

Sensory versus Core Affect

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This talk is basically a progress report. It is exploratory and tentative. It starts from a mild puzzle about the apparent mismatch between the notion of affect that affective neuroscientists generally deploy and the notion of affect that emotion psychologists deploy. The notion favored by psychologists is the notion of **core affect**. The phenomenon studied by affective neuroscientists is usually the notion of **sensory affect**. It's not clear how these two notions are related to each other. I'll present the main outlines of both notions and raise a few questions at the end. I don't have any strong claim to make or argument to promote — not yet anyway. As I said, this is a work in progress.

In the last 30 years or so, both research fields have made substantial progress. While the notion of affect and its cognates tended to focus on sensory affect in affective neuroscience, the notion of affect that's been increasingly relied upon in the psychology of emotion is the notion of *core affect* that seems, on the face of it, to have very little to do with sensory affect. Nevertheless, when you look at the literature in psychology, you see a lot of passing references to the neuroscience of affect citing hesitating support for the notion of core affect. There are also some neuroscientists who seem to think that the notion of core affect is relevant to what they study. Yet, after having read in both areas, I am yet to see what the exact relationship is between the two notions.

What does this all have to do with the focus of this symposium, the *moods*? Everybody, including philosophers, agree that moods are affective states, perhaps along with emotions, even paradigmatically affective states. Part of what it means for moods to be affective states is that they are positively or negatively valenced states — they have positive or negative hedonic valence. It feels good or bad to be in them to varying degrees. In this particular regard, moods are like emotions. Although there is a bit of controversy over it, *emotions* are also said to have hedonic valence: it feels good or bad to be undergoing certain emotions. Yet you don't see a lot of philosophers, at least in the philosophy of mind tradition, trying to understand what the hedonic valence of a mood or emotion is. This may be excused, to some extent at least, in the case of emotions, which are a lot more complex than moods — so there is a lot to focus on apart from the valence component. But if you subtract affect from moods, it's not clear what would be left to study. Affect seems to be the most prominent component of moods. Indeed, the dimensional approaches to emotion in psychology simply equates moods with prolonged

core affect: moods are just prolonged core affect with no intentional object attached (Russell 2003, 2104)

Let me start then with an examination of the notion of core affect prominent in the dimensional approaches to emotions in psychology. Among the prominent defenders of the notion of core affect as fundamental in the psychology of emotions and moods are constructivists such as James Russell and Lisa Feldman Barrett — among others. Indeed, these two have been the most vocal in popularizing and developing the notion of core affect. Nevertheless, it's important to distinguish the notion of core affect they deem as lying at the core of emotions and moods from their more specific theories of emotions, which are known under different names as dimensional, constructivist, or more recently, as the conceptual act theory of emotions (Barrett 2017). Constructivism in emotion theory has been influential but controversial. There are different versions of it, but the basic tenet of the approach is that all emotions, including the basic or standard emotions, are cognitive constructions out of core affect. The elements of this construction are complex and multi-faceted, but many require the emoter's own cognitive interpretation of how her environment affects her core affect. I won't pursue the details of the constructivist theory of emotion here except as it relates to the notion of core affect. But it's important to note that there are other emotion theorists and affective scientists who seem to embrace the notion of core affect without embracing the constructivist program in emotion theory. So, if you are not thrilled by the constructivist agenda in emotion theory, as I am not, you may still want to have a close look at the notion of core affect that is important to and instrumental in a broader spectrum of theories.

Core affect

James Russell defines core affect as follows:

“a neurophysiological state that is consciously accessible as a simple, non-reflective feeling that is an integral blend of hedonic (pleasure–displeasure) and arousal (sleepy–activated) values.” (Russell 2003: 147)

In later writings, Russell became somewhat more explicit about the shortcomings of using the term 'neurophysiological'. He said that to characterize the this state as neurophysiological is

“... a promissory note that so far has been left unfulfilled. The neural basis of core affect is an active research concern (Gerber et al., 2008; Posner, Russell, & Peterson, 2005; Barrett, Wilson-Mendenhall, & Barsalou, Chapter 4, this volume). There are some attractive leads (Kringelbach, 2010; Leknes & Tracey, 2008; Pfaff, 2006; Smith, Mahler, Peciña, & Berridge, 2010).” (Russell 2014: 196)

