

Winkielman, P., Berridge, K., & Sher, S. (2011). Emotion, consciousness, and social behavior. In J. Decety & J. T. Cacioppo (Eds.), *Handbook of social neuroscience* (pp 195-211). Oxford University Press.

# Emotion, Consciousness, and Social Behavior

Piotr Winkielman, Kent Berridge, and Shlomi Sher

## 1 Abstract

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

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

12 One of the most fascinating topics in social neuro-  
13 science is the operation of emotions. This chapter  
14 focuses on the relation of emotion to consciousness  
15 and the implication of this relation for social behav-  
16 ior. That is, we will ask questions like the following:  
17 Which components of emotion are necessarily consci-  
18 ous and which can operate without conscious  
19 awareness? Can emotions be triggered with uncon-  
20 scious stimuli? Can they drive social behavior? And  
21 what about the emotional reaction itself? Can it  
22 remain unconscious while it has meaningful impact  
23 on behavior? What are the neural and psychological  
24 mechanisms underlying unconscious emotions? And  
25 what mechanisms support conscious feelings? To  
26 clarify, by conscious feelings we mean the experiential,  
27 first-person, phenomenological “what-is-it-like”  
28 aspect of emotion. In common language, it is what  
29 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.”

30  
31  
32 Though questions about the role of conscious-  
33 ness may seem “philosophical,” they address impor-  
34 tant aspects of psychology and neurobiology and  
35 the answers are relevant for both theoretical and  
36 practical understanding of social behavior. Let us  
37 give a few examples. First, consider the task of  
38 understanding and changing attitudes—the basis  
39 of social relations. This task requires figuring out  
40 the interplay between their conscious and uncon-  
41 scious elements. For example, can “dislikes” or even  
42 “hatred” remain unconscious and drive stereotypic  
43 or aggressive behavior? If so, how do we make them  
44 conscious? Researchers and the public care whether  
45 people’s emotional reactions can be driven by unat-  
46 tended emotional pictures and words that might  
47 influence emotions and decisions without ever being

1 explicitly detected. For example, recall the contro-  
2 versy about the advertisement produced by GW  
3 Bush's 2000 campaign against Al Gore which con-  
4 tained a briefly flashed word "RATS"—a fragment  
5 of the word "bureaucrats" (Berke, 2000). The crit-  
6 ics' concern was that forming an association with  
7 pestilential rodents might lead viewers to uncon-  
8 sciously form a negative view of a public health care  
9 plan. Second, consider the task of understanding the  
10 validity of people's reports of their own emotion.  
11 Shall we trust people's self-reports of happiness or  
12 rather establish their well-being via behavioral mea-  
13 sures (e.g., smiling, stress hormones)? Psychiatrists  
14 also care whether it is better to diagnose a patient's  
15 anxiety or depression via their reports of conscious  
16 feeling or via observation of the patient's actions.  
17 Activists thinking about issues of animal conscious-  
18 ness or fetal consciousness care what kind of organ-  
19 isms can feel conscious pleasure or pain (e.g., the  
20 "fish pain" debate in the UK, and the abortion  
21 debate in the US). Neurologists care whether emo-  
22 tional behavior (e.g., withdrawal from a noxious  
23 stimulation) of post-accident patients suspected of  
24 being in a vegetative state signifies a conscious state  
25 or can occur in the absence of consciousness.

26 Our chapter aims to show that answers to these  
27 difficult questions are beginning to emerge from  
28 psychology and neuroscience. The chapter is struc-  
29 tured as follows. First, we briefly show that the  
30 traditional perspectives on human emotions view  
31 them as necessarily conscious. Second, we show evi-  
32 dence that emotions can be unconsciously triggered.  
33 Third, and most importantly, we show that there  
34 are cases of truly "unconscious" or "unfelt" emotion.  
35 Fourth, we address some challenges to these ideas.  
36 Fifth, we address the relation between conscious  
37 and unconscious components of emotion. Reflecting  
38 the focus of this book, throughout our chapter we  
39 discuss neuroscience research that identifies struc-  
40 tures and functions associated with conscious and  
41 unconscious aspects of emotions and consider their  
42 implications for social behavior.

### 43 **Emotion as a Conscious Experience**

44 Let us start with some terminological clarifications.  
45 It is common to define emotion as a state character-  
46 ized by loosely coordinated changes in the following  
47 five components: (i) *feeling*—changes in subjective  
48 experience, (ii) *cognition*—changes in attentional,  
49 perceptual, and inferential processes (appraisals),  
50 (iii) *action*—changes in the predisposition for or  
51 execution of specific responses, (iv) *expression*—  
52 changes in the facial, vocal, postural appearance,

and (v) *physiology*—changes in the central and  
53 peripheral nervous systems. 54

55 It is also useful to distinguish "*affect*" and "*emo-*  
56 "*tion*." The term "*affect*" describes a state identified  
57 primarily by valence (positive/negative). The term  
58 "*emotion*" describes a state that can be identified  
59 by more than its valence, and includes specific types  
60 of negative states such as fear, guilt, anger, sadness,  
61 or disgust, and specific positive states, such as hap-  
62 piness, love, or pride. Throughout this chapter, we  
63 will primarily use the term *emotion*. This is because  
64 we believe that our arguments also apply to specific  
65 emotion states, even though the empirical evidence  
66 for our position has been obtained so far primarily  
67 in the domain of *affect*. We will return to this issue  
68 later.

