CHAPTER

12

Emotion, Consciousness, and Social Behavior

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Abstract

This chapter focuses on the relation of emotion to consciousness and the implication of this relation for social behavior. The chapter is structured as follows. First, it briefly shows that the traditional perspectives on human emotions view them as necessarily conscious. Second, it shows evidence that emotions can be unconsciously triggered. Third, it shows that there are cases of truly "unconscious" or "unfelt" emotion. Fourth, it addresses some challenges to these ideas. Fifth, it addresses the relation between conscious and unconscious components of emotion. Reflecting the focus of this book, the chapter discusses neuroscience research that identifies structures and functions associated with conscious and unconscious aspects of emotions and considers their implications for social behavior.

Keywords: emotion, affect, consciousness, unconscious, subliminal stimuli, subjective experience, phenomenology, affective influence

One of the most fascinating topics in social neuroscience is the operation of emotions. This chapter focuses on the relation of emotion to consciousness and the implication of this relation for social behavior. That is, we will ask questions like the following: Which components of emotion are necessarily conscious and which can operate without conscious awareness? Can emotions be triggered with unconscious stimuli? Can they drive social behavior? And what about the emotional reaction itself? Can it remain unconscious while it has meaningful impact on behavior? What are the neural and psychological mechanisms underlying unconscious emotions? And what mechanisms support conscious feelings? To clarify, by conscious feelings we mean the experiential, first-person, phenomenological "what-is-it-like" aspect of emotion. In common language, it is what a depression sufferer refers to when saying: "I am feeling blue" or what a substance user refers to when saying "I am feeling so good."

Though questions about the role of consciousness may seem "philosophical," they address important aspects of psychology and neurobiology and the answers are relevant for both theoretical and practical understanding of social behavior. Let us give a few examples. First, consider the task of understanding and changing attitudes—the basis of social relations. This task requires figuring out the interplay between their conscious and unconscious elements. For example, can "dislikes" or even "hatred" remain unconscious and drive stereotypic or aggressive behavior? If so, how do we make them conscious? Researchers and the public care whether people's emotional reactions can be driven by unattended emotional pictures and words that might influence emotions and decisions without ever being explicitly detected. For example, recall the controversy about the advertisement produced by GW Bush's 2000 campaign against Al Gore which contained a briefly flashed word "RATS"—a fragment of the word "bureaucrats" (Berke, 2000). The critics' concern was that forming an association with pestilential rodents might lead viewers to unconsciously form a negative view of a public health care plan. Second, consider the task of understanding the validity of people's reports of their own emotion. Shall we trust people's self-reports of happiness or rather establish their well-being via behavioral measures (e.g., smiling, stress hormones)? Psychiatrists also care whether it is better to diagnose a patient's anxiety or depression via their reports of conscious feeling or via observation of the patient's actions. Activists thinking about issues of animal consciousness or fetal consciousness care what kind of organisms can feel conscious pleasure or pain (e.g., the "fish pain" debate in the UK, and the abortion debate in the US). Neurologists care whether emotional behavior (e.g., withdrawal from a noxious stimulation) of post-accident patients suspected of being in a vegetative state signifies a conscious state or can occur in the absence of consciousness.

Our chapter aims to show that answers to these difficult questions are beginning to emerge from psychology and neuroscience. The chapter is structured as follows. First, we briefly show that the traditional perspectives on human emotions view them as necessarily conscious. Second, we show evidence that emotions can be unconsciously triggered. Third, and most importantly, we show that there are cases of truly "unconscious" or "unfelt" emotion. Fourth, we address some challenges to these ideas. Fifth, we address the relation between conscious and unconscious components of emotion. Reflecting the focus of this book, throughout our chapter we discuss neuroscience research that identifies structures and functions associated with conscious and unconscious aspects of emotions and consider their implications for social behavior.

Emotion as a Conscious Experience

Let us start with some terminological clarifications. It is common to define emotion as a state characterized by loosely coordinated changes in the following five components: (i) *feeling*—changes in subjective experience, (ii) *cognition*—changes in attentional, perceptual, and inferential processes (appraisals), (iii) *action*—changes in the predisposition for or execution of specific responses, (iv) *expression*—changes in the facial, vocal, postural appearance, and (v) *physiology*—changes in the central and peripheral nervous systems.

It is also useful to distinguish "*affect*" and "*emotion*." The term "affect" describes a state identified primarily by valence (positive/negative). The term "emotion" describes a state that can be identified by more than its valence, and includes specific types of negative states such as fear, guilt, anger, sadness, or disgust, and specific positive states, such as happiness, love, or pride. Throughout this chapter, we will primarily use the term emotion. This is because we believe that our arguments also apply to specific emotion states, even though the empirical evidence for our position has been obtained so far primarily in the domain of affect. We will return to this issue later.

Theories of Emotion: Feeling as a Central Component

Theorists have long recognized that there are many components of emotion. Yet, psychologists and philosophers of emotion typically have considered feeling as central or even a necessary component. This is true for many historical figures (e.g., Freud, 1950, James, 1884). It is also true for many contemporary theorists in psychology (e.g., Clore, 1994). For example, one definition of "affect" says that the term "primarily refers to hedonic experience, the experience of pleasure and pain" (Frijda, 1999 p., 194). Interestingly, some emotion theorists grounded in animal research and clinical neuroscience typically do not consider subjective experience as a central or necessary component of emotion (Damasio, 1999; LeDoux, 1996; but see Panksepp, 2005).

Emotion Research in Psychology: Feeling as a Central Agenda

The feeling component is emphasized not only in theories, but also in research on human emotion. In social psychological studies, for example, the presence of an emotion is typically determined by self-reports of feelings (e.g., mood questionnaires). When studies collect multiple measures of emotion, including physiological ones, self-report is often considered as the "gold standard" for determining whether emotion had occurred (Larsen & Frederickson, 1999). There is also a lot of substantive interest in the nature of feelings. For example, some of the debates in emotion literature concern the contribution of bodily responses to subjective feelings (Niedenthal, Barsalou, Winkielman, Ric, & Krauth-Gruber, 2005) or the simultaneous co-existence of positive and negative feelings (Cacioppo, Larsen, Smith, & Berntson, 2004). Most importantly, conscious feeling is seen as a central causal force in emotional impact on social behavior. For example, a popular social psychological model, tellingly called "feeling-as-information," proposes that emotions influence behavior because people use subjective experience as a heuristic shortcut to judgment (Schwarz & Clore, 2003).