According to Russell,

"... this neurophysiological state has important functions. ... A change in core affect evokes a search for its cause and therefore facilitates attention to and accessibility of like-valenced material. Core affect guides cognitive processing according to the principle of mood congruency. When core affect is positive, then events encountered, remembered, or envisioned tend to seem more positive ... Core affect influences behavior, from reflexes to complex decision making. Core affect is a background state that continuously changes in response to a host of events, most beyond conscious monitoring. Core affect in turn provides a powerful bias in processing of new information. ... People generally (but not always) seek behavioral options that maximize pleasure and minimize displeasure. Decisions therefore involve predictions of future core affect... Core affect is involved in motivation, reward, and reinforcement. ... " (Russell 2014: 196–97)

It is tempting to construct a Ramsey sentence out of this to see whether there would a unique natural kind to fill the functional role thereby defined. A lot is going on here, but we can simplify somewhat by using the affective circumplex, and noting that the term ‘core affect’, for Russell and Barrett, denotes not just the hedonic value, but it denotes hedonic value along with a value of another dimension — the arousal or activation dimension. One is always in a state of core affect which consists of two bi-polar dimensions. It can therefore be represented as an ordered-pair consisting of the specification of the values of the two dimensions.

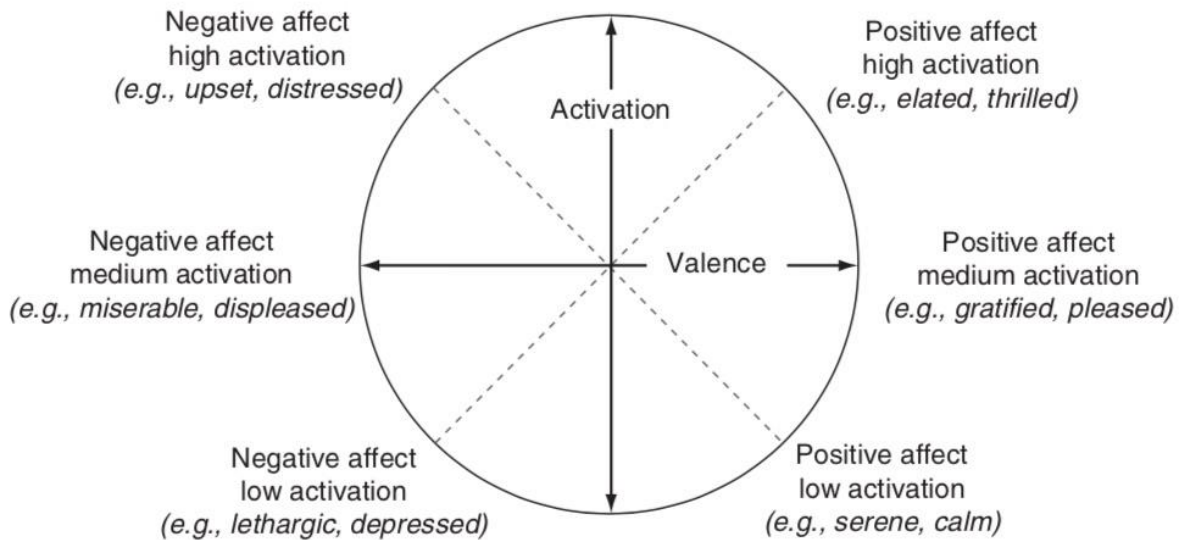


Figure 1. The affective circumplex. Hedonic valence is represented on the horizontal axis and arousal on the vertical axis. (From Barrett & Bliss-Moreau 2009)

Other psychologists use different models with different axes and labels, sometimes 3-dimensional. Here are some 2-dimensional samples (from Yik, Russell, & Feldman Barrett, 1999: 601).