### 69 **Theories of Emotion: Feeling as 70 a Central Component**

71 Theorists have long recognized that there are many  
72 components of emotion. Yet, psychologists and phil-  
73 osophers of emotion typically have considered feel-  
74 ing as central or even a necessary component. This  
75 is true for many historical figures (e.g., Freud, 1950,  
76 James, 1884). It is also true for many contempo-  
77 rary theorists in psychology (e.g., Clore, 1994). For  
78 example, one definition of "*affect*" says that the term  
79 "primarily refers to hedonic experience, the experi-  
80 ence of pleasure and pain" (Frijda, 1999 p., 194).  
81 Interestingly, some emotion theorists grounded in  
82 animal research and clinical neuroscience typically  
83 do not consider subjective experience as a central or  
84 necessary component of emotion (Damasio, 1999;  
85 LeDoux, 1996; but see Panksepp, 2005).

### 86 **Emotion Research in Psychology: Feeling 87 as a Central Agenda**

88 The feeling component is emphasized not only in  
89 theories, but also in research on human emotion. In  
90 social psychological studies, for example, the pres-  
91 ence of an emotion is typically determined by self-  
92 reports of feelings (e.g., mood questionnaires).  
93 When studies collect multiple measures of emotion,  
94 including physiological ones, self-report is often  
95 considered as the "gold standard" for determin-  
96 ing whether emotion had occurred (Larsen &  
97 Frederickson, 1999). There is also a lot of substan-  
98 tive interest in the nature of feelings. For example,  
99 some of the debates in emotion literature concern  
100 the contribution of bodily responses to subjective  
101 feelings (Niedenthal, Barsalou, Winkielman, Ric,  
102 & Krauth-Gruber, 2005) or the simultaneous co-  
103 existence of positive and negative feelings (Cacioppo,

1 Larsen, Smith, & Berntson, 2004). Most impor-  
2 tantly, conscious feeling is seen as a central causal  
3 force in emotional impact on social behavior. For  
4 example, a popular social psychological model,  
5 tellingly called “feeling-as-information,” proposes  
6 that emotions influence behavior because people  
7 use subjective experience as a heuristic shortcut to  
8 judgment (Schwarz & Clore, 2003).

### 9 **Unconscious Emotion**

10 As we have just shown, conscious feeling has a  
11 central place in both the theoretical thinking  
12 and empirical practice of human emotion research.  
13 However, do emotions always require conscious-  
14 ness? Can one meaningfully talk about “unfelt” or  
15 “unconscious” emotions? Over the last several years,  
16 researchers have increasingly started to consider  
17 these possibilities. Note that in most studies below,  
18 researchers investigated rather undifferentiated affec-  
19 tive reactions, rather than qualitatively differenti-  
20 ated emotion (we’ll return to this issue).

### 21 *Unconscious Elicitation of Affect*

22 The first challenge to the role of consciousness  
23 in emotion came from demonstrations that sub-  
24 liminal stimuli can trigger affective reactions. One  
25 example comes from research on the mere-exposure  
26 effect, or the increase in liking for repeated items  
27 (Kunst-Wilson & Zajonc, 1980). In one study, par-  
28 ticipants were first subliminally exposed to several  
29 repeated neutral stimuli consisting of random visual  
30 patterns. Later, those participants reported feeling  
31 more positive than participants exposed to non-  
32 repeated stimuli (Monahan, Murphy, & Zajonc,  
33 2000). An example of a subliminal induction of  
34 negative affect comes from studies in which sublimi-  
35 nal stimuli, such as gory scenes embedded in a movie,  
36 or snakes presented to phobic participants, led to an  
37 increase in self-reported anxiety (Öhman & Soares,  
38 1994; Robles, Smith, Carver, & Wellens, 1987).