Unconscious Emotion

As we have just shown, conscious feeling has a central place in both the theoretical thinking and empirical practice of human emotion research. However, do emotions always require consciousness? Can one meaningfully talk about "unfelt" or "unconscious" emotions? Over the last several years, researchers have increasingly started to consider these possibilities. Note that in most studies below, researchers investigated rather undifferentiated affective reactions, rather than qualitatively differentiated emotion (we'll return to this issue).

Unconscious Elicitation of Affect

The first challenge to the role of consciousness in emotion came from demonstrations that subliminal stimuli can trigger affective reactions. One example comes from research on the mere-exposure effect, or the increase in liking for repeated items (Kunst-Wilson & Zajonc, 1980). In one study, participants were first subliminally exposed to several repeated neutral stimuli consisting of random visual patterns. Later, those participants reported feeling more positive than participants exposed to non-repeated stimuli (Monahan, Murphy, & Zajonc, 2000). An example of a subliminal induction of negative affect comes from studies in which subliminal stimuli, such as gory scenes embedded in a movie, or snakes presented to phobic participants, led to an increase in self-reported anxiety (Öhman & Soares, 1994; Robles, Smith, Carver, & Wellens, 1987).

Note that in the just-described studies the presence of the affective reaction is determined by asking people to self report. However, unconscious stimuli can also elicit an affective reaction detectable using physiological measures. For example, skin-conductance response, an indicator of sympathetic arousal, can be triggered by subliminally presented emotional words (Lazarus & McCleary, 1951) and by pictures of fear-relevant objects (Öhman et al., 2000). Similarly, subliminal facial expressions activate the amygdala, a structure involved in assigning affective significance to the stimulus (Whalen, et al., 1998), and elicit facial reactions detectable with electromyography (Dimberg, Thunberg, & Elmehed, 2000). We will return to these interesting findings later.

Unconscious Affective States

The above studies suggest that emotional reactions can be triggered unconsciously. However, they were not designed to test whether the emotional state can be unconscious. First, most studies used self-report as a measure of affect, which by definition requires that the emotion is conscious. Second, in the physiological studies, self-reports of emotion experience were either not collected or collected after the measure of affective reactions. As a result, it is not clear if the reaction registered in physiology was itself conscious or not. Third, because these studies did not measure behavioral consequences, it is possible that any emotion reaction was weak or inconsequential. Still, the physiological studies are suggestive and raise the possibility that, under the right conditions, people may have genuine affective reactions that are not manifested in their conscious experience.

Several years ago, we offered theoretical arguments and empirical support for the idea of unconscious emotion (Berridge & Winkielman, 2003; Winkielman & Berridge, 2004). Our views were in agreement with several authors in psychology, including those who emphasize the relative automaticity of emotional processing (e.g., Kihlstrom, 1999); separability of expressive (verbal), physiological, and behavioral components of emotion (Lang, 1968); and fallibility of the meta-cognitive processes (Lambie & Marcel, 2002). Our views also aligned with several authors in affective neuroscience who emphasize the role of deep brain structures in generating unconscious elements of fear, anger, happiness, or sadness (e.g., Damasio, 1999; LeDoux, 1996).

In the next several sections, we review the main theoretical and empirical arguments that continue to support the idea that emotion may exist independent of conscious experience and offer some updated arguments and evidence. First, we present some functional and evolutionary considerations. Second, we review evidence from research on the emotional brain. Third, we discuss relevant psychological studies. After that, we address theoretical and empirical challenges to the notion of unconscious emotion and address some outstanding issues.

Functional and Evolutionary Considerations

Does the capacity for emotional behavior evolutionarily precede, follow, or co-occur with the capacity for conscious feeling? This is a difficult question as it involves making historical assumptions about the conjunction of two complex mental faculties—emotion and consciousness (Hayes & Huber, 2001). It is more manageable to ask whether evolutionarily basic affective reactions require conscious processing. Consider simple positive-negative reactions that animals produce to stimuli, such as predators, prey, strangers, con-specifics, food, drink, or mates (Konorski, 1967). The function of these affective reactions is to allow animals to react appropriately to favorable or unfavorable events by adjusting sensory apparatus (e.g., prioritizing certain stimuli), physiology (e.g., cardiovascular and hormonal changes), and action (e.g., priming of motor programs). From a design standpoint, it would be inefficient (and disadvantageous) if performing this basic function required the organism to possess a cognitive apparatus capable of consciousness (Cosmides & Tooby, 2000). Even in humans, conscious mechanisms are often too slow and imprecise for coordinating critical approach-avoidance responses. Most importantly, consciousness is often unnecessary. The disconnected (and presumably unconscious) spinal cord will reflexively withdraw the leg from a noxious stimulus delivered to the sole of the foot. Furthermore, many relatively complex coordination functions in organisms are efficiently performed without experiential representation. For example, decorticated rats, given proper female stimulation, will perform mounts, intromissions, and ejaculations that are similar to control rats (Whishaw, Kolb, 1985). In humans, one example of this is the automatic coupling between the cardiovascular, respiratory, and digestive systems (Porges, 1997). In short, it is reasonable to assume that at least basic affective reactions can be performed without mechanisms responsible for conscious feelings (LeDoux, 1996).

One standard challenge psychologists sometimes offer to the above arguments is that brute positive/negative reactions should not be called "affective." For example, paramecia can approach some stimuli, but it makes little sense to use the term "positive affect" for an organism that does not even have neurons. Further, even in more complex organisms, many reactions to favorable or unfavorable stimuli are more aptly classified as "reflexes" than "affective behaviors." For example, when a spider jumps to kills a prey, it makes little sense to explain this behavior by positing an underlying state of "negative affect." We agree, and along with most authors, require that to count as affective, the behavior should meet several criteria. First, the organism must be able to assess the input in terms of "valence." Second, this assessment must lead to a temporary state that involves several reasonably synchronized components (i.e., perceptual, hormonal, cardiovascular, muscular). Importantly, these criteria do not require the organism to explicitly represent its goals or explicitly make emotional "judgments"—only to respond in a coherent way to challenges and opportunities in its environment. Given these criteria, affect perhaps should *not* be assigned to reflexes, or to creatures like paramecia. But, it should be assigned to organisms that respond bivalently in a coherent, multisystem fashion to appropriate challenges and opportunities, even if these organisms have limited consciousness. For example, under these criteria, reptiles are capable of affect because they show coherent cardiovascular, hormonal, perceptual, and behavioral responses to favorable and unfavorable stimuli (Cabanac, 1999). In fact, there are many structural homologies between reptiles and mammalian limbic system (Martinez-Garcia, Martinez-Marcos, & Lanuza, 2002) and there are also remarkable similarities in the affective neurochemistry in birds, fish, reptiles, and mammals (Goodson & Bass, 2001).

