Schlaug, G. and Northoff, G. (2005), 'How do we modulate our emotions? Parametric fMRI reveals cortical midline structures as regions specifically involved in the processing of emotional valences', *Brain Res Cogn Brain Res*, **25**(1), pp. 348–58.
- Hornak, J., Bramham, J., Rolls, E.T., Morris, R.G., O'Doherty, J., Bullock, P.R. and Polkey, C.E. (2003), 'Changes in emotion after circumscribed surgical lesions of the orbitofrontal and cingulate cortices', *Brain*, **126**, pp. 1691–712.
- Hurley, S. (1998), *Consciousness in Action* (Cambridge, MA: Harvard University Press).
- Kenny, A.J.P. (1963), *Action, Emotion and Will* (London: Routledge and Kegan Paul).
- Kihlstrom, J.F. (1999), 'The psychological unconscious', in *Handbook of Personality: Theory and Research* (2nd ed.), ed. L.A. Pervin & O.P. John (New York: Guilford Press), pp. 424–42.
- Kihlstrom, J.F., Eich, E., Sandbrand, J. & Tobias, B. (2000), 'Emotion and Memory: Implications for self-report', in *The Science of Self-report: Implications for Research and Practice*, ed. J. Turkkan & A. Stone (Hillsdale, NJ: Lawrence Erlbaum Associates).
- Kringelbach, M.L., O'Doherty, J., Rolls, E.T. and Andrew, C. (2003), 'Activation of the human orbitofrontal cortex to a liquid food stimulus is correlated with its subjective pleasantness', *Cereb Cortex*, **13** (10), pp. 1064–71.
- Lane, R.D., Reiman, E.M., Axelrod, B., Yun, L.S., Holmes, A. and Schwartz, G.E. (1998), 'Neural correlates of levels of emotional awareness: Evidence of an interaction between emotion and attention in the anterior cingulate cortex', *J Cogn Neurosci*, **10** (4), pp. 525–35.
- Lang et al. (1993), 'Looking at pictures: Affective, facial, visceral, and behavioral reactions', *Psychophysiology*, **30**, pp. 261–73.
- Lazarus, R.S. (1991), *Emotion and Adaptation* (New York: Oxford University Press).
- LeDoux, J.E. (1996), *The Emotional Brain: The Mysterious Underpinnings of Emotional Life* (New York: Simon and Schuster).
- LeDoux, J.E. (2002), *Synaptic Self: How Our Brains Become Who We Are* (Viking).
- Lewis, P.A., Critchley, H.D., Rotshtein, P. and Dolan, R.J. (2007), 'Neural correlates of processing valence and arousal in affective words', *Cereb Cortex*, **17** (3), pp. 742–8.
- Lycan, W.G. (1995), 'We've only just begun', *Behavioral and Brain Sciences*, **18** (2), pp. 262–3.
- Lycan, W.G. (2001), 'Have we neglected phenomenal consciousness?', *Psyche*, **7**.
- Lyons, W.E. (1980), *Emotion* (Cambridge: Cambridge University Press).
- Mearleau-Ponty, M. (1962), *Phenomenology of Perception* (London: Routledge).
- Metzinger, T. and Gallese, V. (2003), 'The emergence of a shared action ontology: Building blocks for a theory', *Conscious Cogn*, **12**(4), pp. 549–71.
- Montague, P.R. and Berns, G.S. (2002), 'Neural economics and the biological substrates of valuation', *Neuron*, **36**(2), pp. 265–84.