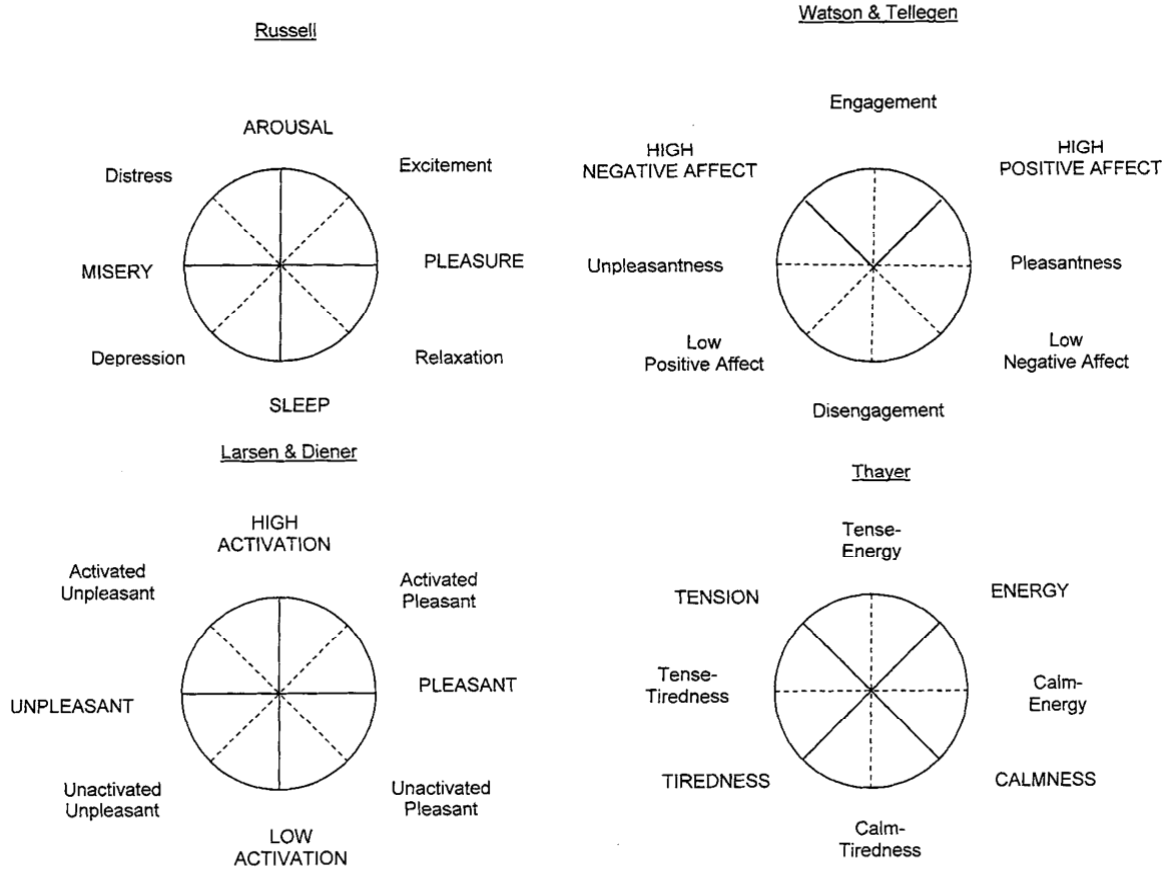


Figure 2. Russell (1980, p. 1164), Watson and Tellegen (1985, p. 221), Larsen and Diener (1992, p. 39), and Thayer (1996, p. 150). The dimensions are rotated in order to highlight the similarity among the four models.

Russell and Barrett think that the two bipolar dimensions are independent of each other. But there are others who think they are not. Here are some ways in which they may be interacting with each other:

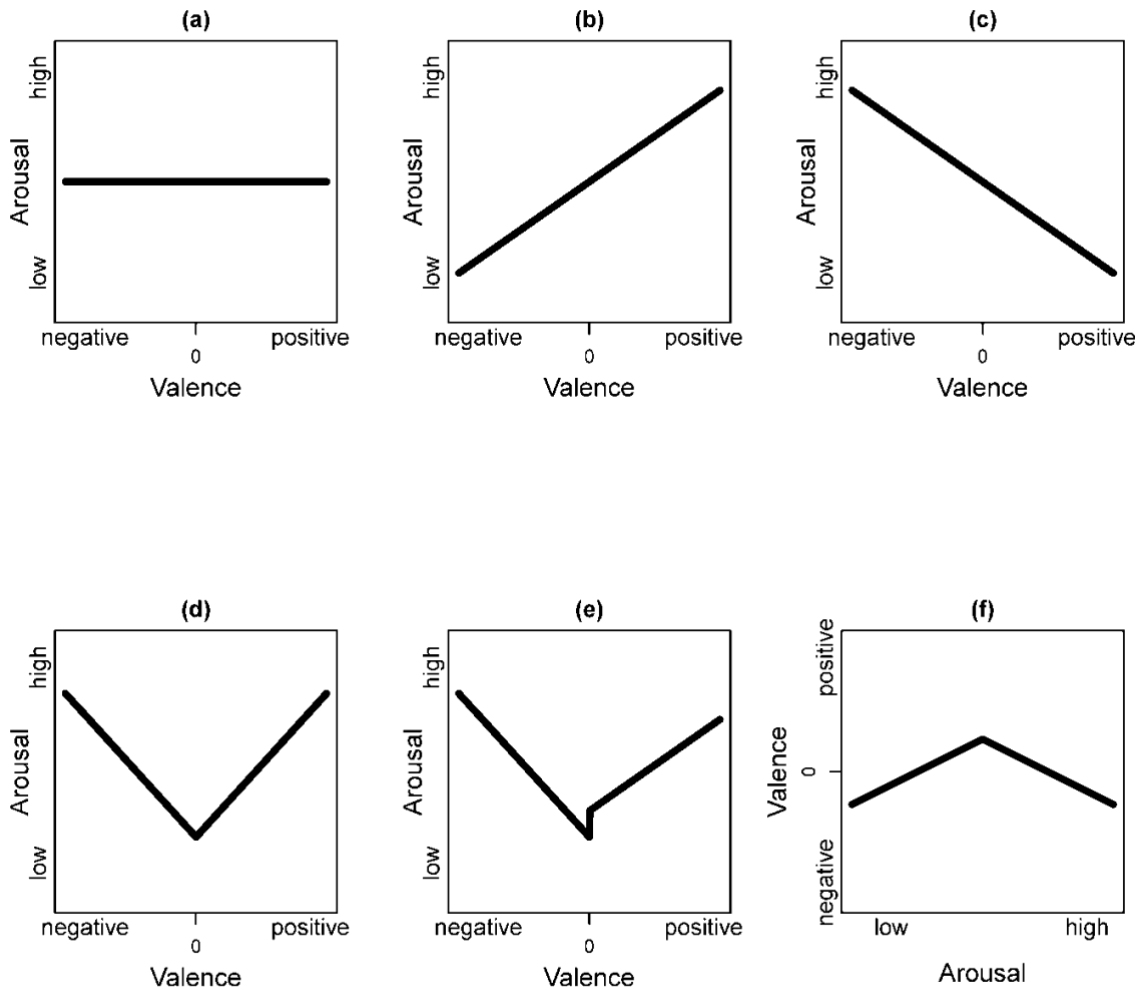


Figure 3. Overview of possible relations between valence and arousal: (a) independence, (b) positive linear relation, (c) negative linear relation, (d) symmetric V-shaped relation, (e) asymmetric V-shaped relation including both positivity offset and negativity bias, and (f) an inverted V-shaped relation when valence is a function of arousal. (From Kuppens et al 2013)

My first critical point relates to the alleged dimensionality of the core affect. Russell and others conceive of core affect, at the psychological level, in the following way:

"Core affect is a state to which all humans have conscious access, although people do not always attend to it. When core affect is accessed, it is experienced as a simple, nonreflective feeling that is an integral blend of hedonic (pleasure–displeasure) and arousal (sleepy–activated) values. At the level of consciousness,

core affect is simple in the sense that it cannot be decomposed at that level (although, of course, it can at a neurological level); that is, feeling good cannot be analyzed into simpler constituents. Rather, core affect is an elemental building block of other psychological events, such as feeling good about having an article accepted for publication." (Russell 2014: 197)

Russell makes clear that the relation he has in mind is like that of seeing colors. A definite shade of color, say, orange¹⁶, has dimensional features that are blended when seen: the hue, saturation, and the brightness or intensity. I am sure you are all familiar with the color quality space, or Munsell's color solid depicting these three dimensions.

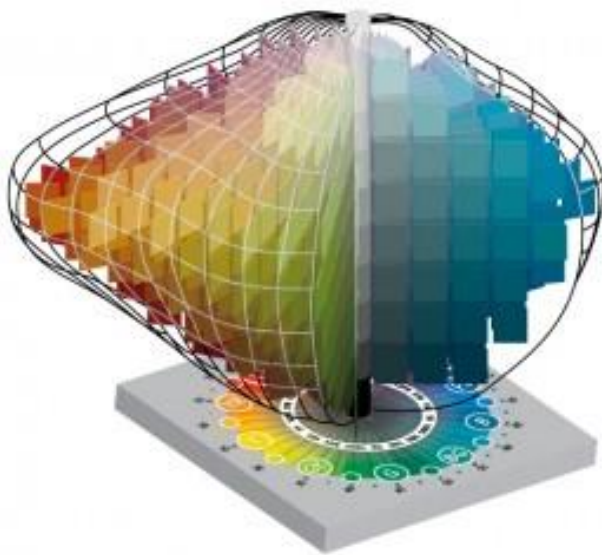


Figure 4. Munsell's color solid.