39 Note that in the just-described studies the pres-  
40 ence of the affective reaction is determined by  
41 asking people to self report. However, unconscious  
42 stimuli can also elicit an affective reaction detectable  
43 using physiological measures. For example, skin-  
44 conductance response, an indicator of sympathetic  
45 arousal, can be triggered by subliminally presented  
46 emotional words (Lazarus & McCleary, 1951) and  
47 by pictures of fear-relevant objects (Öhman et al.,  
48 2000). Similarly, subliminal facial expressions acti-  
49 vate the amygdala, a structure involved in assigning  
50 affective significance to the stimulus (Whalen, et al.,  
51 1998), and elicit facial reactions detectable with

electromyography (Dimberg, Thunberg, & Elmehed, 52  
2000). We will return to these interesting findings 53  
later. 54

### *Unconscious Affective States* 55

The above studies suggest that emotional reactions 56  
can be triggered unconsciously. However, they were 57  
not designed to test whether the emotional state can 58  
be unconscious. First, most studies used self-report 59  
as a measure of affect, which by definition requires 60  
that the emotion is conscious. Second, in the physi- 61  
ological studies, self-reports of emotion experience 62  
were either not collected or collected after the mea- 63  
sure of affective reactions. As a result, it is not clear if 64  
the reaction registered in physiology was itself consci- 65  
ous or not. Third, because these studies did not 66  
measure behavioral consequences, it is possible that 67  
any emotion reaction was weak or inconsequential. 68  
Still, the physiological studies are suggestive and 69  
raise the possibility that, under the right conditions, 70  
people may have genuine affective reactions that are 71  
not manifested in their conscious experience. 72

Several years ago, we offered theoretical argu- 73  
ments and empirical support for the idea of uncon- 74  
scious emotion (Berridge & Winkielman, 2003; 75  
Winkielman & Berridge, 2004). Our views were 76  
in agreement with several authors in psychology, 77  
including those who emphasize the relative auto- 78  
maticity of emotional processing (e.g., Kihlstrom, 79  
1999); separability of expressive (verbal), physiolog- 80  
ical, and behavioral components of emotion (Lang, 81  
1968); and fallibility of the meta-cognitive processes 82  
(Lambie & Marcel, 2002). Our views also aligned 83  
with several authors in affective neuroscience who 84  
emphasize the role of deep brain structures in gener- 85  
ating unconscious elements of fear, anger, happiness, 86  
or sadness (e.g., Damasio, 1999; LeDoux, 1996). 87

In the next several sections, we review the main 88  
theoretical and empirical arguments that continue 89  
to support the idea that emotion may exist independ- 90  
ent of conscious experience and offer some updated 91  
arguments and evidence. First, we present some 92  
functional and evolutionary considerations. Second, 93  
we review evidence from research on the emotional 94  
brain. Third, we discuss relevant psychological stud- 95  
ies. After that, we address theoretical and empirical 96  
challenges to the notion of unconscious emotion 97  
and address some outstanding issues. 98

### *Functional and Evolutionary Considerations* 99

Does the capacity for emotional behavior evolution- 101  
arily precede, follow, or co-occur with the capacity 102

1 for conscious feeling? This is a difficult question as it  
2 involves making historical assumptions about the  
3 conjunction of two complex mental faculties—  
4 emotion and consciousness (Hayes & Huber, 2001).  
5 It is more manageable to ask whether evolution-  
6 arily basic affective reactions require conscious pro-  
7 cessing. Consider simple positive-negative reactions  
8 that animals produce to stimuli, such as predators,  
9 prey, strangers, con-specifics, food, drink, or mates  
10 (Konorski, 1967). The function of these affective  
11 reactions is to allow animals to react appropriately to  
12 favorable or unfavorable events by adjusting sensory  
13 apparatus (e.g., prioritizing certain stimuli), physi-  
14 ology (e.g., cardiovascular and hormonal changes),  
15 and action (e.g., priming of motor programs). From  
16 a design standpoint, it would be inefficient (and  
17 disadvantageous) if performing this basic function  
18 required the organism to possess a cognitive appara-  
19 tus capable of consciousness (Cosmides & Tooby,  
20 2000). Even in humans, conscious mechanisms  
21 are often too slow and imprecise for coordinating  
22 critical approach-avoidance responses. Most impor-  
23 tantly, consciousness is often unnecessary. The dis-  
24 connected (and presumably unconscious) spinal cord  
25 will reflexively withdraw the leg from a noxious stim-  
26 ulus delivered to the sole of the foot. Furthermore,  
27 many relatively complex coordination functions  
28 in organisms are efficiently performed without  
29 experiential representation. For example, decorti-  
30 cated rats, given proper female stimulation, will per-  
31 form mounts, intromissions, and ejaculations that  
32 are similar to control rats (Whishaw, Kolb, 1985).  
33 In humans, one example of this is the automatic  
34 coupling between the cardiovascular, respiratory,  
35 and digestive systems (Porges, 1997). In short, it is  
36 reasonable to assume that at least basic affective  
37 reactions can be performed without mechanisms  
38 responsible for conscious feelings (LeDoux, 1996).