In short, the available data suggest that vertebrates are capable of coordinated, multisystem responses to emotionally-relevant stimuli, with homologous neural circuitry regulating these responses across a diversity of vertebrate groups. Thus, while there are obvious differences in the neural substrates required for conscious experience across these groups, there is nonetheless remarkable consistency in other components of affective response. It therefore seems logical to propose that neural components of emotional processing can function in a way that is largely uncoupled from the neural components of consciousness.

Neural basis of Emotional Processing: Review of Relevant Areas

The just-presented evolutionary arguments are consistent with research on modern mammalian brains. As we discuss next, both subcortical and cortical structures participate in affective processes. The location of the most important structures of the generalized emotional brain is indicated in Figure 12.1. Below, we provide a brief overview of what is known about the roles of those structures in generating positive and negative affect. However, we remind the reader that our presentation here is highly simplified and does not capture the multiple roles these structures play in both affect and cognition, and

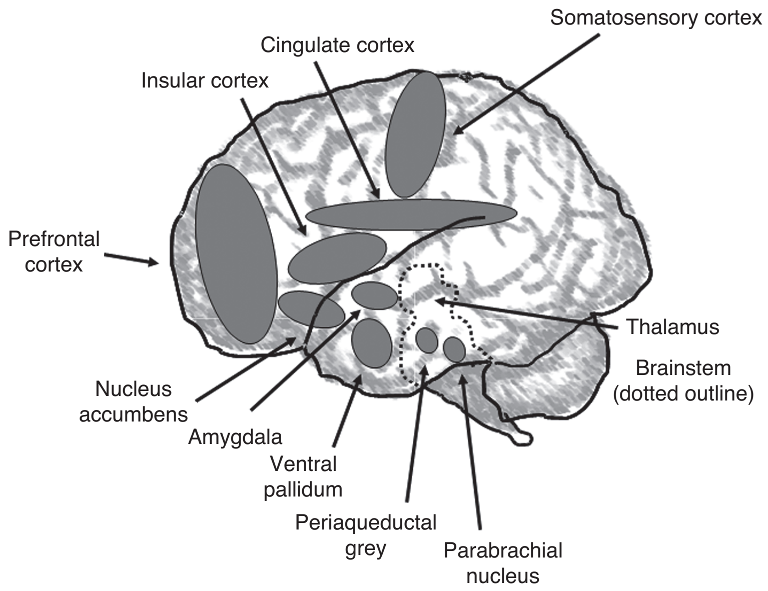

Fig. 12.1 Generalized Emotional Brain in Mammals.

their complex neuroanatomy and neurochemistry (see Berridge, 2003). In the next section, we will consider functional patterns of activity across these areas that may correspond to conscious and unconscious emotion.

Subcortical Networks and Basic Affective Reactions

The subcortical structures involved in causing basic affective reactions range from the "mere" brainstem to the complex network of the "extended amygdala" (Berridge, 2003). Let us illustrate with a few examples the critical role of these structures in both positive and negative affect.

Brainstem

In both animals and humans the brainstem modulates basic affective responses. For example, in the domain of positive affect, research highlights the importance of the parabrachial nucleus (PBN). The PBN receives signals ascending from many sensory modalities, including visceral signals regarding internal bodily functions, and also taste sensations from the tongue. Not surprisingly, PBN plays a role in generating positive responses to tasty foods. For example, when a rat's PBN is tweaked by microinjections that activate its benzodiazepine/GABA receptors, the rat produces greater "liking" reactions to sugar, such as tongue protrusions and lip licking (Berridge & Pecina, 1995). In the domain of negative affect, research highlights the importance of the periaqueductal gray (PAG). In animals, the PAG mediates defensive reactions to threatening stimuli (Panksepp, 1998), and in both animals and humans, the PAG mediates responses to pain (Willis & Westlund, 1997). Importantly, the PAG does not simply compile incoming information to relay to the forebrain, but forms reciprocal connections with subcortical forebrain structures, thereby providing an anatomical basis for sensory stimuli to be processed by the PAG in a context-dependent and coordinated fashion (Pankseep, 1998).

A particularly poignant demonstration of the importance of brainstem to basic affective reactions is offered by a cruel experiment of nature. As a result of a birth defect, some infants have a congenitally malformed brain, possessing only a brainstem, but no cortex and little else of the forebrain (i.e., no amygdala, nucleus accumbens, etc). Yet, in these anencephalic infants, the sweet taste of sugar still elicits facial expressions that resemble normal "liking" reactions, such as lip sucking and smiles, whereas bitter tastes elicit facial expressions that resemble "disliking" reactions, such as mouth gapes and nose wrinkling (Steiner, 1973). In this context, it is also interesting that positive facial expressions to sweetness are emitted by various apes and monkeys and even rats (Berridge, 2000; Steiner et al., 2001). The pattern of positive facial expression becomes increasingly less similar to humans as the taxonomic distance increases between a species and us. But all of these species share some reaction components that are homologous to ours, suggesting common evolutionary ancestry and a similar neural mechanism that may be anchored in the brainstem.

Extended Amygdala

The term "extended amygdala" designates a configuration including the central and medial nuclei of amygdala, the bed nucleus of the stria terminalis, and other structures, and which works in close concert with parallel limbic circuits such as the mesolimbic nucleus accumbens and ventral pallidum system (Heimer & Van Hoesen, 2006). Recent years have witnessed an explosion of research highlighting the role of extended amygdala in basic affective reactions.