According to Russell, when one consciously accesses one's core affect, one has access to a property constituted by the hedonic and arousal dimensions in the same way as colors are constituted by the three dimensions of hue, saturation and brightness when one sees, say, an instance of orange¹⁶. However, this seems doubtful to me. There is a difference between two contingently related properties that are always instantiated together by the same entity (hedonic value and arousal), and the distinct but metaphysically necessary constituents (like dimensional features) of a single property. It seems to me that Russell and Barrett just define core affect as a conjunctive property on the basis that hedonic valence and arousal always get co-instantiated. But what they need for the color analogy to hold is an argument that shows that core affect is a single property that has dimensional features in the way colors do. The color dimensions aren't just constant conjunction of distinct properties, they are distinct constituents that seem to metaphysically necessitate each other. At least, it's difficult to conceive of a color shade lacking a dimension, in a way that it is not difficult to conceive of hedonic value without arousal or vice-versa. Indeed, affective neuroscientists

don't think of arousal much when they study hedonic valence of sensations. [[Talk a little here about how Russell and others obtained their psychometric data ...]]

In fact, many times Russell and others seem to have in mind hedonic valence when they talk about core affect [[just read, the last sentence of the last quotation, as an example.]] For simplicity's sake in what follows and to facilitate the comparison to sensory affect later, I'll ignore the arousal dimension, and concentrate on pleasure/displeasure dimension.

Russell and others think of core affect as essentially free-floating and consciously accessible to the subject. At any given time, a subject is exactly in one state of core affect. Russell and others don't seem to think of core affect in representational terms:

"...core affect per se is not about anything. That is, core affect can be experienced in relation to no known stimulus—in a free-floating form—as seen in moods."
(Russell 2003: 148)

and yet Russell says:

"Core affect is a continuous assessment of one's current state, and it influences other psychological processes accordingly." (Russell 2014: 196)

According to Russell and others, core affect can be attributed to environmental stimuli. When so attributed, objective stimuli acquire affective qualities that can be perceived:

"...affective quality is a property of the stimulus: its capacity to change core affect. Perception of affective quality is a perceptual process that estimates this property. It begins with a specific stimulus and remains tied to that stimulus." (Russell 2003: 149)

The process of attribution is explained thus:

"In an attributed affect, a change in core affect is linked to its perceived cause (person, place, event, physical object, or state of affairs). Sometimes the cause is obvious; sometimes a search is required; sometimes mistakes are made. Whatever cause is identified becomes the Object. Attributed affect is thus defined by three necessary and, when together, sufficient features: (a) a change in core affect, (b) an Object, and (c) attribution of the core affect to the Object. ... Attribution is the perception of causal links between events..." (Russell 2003: 149)

This is presumably where we should expect to see some hints about how core affect relates to sensory affect. The picture seems to be this. Various environmental stimuli, like food items, odors, sounds, objects in touch with body surfaces, etc. have affective qualities in the sense that they have the power to causally change one's core affect. So, tasting chocolate and smelling rose are normally pleasant, because they have the power to positively

influence your core affect, that is, to increase core affect in the positive direction. Eating rotten fish and smelling ammonia are unpleasant because they have the opposite power: they influence your core affect in the negative direction. Russell and others talk about stimuli literally having these relational or rather dispositional affective qualities and these qualities are attributed to the perceived cause of the change in the core affect, which are usually the stimuli themselves. So, sensations are pleasant or unpleasant only in so far as they contribute to the positivity or negativity of the core affect. More colloquially put, a sensation is pleasant only in so far as it makes a positive contribution to my mood, and is unpleasant only in so far as it makes a negative contribution to my mood.

My second and main critical comment is just on this point. Indeed, this was the source of my mild puzzle with the core affect movement as I compared it to both the philosophical literature and the affective neuroscience literature on sensory pleasure. In the philosophical literature and in neuroscience, and according to common sense, a pleasant sensation would make a positive contribution to one's mood only because it is already pleasant, not the other way around. Similarly with the unpleasant sensations — unpleasant sensations would make a negative contribution to the one's mood only if they are already negative.