39 One standard challenge psychologists sometimes  
40 offer to the above arguments is that brute positive/  
41 negative reactions should not be called “affective.”  
42 For example, paramecia can approach some stimuli,  
43 but it makes little sense to use the term “positive  
44 affect” for an organism that does not even have neu-  
45 rons. Further, even in more complex organisms,  
46 many reactions to favorable or unfavorable stimuli  
47 are more aptly classified as “reflexes” than “affective  
48 behaviors.” For example, when a spider jumps to  
49 kills a prey, it makes little sense to explain this  
50 behavior by positing an underlying state of “nega-  
51 tive affect.” We agree, and along with most authors,  
52 require that to count as affective, the behavior should  
53 meet several criteria. First, the organism must be

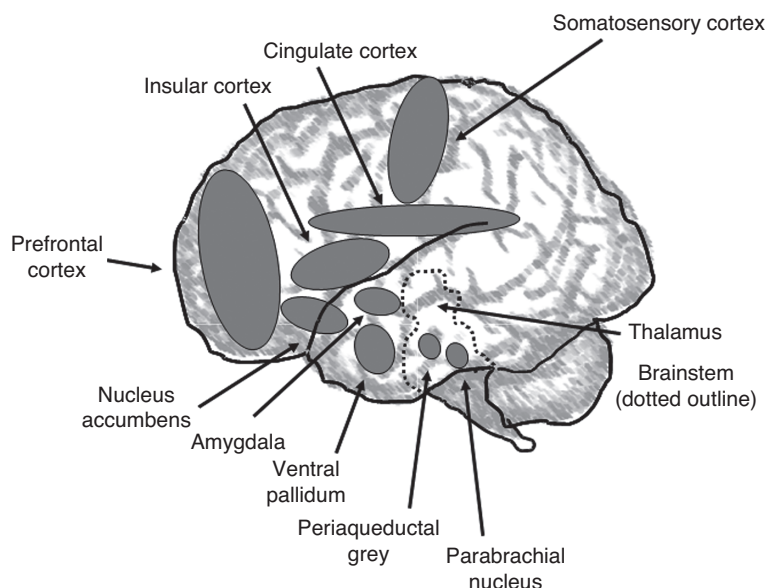
54 able to assess the input in terms of “valence.” Second,  
55 this assessment must lead to a temporary state  
56 that involves several reasonably synchronized com-  
57 ponents (i.e., perceptual, hormonal, cardiovascular,  
58 muscular). Importantly, these criteria do not require  
59 the organism to explicitly represent its goals or  
60 explicitly make emotional “judgments”—only to  
61 respond in a coherent way to challenges and oppor-  
62 tunities in its environment. Given these criteria,  
63 affect perhaps should *not* be assigned to reflexes,  
64 or to creatures like paramecia. But, it should be  
65 assigned to organisms that respond bivalently in  
66 a coherent, multisystem fashion to appropriate  
67 challenges and opportunities, even if these organ-  
68 isms have limited consciousness. For example, under  
69 these criteria, reptiles are capable of affect because  
70 they show coherent cardiovascular, hormonal, per-  
71 ceptual, and behavioral responses to favorable and  
72 unfavorable stimuli (Cabanac, 1999). In fact, there  
73 are many structural homologies between reptiles  
74 and mammalian limbic system (Martinez-Garcia,  
75 Martinez-Marcos, & Lanuza, 2002) and there are  
76 also remarkable similarities in the affective neuro-  
77 chemistry in birds, fish, reptiles, and mammals  
78 (Goodson & Bass, 2001).

79 In short, the available data suggest that vertebrates  
80 are capable of coordinated, multisystem responses  
81 to emotionally-relevant stimuli, with homologous  
82 neural circuitry regulating these responses across a  
83 diversity of vertebrate groups. Thus, while there  
84 are obvious differences in the neural substrates  
85 required for conscious experience across these  
86 groups, there is nonetheless remarkable consistency  
87 in other components of affective response. It there-  
88 fore seems logical to propose that neural compo-  
89 nents of emotional processing can function in a way  
90 that is largely uncoupled from the neural compo-  
91 nents of consciousness.

### 92 *Neural basis of Emotional Processing:* 93 *Review of Relevant Areas*

94 The just-presented evolutionary arguments are con-  
95 sistent with research on modern mammalian brains.  
96 As we discuss next, both subcortical and cortical  
97 structures participate in affective processes. The loca-  
98 tion of the most important structures of the general-  
99 ized emotional brain is indicated in Figure 12.1.  
100 Below, we provide a brief overview of what is known  
101 about the roles of those structures in generating  
102 positive and negative affect. However, we remind  
103 the reader that our presentation here is highly sim-  
104 plified and does not capture the multiple roles these  
105 structures play in both affect and cognition, and

**Fig. 12.1** Generalized Emotional Brain in Mammals.



1 their complex neuroanatomy and neurochemistry  
 2 (see Berridge, 2003). In the next section, we will  
 3 consider functional patterns of activity across these  
 4 areas that may correspond to conscious and uncon-  
 5 scious emotion.

6 ***Subcortical Networks and Basic***  
 7 ***Affective Reactions***

8 The subcortical structures involved in causing basic  
 9 affective reactions range from the “mere” brainstem  
 10 to the complex network of the “extended amygdala”  
 11 (Berridge, 2003). Let us illustrate with a few exam-  
 12 ples the critical role of these structures in both posi-  
 13 tive and negative affect.