Amygdala

The amygdala consists of a set of almond-shaped nuclei located in the medial temporal lobe, just anterior to the hippocampus. The amygdala is reciprocally connected to a variety of areas. This includes visual thalamus and visual cortex, allowing for affective modification of perception; the dorsolateral prefrontal cortex, allowing for upstream and downstream regulation of affect state; and subcortical structures, allowing affective influence on sympathetic and parasympathetic regulation of cardiovascular activity, respiration, hormone levels, and basic muscular reactions. The role of the amygdala in perceptual and learning aspects of emotion has been confirmed in animal research as well as human neuroimaging and lesion studies. Thus, patients with congenital or acquired amygdala damage show impairments in conditioned fear responses, fear-potentiated startle, and arousal-enhanced perception and memory (Whalen & Phelps, 2009). Remarkably, patients with damage to the amygdala show little, if any, impairment in their subjective experience of emotion, at least as measured by the magnitude and frequency of self-reported positive or negative affect assessed on the PANAS scale (Anderson & Phelps, 2002). This suggests a relative independence of the amygdala from the mechanisms underlying generation of feelings.

The relative separation of the amygdala from the mechanisms involving a generation of a conscious feeling response is also suggested by research on patients with autism, who are known to have anatomical irregularities in the amygdala (Schumann & Amaral, 2009). These patients show atypical patterns of physiological responses to affective stimuli (e.g., potentiation of startle responses by both positive and negative stimuli) but a typical pattern of self-reported feeling reactions to emotional stimuli (Wilbarger, McIntosh, & Winkielman, 2009, see Winkielman, McIntosh, & Oberman, 2009 for review).

As mentioned earlier, there is some evidence that amygdala activation can occur without conscious perception of the stimulus. Thus, fMRI studies show that the amygdala can be activated with facial expressions that are not consciously perceived, including expressions of fear and anger presented subliminally (Morris, Öhman, & Dolan, 1999; Whalen et al., 1998), under condition of binocular suppression (Williams et al., 2004), or presented to a patient's blind visual field (Morris, et al, 2001). A component of these effects may involve a direct pathway from the visual thalamus to the amygdala. However, the human amygdala is richly interconnected with the visual cortex and probably receives the majority of input this way, thus challenging the popular notion of the "low-road" to emotion in typical humans (Pessoa & Adolphs, 2010).

Importantly, these studies should not be read as indicating a full independence of amygdala from attention. For example, in one study, none of the affect-related activations observed when attention was focused on happy or angry faces survived when attention was allocated to other items in the same displays (Pessoa, 2005). This suggests that attention can modulate amygdala responses to emotional stimuli under some conditions, and sometimes dramatically. Yet, it is not entirely clear how general these effects of attention are. Critically, it might be that attention (which amplifies neural signals) might be a prerequisite for any processing—conscious or unconscious (see Koch & Tsuchiya, 2007 for distinction between attention and consciousness). Finally, it is important to remember that the levels of amygdala activation revealed in an fMRI study supply only a crude measure of what the amygdala may or may not be computing.

Ventral Pallidum

The ventral pallidum borders on the lateral hypothalamus at its front and lateral sides. It is a major target of the limbic nucleus accumbens (Smith et al., 2009). The ventral pallidum also feeds subcortical affective signals forward into corticolimbic loops by projecting to the orbitofrontal and ventromedial areas of prefrontal cortex via a relay in the medial dorsal thalamus. In rats, this structure is involved in producing positive reactions to tasty foods, as suggested by the facts that (i) ventral pallidal neurons fire to tasty rewards, (ii) behavioral "liking" reactions to sweetness are increased by opioid drug microinjections in ventral pallidum, and (iii) excitotoxin lesions of ventral pallidum abolish hedonic reactions and cause aversive reactions (e.g., gaping and headshakes) to be elicited even by normally palatable foods (Cromwell & Berridge, 1993; Smith et al., 2009; Tindell et al., 2006). Ventral pallidum may also be crucial to sexual and social pair-bonding in rodents (Insel & Fernald, 2004). Less is known regarding the role of ventral pallidum in affect for humans, as the structure is too small to study in brain-imaging studies. However, there are a few intriguing observations. For example, electrical stimulation of the adjacent structure, globus pallidus, has been reported to sometimes induce bouts of affective mania that can last for days (Miyawaki, Perlmutter, Troster, Videen, & Koller, 2000). Also, the induction of a state of sexual or competitive arousal in normal men was found to be accompanied by increased blood flow in the ventral globus pallidus (Rauch et al., 1999).

Nucleus Accumbens

The nucleus accumbens lies at the front of the subcortical forebrain and is rich in dopamine and opioid neurotransmitter systems. The accumbens is often portrayed as a reward and pleasure "center" (as often as the amygdala is portrayed as a "center" of fear). In fact, activation of dopamine projections to the accumbens and related targets has been viewed by many neuroscientists as a neural "common currency" for reward. There is actually evidence that dopamine contributions to the accumbens reflect not "pleasure," or "liking" of the stimulus, but rather an incentive salience, or "wanting" of the stimulus (Berridge & Robinson, 1998). However, for the purpose of our argument here it is only important to highlight the role of accumbens in positive affective reactions. For example, in rats, brain microinjections of drug droplets that activate opioid receptors in nucleus accumbens cause increased "liking" for sweetness, as well as increased "wanting" (Pecina & Berridge, 2000; 2005). In humans, the accumbens activates to drug cues, sex cues, and also to other desired stimuli, including foods, drinks, and even money (Knutson et al., 2001; Knutson et al. 2008).

Cortical Networks

One cannot talk about the emotional brain of mammals without discussing the cortex. In fact, when human subjects spontaneously recall emotional events, a host of cortical structures activate, including the prefrontal cortex, the insula, the somatosensory cortices, and the cingulate cortex (Damasio et al., 2000). The approximate location of those structures is shown in Figure 12.1.

PREFRONTAL CORTEX

The prefrontal cortex lies, not surprisingly, at the very front of the brain. The ventral or bottom one-third of the prefrontal cortex is called the orbitofrontal cortex and is most elaborately developed in humans and other primates. There is some evidence that subcortical projections to the prefrontal cortex contribute to conscious affective experience. For example, the intense feeling of pleasure experienced by heroin users appears to involve accumbens-to-cortex signals that are relayed to cortical regions via the ventral pallidum and thalamus (Wise, 1996). In another example, self-reports of "excitement" in typical participants are related to the degree of activation in the nucleus accumbens and prefrontal cortex (Knutson et al., 2004). The orbitofrontal cortex contains a special zone in its midanterior region that specifically codes positive pleasure, and where fMRI activation tracks changes in a food sensory pleasure induced by sensory-specific satiety (Kringelbach, 2005; 2010). The prefrontal cortex is not only directly involved in conscious emotional experience but also participates in affective reactions by modulating lower brain structures via descending projections (Damasio, 1999; Phan, Wager, Taylor, & Liberzon, 2004). For example, the orbitofrontal cortex projects back to the accumbens (Davidson, Jackson, & Kalin, 2000) and the dorsolateral prefrontal cortex projects back to the amygdala (Ochsner & Gross, 2004).