It is true of course that moods are known to influence one's sensory encounter with the world. The phenomenon of mood congruency is robust. It's also true that experiencing a lot of affectively laden sensations typically influences one's mood. But these well-known phenomena are not to be confused with what the defenders of core affect have in mind about what makes a sensation pleasant or unpleasant. On the core affect view, the pleasantness or unpleasantness of a sensation is purely a matter of whether the sensation positively or negatively contributes to one's current mood. Free-floating core affect is primary, sensory affect derives its value from what effects the sensory stimuli have on the core affect. A pleasant sensation is a sensation in virtue of how it "participates in" this core affect — whether it positively enhances it. Independent of how it effects core affect it has no hedonic valence.

Affective Neuroscience

I find this view strange and unmotivated especially in light of what we know from the research coming out affective neuroscience. For instance, here is how Morten Kringelbach and Kent Berridge characterize pleasure:

"... research [in affective neuroscience] has shown that pleasure is never merely a sensation nor a thought, but an additional hedonic gloss, which is the pleasure versus displeasure affect that is actively generated by the brain and attached to its sensory or cognitive object. This [positive or negative] hedonic gloss of an object is generated by the brain in dedicated networks of hedonic hotspots and coldspots."
(2017: 198)

The circuitry that seems essential for turning incoming sensory information into pleasant sensations consists of a network of these “hotspots” that are functionally connected to each other and are to be found in the rostradorsal quadrant of the medial shell of nucleus accumbens (NA) and the posterior part of ventral pallidum (VP) as well as in the parabrachial nucleus (Pecina et al 2006; Smith & Berridge 2007). The NA hotspots receive major input from the infralimbic cortex, which itself interacts heavily with orbitofrontal, prelimbic and anterior cingulate cortices. NA has strong projections to VP (as well as parts of amygdala). VP hotspots project to the paraventricular nucleus of the thalamus that in turn have connections to the infralimbic cortex and other frontal areas, thus closing the loop. This circuitry interacts with the dopamine systems but also uses different neuromodulators (Castro & Berridge 2014a,b). There are also cold spots in NA and VP. The terms ‘hot spot’ and ‘cold spot’ were used by Pecina and Berridge (2005) to denote tiny anatomical regions within some of these brain structures where microinjections of opioids significantly increase or decrease hedonic reactions. It is thought that these functionally connected hubs of hotspots act in unison to stamp a sensation as pleasant in that if any hub in the circuitry defects or issues a veto, the sensation that is being processed is denied the ‘pleasant’ stamp or no increase in hedonic impact occurs (Berridge & Kringelbach 2013).