14 ***Brainstem***

15 In both animals and humans the brainstem modulates  
 16 basic affective responses. For example, in the domain  
 17 of positive affect, research highlights the importance  
 18 of the parabrachial nucleus (PBN). The PBN receives  
 19 signals ascending from many sensory modalities,  
 20 including visceral signals regarding internal bodily  
 21 functions, and also taste sensations from the tongue.  
 22 Not surprisingly, PBN plays a role in generating  
 23 positive responses to tasty foods. For example, when  
 24 a rat’s PBN is tweaked by microinjections that activate  
 25 its benzodiazepine/GABA receptors, the rat  
 26 produces greater “liking” reactions to sugar, such as  
 27 tongue protrusions and lip licking (Berridge &  
 28 Pecina, 1995). In the domain of negative affect,  
 29 research highlights the importance of the periaque-  
 30 ductal gray (PAG). In animals, the PAG mediates  
 31 defensive reactions to threatening stimuli (Pankseep,

1998), and in both animals and humans, the PAG 32  
 mediates responses to pain (Willis & Westlund, 33  
 1997). Importantly, the PAG does not simply compile 34  
 incoming information to relay to the forebrain, 35  
 but forms reciprocal connections with subcortical 36  
 forebrain structures, thereby providing an anatomical 37  
 basis for sensory stimuli to be processed by the 38  
 PAG in a context-dependent and coordinated 39  
 fashion (Pankseep, 1998). 40

41 A particularly poignant demonstration of the  
 42 importance of brainstem to basic affective reactions  
 43 is offered by a cruel experiment of nature. As  
 44 a result of a birth defect, some infants have a  
 45 congenitally malformed brain, possessing only a  
 46 brainstem, but no cortex and little else of the forebrain  
 47 (i.e., no amygdala, nucleus accumbens, etc). Yet, in  
 48 these anencephalic infants, the sweet taste of sugar  
 49 still elicits facial expressions that resemble normal  
 50 “liking” reactions, such as lip sucking and smiles,  
 51 whereas bitter tastes elicit facial expressions that  
 52 resemble “disliking” reactions, such as mouth gapes  
 53 and nose wrinkling (Steiner, 1973). In this context,  
 54 it is also interesting that positive facial expressions  
 55 to sweetness are emitted by various apes and mon-  
 56 keys and even rats (Berridge, 2000; Steiner et al.,  
 57 2001). The pattern of positive facial expression  
 58 becomes increasingly less similar to humans as the  
 59 taxonomic distance increases between a species  
 60 and us. But all of these species share some reaction  
 61 components that are homologous to ours, suggest-  
 62 ing common evolutionary ancestry and a similar  
 63 neural mechanism that may be anchored in the  
 64 brainstem.

1 **Extended Amygdala**

2 The term “extended amygdala” designates a configura-  
3 tion including the central and medial nuclei  
4 of amygdala, the bed nucleus of the stria terminalis,  
5 and other structures, and which works in close concert  
6 with parallel limbic circuits such as the mesolimbic  
7 nucleus accumbens and ventral pallidum system  
8 (Heimer & Van Hoesen, 2006). Recent years have  
9 witnessed an explosion of research highlighting the  
10 role of extended amygdala in basic affective reactions.

11 **Amygdala**

12 The amygdala consists of a set of almond-shaped  
13 nuclei located in the medial temporal lobe, just  
14 anterior to the hippocampus. The amygdala is recip-  
15 rocallly connected to a variety of areas. This includes  
16 visual thalamus and visual cortex, allowing for affective  
17 modification of perception; the dorsolateral  
18 prefrontal cortex, allowing for upstream and down-  
19 stream regulation of affect state; and subcortical  
20 structures, allowing affective influence on sympa-  
21 thetic and parasympathetic regulation of cardiovas-  
22 cular activity, respiration, hormone levels, and basic  
23 muscular reactions. The role of the amygdala in  
24 perceptual and learning aspects of emotion has been  
25 confirmed in animal research as well as human neuro-  
26 imaging and lesion studies. Thus, patients with  
27 congenital or acquired amygdala damage show  
28 impairments in conditioned fear responses, fear-  
29 potentiated startle, and arousal-enhanced perception  
30 and memory (Whalen & Phelps, 2009). Remarkably,  
31 patients with damage to the amygdala show little, if  
32 any, impairment in their subjective experience of  
33 emotion, at least as measured by the magnitude and  
34 frequency of self-reported positive or negative affect  
35 assessed on the PANAS scale (Anderson & Phelps,  
36 2002). This suggests a relative independence of the  
37 amygdala from the mechanisms underlying genera-  
38 tion of feelings.