SOMATOSENSORY CORTEX AND INSULA

The primary (S1) and secondary (S2) somatosensory cortex is located behind the central sulcus. The somatosensory cortex is responsible for monitoring the state of the body, including sensations (e.g., touch) and proprioception (i.e., state of muscles and joints). The insula is located near the bottom of the somatosensory cortex, almost at the intersection of the frontal, parietal, and temporal lobes. The insula receives inputs from limbic structures, such as the amygdala, and cortical structures, such as the prefrontal cortex and posterior parietal cortex and the anterior cingulate, and appears particularly important for interoception, or monitoring the state of internal organs (Craig, 2003; Critchley et al., 2004).

There is evidence that the somatosensory cortex and the insula may jointly contribute to emotional experience by representing the current body state (Craig, 2009). For example, neuroimaging studies show that recall of emotional memories is associated with extensive activation of the somatosensory cortex (Damasio et al., 2000). In another example, lesions to the right somatosensory cortex are associated with impaired perception of facial expressions as well as impaired touch perception (Adolphs et al., 2000). Finally, human studies show involvement of insula in pain (Peyron et al., 2000), disgust (Wicker et al., 2003), and appreciation of sweet tastes and related rewards (O'Doherty et al., 2002). These findings are generally consistent with the so called "embodiment" approach to emotion, which emphasizes the representational role of the central and peripheral representations of the body (e.g., Niedenthal et al., 2005).

CINGULATE CORTEX

The cingulate cortex consists of a longitudinal strip running front to back along the midline on each hemisphere of the brain, just above the corpus callosum. Again, it is a richly interconnected structure thought to interface between the limbic system and prefrontal cortex (Craig, 2009 above). The cingulate cortex has been implicated in human clinical conditions such as pain, depression, anxiety, and other distressing states (Davidson, Abercrombie, Nitschke, & Putnam, 1999; Peyron et al., 2000). Interestingly, some research suggests that emotion experience is associated with the dorsal anterior region of the cingulate cortex, whereas more reflective parts of the awareness are associated with the rostral anterior region (Lane, 2000).

Functional Organization of Conscious States

As the foregoing review indicates, a host of subcortical and cortical structures is involved in the production of emotional responses to valenced stimuli. This raises the important question: How does neural activity in these structures relate to the complexity and consciousness of the corresponding emotional state? A simple (and probably over-simplistic) viewpoint would identify the subjective component of emotion with activity in the cortical components of the neural emotion network. Subcortical structures would then be mediating only the nonconscious components of the emotional response. From this viewpoint, evidence for "unconscious emotion" would be explained by the autonomous operation of (a subset of) the subcortical components of the network, in the absence of direct cortical involvement. In a more nuanced (and more realistic) perspective, however, cortical representations of emotion may themselves be conscious or unconscious, and the neural basis of conscious emotion is expected to essentially involve interactions between cortical and subcortical structures in the network. Conscious emotion may emerge, for example, as the cortex hierarchically re-represents and feeds back on subcortical processes that inform it. On such view, conscious emotion is not "localizable" to particular structures at either level. Adopting this perspective, the question becomes: What qualitative patterns of functional organization across the areas reviewed above are likely to underlie conscious and unconscious emotion? In this section, we address this question in the context of a general "global workspace" model of the functional organization of conscious states.

Global Workspace

Attempts to functionally distinguish conscious from unconscious cognitive processing commonly focus, at the input side, on integration, and on flexibility of response at the output side. In this framework, a conscious representation characteristically (i) involves a unified interpretation coherently integrating information from multiple sensory modalities and other systems (e.g., vision, touch, introception, working and long-term memory), and (ii) supports a coherent suite of actions ranging over arbitrary response mappings and implemented by arbitrary motor effectors (e.g., a button-press with the right index finger, a verbal response in, say, English, Polish or German, the coded eye movements of a locked-in patient). Included among the coherent suite of actions in (ii) is the subject's adamant verbal report about the qualitative character of his/her subjective experience—as well as a wealth of possible meta-cognitive reports about the contents of current cognition (cf. Schooler, 2002 on "meta-consciousness").

Consciousness, in this functional approach, is uniquely associated with a massive integrated choreography of representation and response. While conscious experience has sometimes been speculatively identified with a putative choreographer residing at a specific brain locus (e.g., the pineal gland of Descartes, 1649; cf. Dennett, 1991), it is presently more popular to identify conscious experience (somehow) with the neural choreography itself. The "neural correlate of consciousness" is then expected to be a pattern of coordinated neural activity across perceptual, associative, and premotor areas all working (somehow) on the same page.

This general idea is neatly captured in Baars' (1993, 1997) influential metaphor of a "global workspace." Cognition is comprised of a collection of semi-independent specialized processors, each capable of rapidly performing a limited set of nonconscious computations. Information becomes conscious when the output of a subset of the processors is globally broadcast to the entire network of processors. Broadcasting a common pool of information allows the network of processors, coherently but slowly, to collectively deal with novel contingencies for which no single processor is adequately specialized. Consistent with this idea, several specific instances of unconscious processing are believed to involve the same dedicated cortical sites that are critical for conscious processing of similar information, but without sustained orchestrated activation across distant brain areas. For example, numerous studies have found evidence for semantic priming from visually masked words, even when subjects are unable to report the identity of the words (e.g., Merikle & Daneman, 1998). In neuroimaging experiments, unconsciously masked words produce sustained activity (albeit at reduced levels) in the same specialized cortical region of the left temporal lobe that is strongly and specifically activated by consciously visible words. However, when subjects are not conscious of the word stimuli, sustained activity is *not* seen across a slew of word non-specific areas strongly activated by conscious word stimuli (Dehaene et al., 2001).