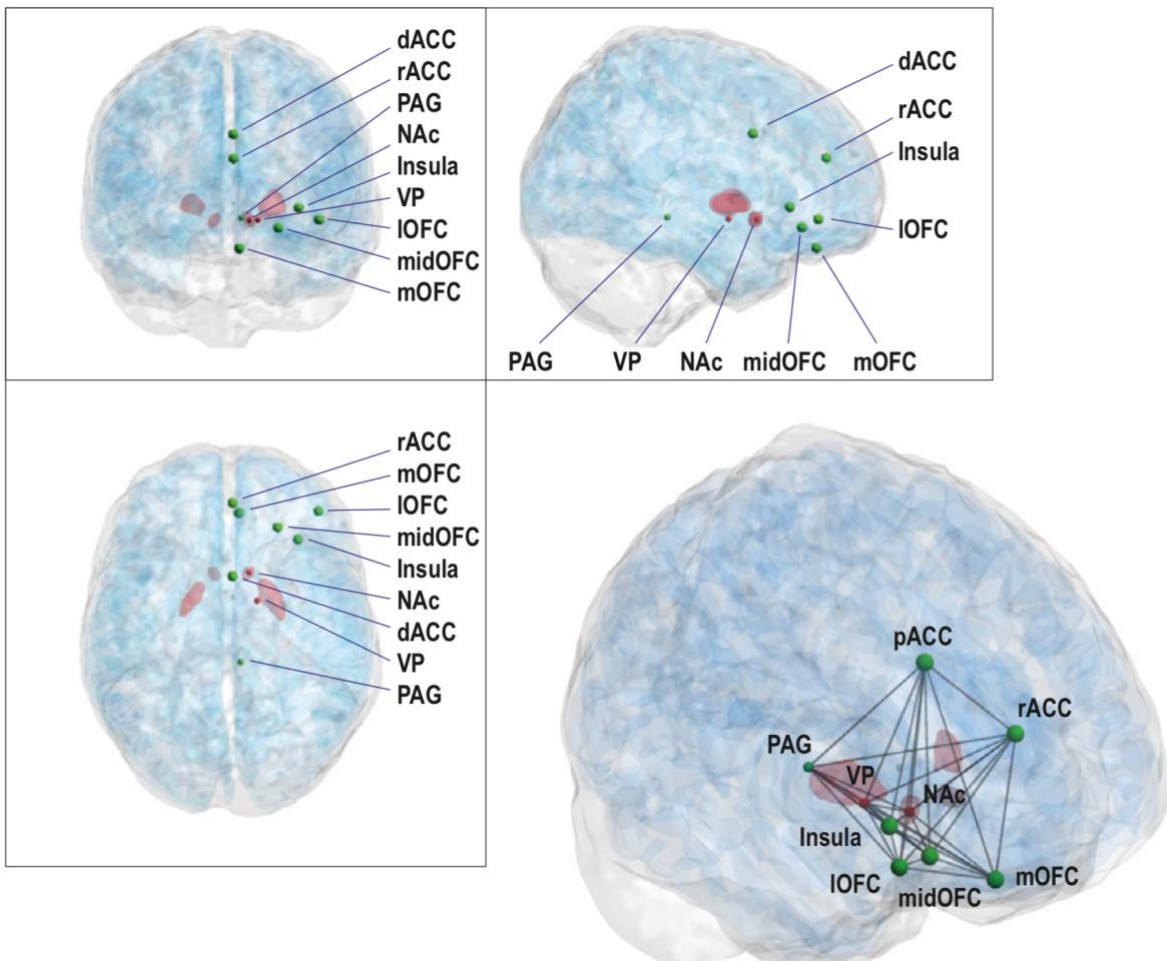


Figure 5. Human brain shows extrapolation of rat causal hot spots to analogous human sites in the NAc and VP (red) and shows fMRI coding sites for positive affective reactions in green (from text). Human views are also from front, side, 3D perspective, and top (clockwise from top left of B). The tentative functional networks between the different hot spots and cold spots have been added to give an impression of the topology of a pleasure network. The functional connection lines are not meant to imply direct anatomical projections between two connected structures, but rather a functional network in mediating hedonic “liking” reactions and subjective pleasure ratings. Parabrachial nucleus (PBN); medial OFC (mOFC); lateral OFC (lOFC); mid-anterior OFC (midOFC); dorsal anterior cingulate cortex (dACC); rostral anterior cingulate cortex (rACC); and periaqueductal gray (PAG). (From Berridge and Kringelbach 2015)

Berridge and colleagues sometimes call this system of hotspots/coldspots **hedonic (or, "liking") system or network**, and separate it from the mesocorticolimbic dopaminergic system. This latter system is not directly responsible for ‘liking’ whatever the primary sensations the animal may be undergoing.¹ The dopamine system primarily consists of projections from a region in the midbrain called the Ventral Tegmental Area (VTA) to the nucleus accumbens, NA, and some neighboring areas. Berridge and colleagues think the dopamine network is the motivation system or as they prefer to call it, the "wanting" system.

One of the most significant results that have come out of the research by Berridge and his colleagues (and others) in recent years is that the liking and wanting systems disassociate. Most of the evidence for the separability of these two systems comes from various experiments that show that the liking system can be modulated (enhanced or inhibited) independently of the wanting system, and vice versa (Berridge 1999; Berridge & Kringelbach 2011). For instance, you see motorically capable dopamine-depleted rats starving themselves to death in the presence of readily available food — they are not motivated to eat in the sense that they seem to lack a desire for food. But when these rats are force-fed, they exhibit orofacial movements clearly indicative of them liking the taste (Berridge & Robinson 1998). There are also experiments where you can increase or decrease liking without a corresponding change in wanting, or you can make rats work hard to get and consume food or sucrose solution without them liking their taste (Pecina et al. 2006). Similar disassociations seem to exist in humans — indeed addiction is taken to be the overreaction of an overly sensitized ‘wanting’ (dopamine) system to contextual cues

¹ Kent Berridge and his colleagues have been most vocal about this evidence: see Berridge 1996, 1999, 2006; Berridge & Robinson 1998, 2003; Pecina et al. 2006; Berridge & Kringelbach 2011, 2015. The collection edited by Berridge and Kringelbach (2010) contains very useful chapters reflecting the state of the art. See also Salamone et al. (1997, 2002), Ikemoto & Panksepp (1996, 1999), among others. Berridge and his colleagues distinguish liking/wanting, which they take to be consciously experienced, from core ‘liking’/‘wanting’ (with quotes) that are not necessarily conscious. I’ll ignore this for convenience and use the words without quotations and leave open their status as conscious or not. Needless to say, conscious liking/disliking will be underlain by additional neural structures and mechanisms, especially the orbitofrontal and insular cortices.

surrounding drug use without corresponding proportional hedonic impact (Robinson & Berridge 1993, 2008).