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

51 As mentioned earlier, there is some evidence that  
52 amygdala activation can occur without conscious

53 perception of the stimulus. Thus, fMRI studies  
54 show that the amygdala can be activated with facial  
55 expressions that are not consciously perceived,  
56 including expressions of fear and anger presented  
57 subliminally (Morris, Öhman, & Dolan, 1999;  
58 Whalen et al., 1998), under condition of binocular  
59 suppression (Williams et al., 2004), or presented  
60 to a patient’s blind visual field (Morris, et al,  
61 2001). A component of these effects may involve a  
62 direct pathway from the visual thalamus to the  
63 amygdala. However, the human amygdala is richly  
64 interconnected with the visual cortex and proba-  
65 bly receives the majority of input this way, thus  
66 challenging the popular notion of the “low-road”  
67 to emotion in typical humans (Pessoa & Adolphs,  
68 2010).

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

88 **Ventral Pallidum**

89 The ventral pallidum borders on the lateral hypo-  
90 thalamus at its front and lateral sides. It is a major  
91 target of the limbic nucleus accumbens (Smith  
92 et al., 2009). The ventral pallidum also feeds sub-  
93 cortical affective signals forward into corticolimbic  
94 loops by projecting to the orbitofrontal and ventro-  
95 medial areas of prefrontal cortex via a relay in the  
96 medial dorsal thalamus. In rats, this structure is  
97 involved in producing positive reactions to tasty  
98 foods, as suggested by the facts that (i) ventral pal-  
99 lidal neurons fire to tasty rewards, (ii) behavioral  
100 “liking” reactions to sweetness are increased by  
101 opioid drug microinjections in ventral pallidum,  
102 and (iii) excitotoxin lesions of ventral pallidum  
103 abolish hedonic reactions and cause aversive reac-  
104 tions (e.g., gaping and headshakes) to be elicited

1 even by normally palatable foods (Cromwell &  
2 Berridge, 1993; Smith et al., 2009; Tindell et al.,  
3 2006). Ventral pallidum may also be crucial to  
4 sexual and social pair-bonding in rodents (Insel &  
5 Fernald, 2004). Less is known regarding the role  
6 of ventral pallidum in affect for humans, as the  
7 structure is too small to study in brain-imaging  
8 studies. However, there are a few intriguing obser-  
9 vations. For example, electrical stimulation of the  
10 adjacent structure, globus pallidus, has been  
11 reported to sometimes induce bouts of affective  
12 mania that can last for days (Miyawaki, Perlmutter,  
13 Troster, Videen, & Koller, 2000). Also, the induc-  
14 tion of a state of sexual or competitive arousal in  
15 normal men was found to be accompanied by  
16 increased blood flow in the ventral globus pallidus  
17 (Rauch et al., 1999).

### 18 *Nucleus Accumbens*

19 The nucleus accumbens lies at the front of the  
20 subcortical forebrain and is rich in dopamine and  
21 opioid neurotransmitter systems. The accumbens  
22 is often portrayed as a reward and pleasure “center”  
23 (as often as the amygdala is portrayed as a “center”  
24 of fear). In fact, activation of dopamine projections  
25 to the accumbens and related targets has been  
26 viewed by many neuroscientists as a neural “common  
27 currency” for reward. There is actually evidence that  
28 dopamine contributions to the accumbens reflect  
29 not “pleasure,” or “liking” of the stimulus, but rather  
30 an incentive salience, or “wanting” of the stimulus  
31 (Berridge & Robinson, 1998). However, for the  
32 purpose of our argument here it is only important to  
33 highlight the role of accumbens in positive affective  
34 reactions. For example, in rats, brain microinjec-  
35 tions of drug droplets that activate opioid receptors  
36 in nucleus accumbens cause increased “liking” for  
37 sweetness, as well as increased “wanting” (Pecina &  
38 Berridge, 2000; 2005). In humans, the accum-  
39 bens activates to drug cues, sex cues, and also to  
40 other desired stimuli, including foods, drinks, and  
41 even money (Knutson et al., 2001; Knutson et al.  
42 2008).

### 43 *Cortical Networks*

44 One cannot talk about the emotional brain of mam-  
45 mals without discussing the cortex. In fact, when  
46 human subjects spontaneously recall emotional  
47 events, a host of cortical structures activate, includ-  
48 ing the prefrontal cortex, the insula, the somato-  
49 sensory cortices, and the cingulate cortex (Damasio  
50 et al., 2000). The approximate location of those  
51 structures is shown in Figure 12.1.

### PREFRONTAL CORTEX

52 The prefrontal cortex lies, not surprisingly, at the  
53 very front of the brain. The ventral or bottom one-  
54 third of the prefrontal cortex is called the orbitof-  
55 rontal cortex and is most elaborately developed in  
56 humans and other primates. There is some evidence  
57 that subcortical projections to the prefrontal cortex  
58 contribute to conscious affective experience. For  
59 example, the intense feeling of pleasure experienced  
60 by heroin users appears to involve accumbens-  
61 to-cortex signals that are relayed to cortical regions  
62 via the ventral pallidum and thalamus (Wise, 1996).  
63 In another example, self-reports of “excitement” in  
64 typical participants are related to the degree of acti-  
65 vation in the nucleus accumbens and prefrontal  
66 cortex (Knutson et al., 2004). The orbitofrontal  
67 cortex contains a special zone in its midanterior  
68 region that specifically codes positive pleasure, and  
69 where fMRI activation tracks changes in a food  
70 sensory pleasure induced by sensory-specific satiety  
71 (Kringelbach, 2005; 2010). The prefrontal cortex is  
72 not only directly involved in conscious emotional  
73 experience but also participates in affective reactions  
74 by modulating lower brain structures via descending  
75 projections (Damasio, 1999; Phan, Wager, Taylor,  
76 & Liberzon, 2004). For example, the orbitofrontal  
77 cortex projects back to the accumbens (Davidson,  
78 Jackson, & Kalin, 2000) and the dorsolateral  
79 prefrontal cortex projects back to the amygdala  
80 (Ochsner & Gross, 2004).  
81