Vegetative State

The idea that specialized cortical processors can operate autonomously in the absence of conscious awareness is dramatically illustrated in the vegetative state. Vegetative patients have preserved sleep/wake cycles but are deemed to lack awareness of self and environment. The condition, reviewed in Jennett (2002), is typically caused by widespread damage to the cerebral cortex and/or its underlying white matter. Recent experimental evidence suggests that apparent unawareness in the vegetative state may stem from a failure to integrate locally processed information into a unified brain-wide representation. For example, Laureys and colleagues (2002) delivered noxious tactile stimuli to vegetative patients as well as control subjects while changes in regional cerebral blood flow were measured. Both patients and controls showed stimulus-specific activity in primary thalamic and cortical somatosensory areas contralateral to the noxious stimulus. In addition, the noxious stimuli activated a widely distributed array of higher-order "association areas" in both hemispheres of conscious control brains, but not in apparently unconscious vegetative brains.

This principle of largely intact local processors against a background of blocked global representation may, we suggest, likewise explain atypical fragments of coordinated behavior which are occasionally observed in vegetative patients, and which have been associated with relatively preserved activity in isolated neural mini-networks. These stereotyped behavioral fragments sometimes involve a strong affective component. For example, Plum et al. (1998) described a vegetative patient, exhibiting no clear behavioral signs of meaningful awareness for self or environment, in whom the following behavioral pattern was repeatedly demonstrated:

> "When anyone makes a loud noise or attempts to examine, feed or bathe him, he immediately expresses clenched-teeth, rigid extremities, and produces a high pitched noise that sounds like a maximal screaming rage. During these attacks his skin color flushes, and his blood pressure rises" (pp. 1931).

The authors likened this coordinated response pattern to the "sham rage" which Cannon (1927) was able to elicit in brainstem-transected cats. While metabolic levels were severely reduced throughout this patient's cerebrum, the reduction was less marked in a network of brain areas the authors conjectured to be involved in affective response. Further evidence that autonomous neural subnetworks can operate in the absence of global integration and conscious awareness comes from the study of NREM parasomnias (non-rapid eye movement, slow wave sleep). In a SPECT imaging study of presumably unconscious ambulation during sleepwalking, isolated activity was observed in a mini-network including the thalamus, cerebellum, and posterior cingulate cortex—while global activity was significantly depressed throughout most of the cortex (Bassetti et al., 2000).

Recall that "affect" and "emotion" were earlier defined as complex coordinated syndromes of valence-based subjective, physiological, and behavioral components. In the global workspace framework, consciousness itself is viewed as equivalent to, or closely linked with, the system-wide integration of many component processors, ranging widely over modalities, dimensions, and response mappings. In this setting, the binary question—Can emotion be unconscious?—is seen to approximate a more continuous question: To what extent can various subsets of processors in the neural emotion network operate in an internally coherent fashion, without themselves being integrated with the various other processors in the global workspace? How big can a coherent network of affective processors become—and hence how elaborate can affect-congruent behaviors and physiological reactions become—without being recruited into the coherent brain-wide network of activity that is the presumed neural correlate of normal subjective experience?

The next section describes experimental evidence suggesting that affect-congruent responses can reach a remarkably high level of coherence and complexity in the absence of conscious awareness. But first, we briefly note the broad reach of this question—how much integration is possible outside the conscious global workspace—in the affective neuroscience of consciousness.

Sleep Murders and Other Dissociations

The question of "complex yet unconscious emotional actions" is posed in an especially striking form by the numerous putative instances of "sleep-murder" (reviewed in Broughton et al., 1994). In one important Canadian medico-legal case, Kenneth Parks was acquitted of murder and attempted murder after a defense that attributed his actions to "noninsane automatism"—several sleep experts argued, and the jury accepted, that Parks left his home, drove 10–15 minutes to his in-law's house, and assaulted them in an elaborate unconscious automatism during an episode of sleepwalking (Broughton et al., 1994). For a case in which a highly similar sleepwalking defense was rejected by an American jury see Cartwright, 2004. For other examples of remarkably complex behavior during apparent sleepwalking, see Schenck and Mahowald (1995) and Siddiqui et al. (2009).

The question of complex unconscious actions also arises in the longstanding debate between "credulous" and "skeptical" views (Sutcliffe, 1961) of putative functional dissociations in experimental hypnosis (Knox et al., 1974) and dissociative identity disorder (Putnam, 1989). What is the maximum possible level of sub-total neural integration—and correspondingly, how much internal coherence can complex behavioral and physiological responses exhibit in the absence of unified conscious awareness?

Experimental Psychology

Thought the neuroscientific evidence for the possibility of unconscious emotion is rather compelling, it is not enough. After all, much of it comes from animal studies and studies of brain-damaged patients, thus it is unclear how it applies to typical individuals. Further, in many laboratory studies physiology (rather than behavior) is the primary dependent variable. Thus, it is unclear whether physiological activations observed in well-controlled empirical studies have meaningful behavioral consequences. Fortunately, in recent years, psychology has begun to explore these questions with a variety of paradigms, often using a combination of behavioral and physiological methods.

Unconscious Affective Reactions to Facial Expressions

What about ordinary people with fully intact brains? Can they have "unconscious emotions" too? There are now several studies which explored unconscious emotion using subliminal facial expressions. In one of the initial studies, participants were asked to rate neutral Chinese ideographs preceded by subliminal happy or angry faces (Winkielman, Zajonc, & Schwarz, 1997). During the task, some participants were asked to monitor changes in their conscious feelings. They were also told not to use their feelings as a source of their preference ratings. Those participants were given instructions containing plausible alternative explanations for why their feelings might change (e.g., background music, flashing pictures). In effect, these instructions encouraged corrective attributions that typically eliminate the contaminating influence of conscious feelings on evaluative judgments (Clore, 1994). However, even for participants who knew to disregard their "contaminated" feelings, the subliminal happy faces increased, and subliminal angry faces decreased preference ratings. Most relevant to the question of unconscious emotion, participants did not remember experiencing any changes in their mood when asked after the experiment about their emotions.