If sensory affect (hedonic valence) and motivation are only causally connected and can be dissociated, then the question arises as to what the function of sensory affect is — what is the functional signature of hedonic valence within the mental economy of the liking/wanting/acting agent? The function of conative states like wanting or desiring (motivation) is relatively straightforward: move the agent in a way that will tend to bring about the worldly content of these states (when combined with other information about the perceptual environment and past experience, etc.). For instance, if I now want to have a beer to quench my thirst, *ceteris paribus*, I will behave, shortly after, in a way that will bring about *what* I want (the propositional content — that I drink beer). When decoupled from motivation, the function of liking (affect in general) becomes somewhat less obvious.

One natural proposal is that hedonic valence is a “teaching signal” of sorts:² it tells the agent to ‘want,’ or form a ‘desire’ to bring about, what is thus valenced — this involves, and for most animals, *exhausts* learning when and how to perform those sequences of actions similar to those that have actually lead to the obtaining of the valenced sensory experience. Liking helps attribute *incentive salience* to environmental stimuli and sustain it (Berridge 1996, Dickinson & Balleine 2010). The sustaining bit is important. A learning-capable agent that acts out of an existing want or desire (learned, acquired, or otherwise) needs to somehow track the consequences of its behavior, that is, whether its actions result (or have resulted) in the satisfaction or frustration of its ‘desires’ — generating more ‘likes’ or ‘dislikes.’ Plausibly, this is the other side of the same coin — of learning what desires to form on the basis of experienced valence. So, experienced valence is also a signal for desire satisfaction or frustration (cf. Schroeder 2004). Thus, although the mechanisms for affect and motivation are separate, they causally interact. We quite generally want what we like, and, more often than not, we like what we want.

So the picture coming out of affective neuroscience is that sensory affect is primary or at least sensory affect is independent of core affect (if there is any core affect) with a particular function to play. Hedonic valence primarily attaches to sensations and cognitions or modifies them, and thereby plays a particular role in learning and motivating the animal in the material environment in which it needs to survive. This picture is congruent with the way pains and pleasures are discussed in the history of philosophy, in particular value theory and moral psychology. It's also congruent with utility-based economics and decision theory. Philosophers and economists tend to find free-floating affect mysterious.

² I am using this expression *not* to refer to the phasic dopamine signals that are hypothesized to code prediction errors in expected reward. The role of phasic dopamine signals in midbrain structures (VTA, SN) has been controversial but they look a lot like the teaching/learning signals postulated by many reinforcement learning algorithms (see, e.g., Schultz 1997, 2016 for a defense; see Berridge 2012, and Berridge & O’Doherty 2014 for general critical assessment).

Conclusion

Hence my puzzle and the question it raises: what is the relationship between the two notions of affect (hedonic valence) deployed in emotion psychology and affective neuroscience? It is not that these two notions conflict or are incompatible. Clearly the researchers in these fields with passing references to each other's works don't think they are talking about two different constructs. But at the same time, it's not clear to me at all that they aren't.

According to affective neuroscientists, the primary form in which affect manifests itself is through the hedonic modification of sensations, perceptions, and thoughts — these are all intentional states. According to the emotion psychologists, on the other hand, the primary form in which affect manifests itself is the free-floating core affect, which is basically the mood that one finds oneself in at any given moment.

How are these two conceptions of affect related? Is one primary so the other can be accounted in terms of the other, as the constructivists think? Or, do we have two distinct kinds of affect which nevertheless influence each other in various ways, as the mood congruence phenomena seem to show? (This is what I am inclined to think at the moment.) Or is it just that the researchers in these fields don't know much about each other's work and they just happened to have developed their notions according to the dictates of their disciplines' most urgent problems and demands, and they try to relate to each other's work in an *ad hoc* manner when they have to say something about it? Historically that's what seems to have happened.

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