- Montague, P.R., King-Casas, B. and Cohen, J.D. (2006), 'Imaging valuation models in human choice', *Annu Rev Neurosci*, **29**, pp. 417–48.
- Northoff, G. (2003), 'Qualia and the ventral prefrontal cortical function: "Neurophenomenological" hypothesis', *Journal of Consciousness Studies*, **10**(8), pp. 14–48.
- Northoff, G. (2005), 'Is emotion regulation self-regulation?', *Trends Cogn Sci*, **9**(9), pp. 408–9.
- Northoff, G., Heinze, I.A., Bermpohl, F., Niese, R., Pfennig, A., Pascual-Leone, A. and Schlaug, G. (2004), 'Reciprocal modulation and attenuation in the prefrontal cortex: An fMRI study on emotional-cognitive interaction', *Hum Brain Mapp*, **21**(3), pp. 202–12.
- Nussbaum, M.C. (2004), *Hiding from Humanity* (Princeton, NJ: Princeton University Press).
- Ochsner, K.N. and Gross, J.J. (2005), 'The cognitive control of emotion', *Trends Cogn Sci*, **9**(5), pp. 242–9.
- Ochsner, K.N., Ray, R.D. *et al.* (2004), 'For better or for worse: Neural systems supporting the cognitive down- and up-regulation of negative emotion', *Neuroimage*, **23**(2), pp. 483–99.
- Öhman, A. (2000), 'Fear and anxiety: Evolutionary, cognitive, and clinical perspectives', in *Handbook of Emotions*, ed. M. Lewis & J.M. Haviland-Jones (New York: The Guilford Press), pp. 573–93.
- Ohman, A. and Soares, J.J. (1998), 'Emotional conditioning to masked stimuli: Expectancies for aversive outcomes following nonrecognized fear-relevant stimuli', *J Exp Psychol Gen*, **127** (1), pp. 69–82.
- Panksepp, J. (1998), *Affective Neuroscience: The Foundations of Human and Animal Emotions* (Oxford University Press).
- Panksepp, J. (2005), 'Affective consciousness: Core emotional feelings in animals and humans', *Conscious Cogn*, **14**(1), pp. 30–80.
- Phan, K.L., Wager, T., Taylor, S.F. and Liberzon, I. (2002), 'Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI', *Neuroimage*, **16**(2), pp. 331–48.
- Phillips, M.L., Williams, L.M., Heining, M., Herba, C.M., Russell, T., Andrew, C., Bullmore, E.T., Brammer, M.J., Williams, S.C., Morgan, M., Young, A.W. and Gray, J.A. (2004), 'Differential neural responses to overt and covert presentations of facial expressions of fear and disgust', *Neuroimage*, **21**(4), pp. 1484–96.
- Pollatos, O., Herbert, B.M., Matthias, E. and Schandry, R. (2007), 'Heart rate response after emotional picture presentation is modulated by interoceptive awareness', *Int J Psychophysiol*, **63**(1), pp. 117–24.
- Pollatos, O., Kirsch, W. and Schandry, R. (2005), 'On the relationship between interoceptive awareness, emotional experience and brain processes', *Brain Res Cogn Brain Res*, **25**(3), pp. 948–62.
- Pollatos, O., Schandry, R., Auer, D.P. and Kaufmann, C. (2007), 'Brain structures mediating cardiovascular arousal and interoceptive awareness', *Brain Research*, **1141**, pp. 178–87.
- Pollatos, O., Traut-Mattausch, E., Schroeder, H., Schandry, R. (2006), 'Interoceptive awareness mediates the relationship between anxiety and the intensity of unpleasant feelings', *J Anxiety Disord*, **30**.
- Prinz, J. (2004), 'Embodied emotions', in *Thinking about Feeling: Contemporary Philosophers on Emotions*, ed. R.C. Solomon (Oxford University Press), pp. 44–61.
- Robinson, J. (2004), 'Emotion: Biological fact or social construction?', in *Thinking about Feeling: Contemporary Philosophers on Emotions*, ed. R.C. Solomon (Oxford University Press), pp. 28–43.

- Rolls, E.T. (1999), *The Brain and Emotion* (Oxford: Oxford University Press).
- Rolls, E.T. (2000), 'On the brain and emotion', *Behavioral and Brain Sciences*, **23** (2), pp. 219–28.
- Rolls, E.T. (2004), 'The functions of the orbitofrontal cortex', *Brain Cogn*, **55**(1), pp. 11–29.
- Rosenthal, D.M. (1986), 'Two concepts of consciousness', *Philosophical Studies*, **49** (3), pp. 329–59.
- Rosenthal, D.M. (1997), 'Phenomenal consciousness and what it's like', *Behavioral and Brain Sciences*, **20** (1), pp. 156–7
- Russell, J.A. and Barrett, L.F. (1999), 'Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant', *J Pers Soc Psychol*, **76**(5), pp. 805–19.
- Schachter, S. and Singer, J.E. (1962), 'Cognitive, social, and physiological determinants of emotional state', *Psychological Review*, **69**, pp. 379–99.
- Scherer, K.R., Schorr, A. and Johnstone, T. (Ed. 2001), *Appraisal Processes in Emotion: Theory, Methods, Research* (Oxford: Oxford University Press).
- Siebert, M., Markowitsch, H.J. and Bartel, P. (2003), 'Amygdala, affect and cognition: Evidence from 10 patients with Urbach-Wiethe disease', *Brain*, **126** (12), pp. 2627–37.
- Small, D.M., Gregory, M.D., Mak, Y.E., Gitelman, D., Mesulam, M.M. and Parrish, T. (2003), 'Dissociation of neural representation of intensity and affective valuation in human gustation', *Neuron*, **39**(4), pp. 701–11.
- Solomon, R.C. (ed. 2004), *Thinking About Feeling: Contemporary Philosophers on Emotions* (Oxford University Press).
- Williams, L.M., Liddell, B.J., Rathjen, J., Brown, K.J., Gray, J., Phillips, M., Young, A. and Gordon, E. (2004), 'Mapping the time course of nonconscious and conscious perception of fear: An integration of central and peripheral measures', *Hum Brain Mapp*, **21**(2), pp. 64–74.
- Winkielman, P., Berridge, K.C. and Wilbarger, J.L. (2005), 'Unconscious affective reactions to masked happy versus angry faces influence consumption behavior and judgments of value', *Pers Soc Psychol Bull*, **31**(1), pp. 121–35.
- Zajonc, R. (2000), 'Feeling and thinking: Closing the debate over the independence of affect', in *Feeling and Thinking: The Role of Affect in Social Cognition*, ed. J. Forgas (Cambridge University Press).
- Zajonc, R.B. (1998), 'Emotions', in *The Handbook of Social Psychology*, ed. D. Gilbert, S.T. Fiske & G. Lindzey (Boston, MA: McGraw-Hill), Vol.1, pp. 591–632.

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