A more compelling evidence for unconscious emotion would show that cognitively able and motivated participants are *unable to report a conscious feeling* at the same time their behavior reveals the *presence of an affective reaction*. Ideally, the affective reaction should be strong enough to change even behavior that has real consequences for the individual. To obtain such evidence, Winkielman, Berridge, and Wilbarger (2005) assessed consumption behavior after exposing participants to several subliminal emotional facial expressions (happy, neutral, or angry). Each of the subliminal expressions was masked by a clearly visible neutral face on which participants performed a simple gender detection task. Immediately after the subliminal affect induction, some participants rated their feelings (mood and arousal) and then consumed a fruit beverage. Other participants performed consumption behavior and feeling ratings in opposite order. In Study 1, the consumption behavior involved pouring themselves a cup of a novel drink from a pitcher and then drinking it. In Study 2, participants were asked to take a small sip of the drink and rate it on different dimensions (e.g., monetary value). In both studies, there was no evidence of any change in conscious mood or arousal, regardless of whether participants rated their feelings on a simple scale from positive to negative or on a multi-item scale asking about specific emotions. Yet participants' consumption behavior and drink ratings were influenced by those subliminal affective stimuli, especially when participants were thirsty. Specifically, after happy faces thirsty participants poured significantly more drink from the pitcher and drank more from their cup than after angry faces (Study 1). Thirsty participants were also willing to pay about twice as much more for the drink after happy, rather than angry expressions (Study 2). That is, subliminal emotional faces evoked affective reactions that altered participants' consumption behavior and evaluation of the beverage, but produced no mediating change in their conscious feelings at the moment the affective reactions were caused. Since participants rated their feelings of mood immediately after the subliminal affect induction, these results cannot be explained by the failure of affective memory.

One can wonder, however, whether such unconscious emotional reactions can drive a more complex social behavior. After all, a decision to pour and drink a novel beverage is relatively simple and could be driven by activation of basic approach-avoidance tendencies. Would an abstract and cognitive incentive, such as an investment prospect that requires an active decision whether to allocate money, also be increased in attractiveness by a subliminal positive prime, similar to the drink? To address this concern, we have recently used the same priming paradigm but asked participants to make more complex financial decisions (for overview, see Winkielman, Knutson, Paulus, & Trujillo, 2007). For example, in one study participants decided whether to gamble $1 for a 50% chance of winning $2.50 or whether to simply pocket the dollar. Participants primed with subliminal happy faces were more likely to choose the investment than participants primed with angry faces, presumably reflecting a more favorable evaluation of the bet.

One can wonder, however, to what extent the reactions elicited by unconscious affective faces are truly "affective," in the sense of involving "hot" representation of valence in the systems traditionally associated with emotion. Perhaps they are only "evaluative," in the sense of activation of certain meaning components (Clore, 1994). Our recent studies addressed this concern in two ways. First, as mentioned earlier, physiological and neuroimaging studies suggest that subliminal angry and fearful faces activate the amygdala and related limbic structures. Thus, one should be able to find psychophysiological traces of emotion in the just-described ideograph-rating and drinking studies. Indeed, we found that subliminal emotional facial expressions cause weak but detectable changes in response of low-level physiological systems. Specifically, we found congruent facial EMG responses (smiling to happy faces and frowning to angry faces) and emotion-congruent startle modulation, suggesting that the primes activate emotional channels that produce valenced expressions (Starr, Linn, & Winkielman, 2007). Another way to distinguish between the cold "evaluative" and "hot" affective aspects of emotion is by the use of different materials for emotion induction. Specifically, affective words have long been known to prime evaluative processes (e.g., as assessed by priming). On the other hand, affective pictures are more efficient than words in eliciting physiological reactions, which reflect changes in core affective systems (Larsen, Norris, & Cacioppo, 2003). This is true even if words and pictures are matched on self-reported valence and frequency. Consistent with these observations, we found that subliminal (and supraliminal) emotional facial expressions influence consumption in an affect-congruent way, whereas words do not (Starr, Winkielman, & Gogolushko, 2008). Thus, it appears that even though the reaction induced by the emotional facial expressions is unconscious, it works via modification of a low-level emotional response, rather via high-level evaluative priming. In sum, we propose that all these results demonstrate unconscious affect in the strong sense—a genuine affective process strong enough to alter behavior, but of which people are simply not aware.

Challenges and Limits to Unconscious Emotion

Findings like the one just described constitute some evidence for the independence of affect and conscious experience. But, there are several challenges to be met.

How does unconscious affect work?

One challenge involves specifying the mechanisms by which affect can influence behavior towards an object without eliciting conscious feelings. One possibility is that unconscious affect directly modulates the object's ability to trigger affective and motivational responses via a "front-end" or perceptual-attentional mechanism. That is, instead of triggering feelings, the affect could modify the position of the relevant target object on the organism's "incentive landscape." For example, we speculate that subliminal facial expressions might activate the amygdala, which then might project to the adjacent accumbens and related structures responsible for processing of incentives (Berridge, 2003; Rolls, 1999; Whalen et al., 1998). Altered neuronal activity in the nucleus accumbens (constituting unconscious "liking") could then change the human affective reaction to the sight of an incentive (drink, money) leading to differential behaviors, all without eliciting conscious feelings (see Winkielman et al., 2008 for a more comprehensive discussion).

Affect or emotion?
There is now decent evidence for *unconscious affect*—changes in general positivity–negativity. But what about *unconscious emotion*—categorically different states such as fear, anger, disgust, sadness, joy, love, shame, guilt, or pride? Some skeptics doubt this possibility based on the argument that emotional states require sophisticated cognitive differentiation. For example, an emotion such as guilt requires entertaining several beliefs such as "I did something wrong to another person, I was responsible, I could have done something to prevent it." This argument may hold for higher-order social emotion, but not for basic emotions. After all, animals, even reptiles, appear to show categorically different reactions to situations demanding different emotional response (e.g., fear, rage, rejection, Pankseep, 1998). It is also interesting that human neuroimaging studies reveal unique patterns of amygdala activation to consciously presented facial expressions of fear, anger, sadness, and disgust (Phan et al., 2002; Whalen, 1998). If future research shows that, say, masked facial expressions of fear, anger, sadness, or disgust can create different physiological reactions with different behavioral consequences, all without eliciting conscious feelings, then there might indeed be processes fully deserving the label "unconscious emotion." So far, we are not aware of such studies, but we believe the empirical challenges lie more in how to make the disgust or sadness stimuli convincingly "invisible" (which is difficult for faces but especially for complex pictures), rather than with the emotional reaction of disgust or sadness being necessarily conscious. In fact, there are some intriguing hints from a series of studies using subliminal words related to guilt and sadness—two negative but qualitatively different emotions (Zemack-Rugar, Bettman, & Fitzsimons, 2007). When participants were primed with subliminal guilt words, they showed less indulgence in their behavior than participants primed with sad words. Unfortunately, it is unclear in these studies whether the words induced actual emotions (there was no evidence of any feeling changes on the self-report level, but also no physiological measure of actual emotion). Still, these results at least raise a possibility that basic triggers of social emotions can operate unconsciously.