### SOMATOSENSORY CORTEX AND INSULA

82 The primary (S1) and secondary (S2) somatosen-  
83 sory cortex is located behind the central sulcus. The  
84 somatosensory cortex is responsible for monitor-  
85 ing the state of the body, including sensations (e.g.,  
86 touch) and proprioception (i.e., state of muscles  
87 and joints). The insula is located near the bottom of  
88 the somatosensory cortex, almost at the intersection  
89 of the frontal, parietal, and temporal lobes. The  
90 insula receives inputs from limbic structures, such  
91 as the amygdala, and cortical structures, such as the  
92 prefrontal cortex and posterior parietal cortex and  
93 the anterior cingulate, and appears particularly  
94 important for interoception, or monitoring the state  
95 of internal organs (Craig, 2003; Critchley et al.,  
96 2004).  
97

98 There is evidence that the somatosensory cortex  
99 and the insula may jointly contribute to emotional  
100 experience by representing the current body state  
101 (Craig, 2009). For example, neuroimaging studies  
102 show that recall of emotional memories is associ-  
103 ated with extensive activation of the somatosensory

1 cortex (Damasio et al., 2000). In another example,  
2 lesions to the right somatosensory cortex are associ-  
3 ated with impaired perception of facial expres-  
4 sions as well as impaired touch perception (Adolphs  
5 et al., 2000). Finally, human studies show involve-  
6 ment of insula in pain (Peyron et al., 2000), disgust  
7 (Wicker et al., 2003), and appreciation of sweet  
8 tastes and related rewards (O'Doherty et al., 2002).  
9 These findings are generally consistent with the so  
10 called "embodiment" approach to emotion, which  
11 emphasizes the representational role of the central  
12 and peripheral representations of the body (e.g.,  
13 Niedenthal et al., 2005).

#### 14 CINGULATE CORTEX

15 The cingulate cortex consists of a longitudinal strip  
16 running front to back along the midline on each  
17 hemisphere of the brain, just above the corpus cal-  
18 losum. Again, it is a richly interconnected structure  
19 thought to interface between the limbic system and  
20 prefrontal cortex (Craig, 2009 above). The cingulate  
21 cortex has been implicated in human clinical con-  
22 ditions such as pain, depression, anxiety, and other  
23 distressing states (Davidson, Abercrombie, Nitschke,  
24 & Putnam, 1999; Peyron et al., 2000). Interestingly,  
25 some research suggests that emotion experience is  
26 associated with the dorsal anterior region of the  
27 cingulate cortex, whereas more reflective parts of  
28 the awareness are associated with the rostral anterior  
29 region (Lane, 2000).

#### 30 *Functional Organization* 31 *of Conscious States*

32 As the foregoing review indicates, a host of subcorti-  
33 cal and cortical structures is involved in the produc-  
34 tion of emotional responses to valenced stimuli.  
35 This raises the important question: How does neural  
36 activity in these structures relate to the complexity  
37 and consciousness of the corresponding emotional  
38 state? A simple (and probably over-simplistic) view-  
39 point would identify the subjective component of  
40 emotion with activity in the cortical components of  
41 the neural emotion network. Subcortical structures  
42 would then be mediating only the nonconscious  
43 components of the emotional response. From this  
44 viewpoint, evidence for "unconscious emotion"  
45 would be explained by the autonomous operation  
46 of (a subset of) the subcortical components of the  
47 network, in the absence of direct cortical involve-  
48 ment. In a more nuanced (and more realistic) per-  
49 spective, however, cortical representations of emotion  
50 may themselves be conscious or unconscious, and  
51 the neural basis of conscious emotion is expected to

52 essentially involve interactions between cortical  
53 and subcortical structures in the network. Conscious  
54 emotion may emerge, for example, as the cortex  
55 hierarchically re-represents and feeds back on sub-  
56 cortical processes that inform it. On such view,  
57 conscious emotion is not "localizable" to particular  
58 structures at either level. Adopting this perspective,  
59 the question becomes: What qualitative patterns  
60 of functional organization across the areas reviewed  
61 above are likely to underlie conscious and uncon-  
62 scious emotion? In this section, we address this  
63 question in the context of a general "global work-  
64 space" model of the functional organization of  
65 conscious states.