Unnoticed, unverbalized, or unconscious affect?
Another challenge comes from the difficulty of conclusively establishing the absence of feelings (as far as one can ever prove absence). The problem stems from the very nature of reporting on phenomenal states. Several writers pointed out the difference between the primary "experiencing" consciousness and the secondary "reflecting" consciousness (Lambie & Marcel, 2002; Schooler, 2002). Future research should address to what extent the absence of self-reported feelings in human studies represents a genuine absence of phenomenology, or inability to reflect on that phenomenology. Several writers have suggested that these questions could be addressed by providing participants with training in (i) introspection; (ii) use of beepers, ratings scales, or momentary-affect dials; or (iii) alternative, nonverbal ways of expressing emotion (Bartoshuk, 2000; Lambie & Marcel, 2002; Nielsen & Kaszniak, 2007; Schooler & Schreiber, 2004). Finally, neuroscience may be of help. If it's possible in the future to reliably identify a neural correlate of subjective experience, the presence of conscious feelings could be suggested by changes in relevant neural activation.

Conscious and Unconscious Emotion in Social Behavior

In the preceding section we have presented a variety of arguments for "unfelt" affect and emotion. So are conscious feelings just like "icing on the cake"—nice, but not necessary? We do not believe so. In the following section we offer some speculation on the role of conscious feelings in emotion, and the relation between conscious and unconscious components of emotion. We especially emphasize the critical role of conscious feelings in social behavior.

What Good is Conscious Feeling?

In general, there are several benefits for a mental state to be conscious. Consciousness allows the organism to go beyond simple, habitual reactions and design novel, complex, context-sensitive forms of responding. So, in many ways, an emotion system that has access to consciousness is going to be a more sophisticated one. Consciousness also allows control. The organism can stop undesirable responses and promote the desirable ones, and decide how and when to respond. Obviously, this control function has tremendous social consequences (Ochsner & Gross, 2004). Conscious access to feelings also plays a communicative and motivational function. Thus, conscious feelings give internal feedback about how well the organism is doing with the current pursuits, telling it to maintain or change its path. More importantly, being aware of one's emotion and able to communicate it to others seems crucial for basic social coordination. Feelings also come with psychological immediacy and urgency, making the organism "care" about its fate in a way that may not be available to any other mechanism (Searle, 1997). This extends from simple hedonic states, such as pain and pleasure, to complex emotions. Thus, pangs of guilt propel us to make amends, whereas green eyes of jealousy alert us to trespasses of our mates (Frank, 1998). Again, this function appears critical in making emotions social.

What Makes Emotion Unconscious or Conscious?

Given the many benefits, why then are humans sometimes unaware of their emotion? We suppose that a variety of neuroscientific and psychological factors play a role. Most of these factors probably apply regardless of whether the process is emotional or cognitive. Earlier in this chapter, we speculated that under some circumstances relevant neural processes could simply bypass the circuitry for subjective experience and feed directly into behavioral circuitry. That is, sometimes emotion can be unconscious for the same reason why vision can be unconscious. As documented in research on "vision for perception vs. vision for action" (Goodale & Milner, 2004) and in research on "blindsight" (Weiscranz, 1996), the relevant information can feed into the action system without ever reaching brain areas responsible for subjective experience. Further, sometimes rudimentary affective processes may be like other neural processes, such as thermoregulation, which are designed to run unconsciously and to elicit conscious experience only rarely, when there is an important reason for intervention. Another important factor might be the brain's inability to construct a coherent percept, as when alternative sources of activation compete for interpretation (Crick & Koch, 2003).

Other factors preventing the emergence of conscious representation are more psychological. Thus, the input might be too weak or too brief, as amply demonstrated in the work on backward masking (Enns & DiLollo, 2000). Or, the input may be strong, but inconsistent with the perceivers' expectations and thus escape attentional processing, as demonstrated in research on change blindness (Simons & Chabris, 1999). Or, the input may not make sense in the context of the current situation (Dennett, 1991). Yet, in all these cases, the input may be sufficient to influence behavior.

Unfortunately, there is little empirical work on factors that determine the emergence of conscious emotional feelings. Future work could make some progress by, for example, systematically examining what determines whether subliminal stimuli elicit conscious mood. As we discussed earlier, in our work, subliminal facial expressions did not elicit feeling (Winkielman et al., 2008). However, many studies observed feeling changes after subliminal bloody pictures (Robles, Smith, Carver, & Wellens, 1987) or mere-exposed ideographs (Monahan, Murphy, & Zajonc, 2000). These findings suggest that perhaps simple or highly practiced stimuli, like happy and angry faces used in our studies, are less likely to elicit feelings than more complex or novel stimuli, like visual scenes or ideographs. The impact on feelings could also depend on the individual's sensitivity to a particular emotion inducer. For example, subliminally presented snakes increased conscious anxiety in phobic, but not typical, participants (Öhman & Soares, 1994). Similarly, introspectively sensitive participants are better at detecting impact of subliminal stimuli and use their own reactions in behavior (Katkin, Wiens, & Öhman, 2001). Another interesting factor is the salience of the self representation. That is, when the self is salient, a change in an affective state might lead to a reportable conscious feeling, rather than be channeled to a representation of an external object (Lambie & Marcel, 2002). In sum, the emergence of conscious feelings may be determined by a host of stimulus, personal, and motivational factors. Though little is known at this point, it seems clear that the question of when and how emotion becomes conscious can be fruitfully empirically investigated, especially now given all the new experimental and neuroscientific techniques.

Concluding Summary

In this chapter we argued that understanding the relation between emotion and consciousness is important for many basic theoretical and practical questions of social neuroscience. We showed that evidence from many domains supports the idea of "unconscious emotion." Not only can basic emotional reactions be elicited with unconscious stimuli, but the affective reaction itself can remain unconscious. Yet, we also believe that conscious subjective experience plays a major role in human social behavior and should continue as a central topic of emotion research. It is only through the understanding of the relation between conscious and unconscious components that we will be able to fully capture the role of emotion in social life.

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