#### 66 *Global Workspace*

67 Attempts to functionally distinguish conscious from  
68 unconscious cognitive processing commonly focus,  
69 at the input side, on integration, and on flexibil-  
70 ity of response at the output side. In this frame-  
71 work, a conscious representation characteristically  
72 (i) involves a unified interpretation coherently  
73 integrating information from multiple sensory  
74 modalities and other systems (e.g., vision, touch,  
75 interoception, working and long-term memory), and  
76 (ii) supports a coherent suite of actions ranging over  
77 arbitrary response mappings and implemented by  
78 arbitrary motor effectors (e.g., a button-press with  
79 the right index finger, a verbal response in, say,  
80 English, Polish or German, the coded eye move-  
81 ments of a locked-in patient). Included among the  
82 coherent suite of actions in (ii) is the subject's  
83 adamant verbal report about the qualitative charac-  
84 ter of his/her subjective experience—as well as a  
85 wealth of possible meta-cognitive reports about the  
86 contents of current cognition (cf. Schooler, 2002  
87 on "meta-consciousness").

88 Consciousness, in this functional approach, is  
89 uniquely associated with a massive integrated chore-  
90 ography of representation and response. While con-  
91 scious experience has sometimes been speculatively  
92 identified with a putative choreographer residing  
93 at a specific brain locus (e.g., the pineal gland of  
94 Descartes, 1649; cf. Dennett, 1991), it is presently  
95 more popular to identify conscious experience  
96 (somehow) with the neural choreography itself. The  
97 "neural correlate of consciousness" is then expected  
98 to be a pattern of coordinated neural activity across  
99 perceptual, associative, and premotor areas all work-  
100 ing (somehow) on the same page.

101 This general idea is neatly captured in Baars'  
102 (1993, 1997) influential metaphor of a "global  
103 workspace." Cognition is comprised of a collection



1 of semi-independent specialized processors, each  
2 capable of rapidly performing a limited set of  
3 nonconscious computations. Information becomes  
4 conscious when the output of a subset of the proces-  
5 sors is globally broadcast to the entire network of  
6 processors. Broadcasting a common pool of infor-  
7 mation allows the network of processors, coherently  
8 but slowly, to collectively deal with novel contin-  
9 gencies for which no single processor is adequately  
10 specialized. Consistent with this idea, several spe-  
11 cific instances of unconscious processing are believed  
12 to involve the same dedicated cortical sites that are  
13 critical for conscious processing of similar informa-  
14 tion, but without sustained orchestrated activation  
15 across distant brain areas. For example, numerous  
16 studies have found evidence for semantic priming  
17 from visually masked words, even when subjects  
18 are unable to report the identity of the words (e.g.,  
19 Merikle & Daneman, 1998). In neuroimaging  
20 experiments, unconsciously masked words produce  
21 sustained activity (albeit at reduced levels) in the  
22 same specialized cortical region of the left temporal  
23 lobe that is strongly and specifically activated by  
24 consciously visible words. However, when subjects  
25 are not conscious of the word stimuli, sustained  
26 activity is *not* seen across a slew of word non-specific  
27 areas strongly activated by conscious word stimuli  
28 (Dehaene et al., 2001).

### 29 *Vegetative State*

30 The idea that specialized cortical processors can  
31 operate autonomously in the absence of conscious  
32 awareness is dramatically illustrated in the vegeta-  
33 tive state. Vegetative patients have preserved sleep/  
34 wake cycles but are deemed to lack awareness of  
35 self and environment. The condition, reviewed in  
36 Jennett (2002), is typically caused by widespread  
37 damage to the cerebral cortex and/or its underlying  
38 white matter. Recent experimental evidence suggests  
39 that apparent unawareness in the vegetative state may  
40 stem from a failure to integrate locally processed  
41 information into a unified brain-wide representation.  
42 For example, Laureys and colleagues (2002) deliv-  
43 ered noxious tactile stimuli to vegetative patients as  
44 well as control subjects while changes in regional  
45 cerebral blood flow were measured. Both patients  
46 and controls showed stimulus-specific activity in  
47 primary thalamic and cortical somatosensory areas  
48 contralateral to the noxious stimulus. In addition,  
49 the noxious stimuli activated a widely distributed  
50 array of higher-order “association areas” in both  
51 hemispheres of conscious control brains, but not in  
52 apparently unconscious vegetative brains.

This principle of largely intact local processors 53  
against a background of blocked global representa- 54  
tion may, we suggest, likewise explain atypical frag- 55  
ments of coordinated behavior which are occasionally 56  
observed in vegetative patients, and which have 57  
been associated with relatively preserved activity in 58  
isolated neural mini-networks. These stereotyped 59  
behavioral fragments sometimes involve a strong 60  
affective component. For example, Plum et al. 61  
(1998) described a vegetative patient, exhibiting no 62  
clear behavioral signs of meaningful awareness for 63  
self or environment, in whom the following behav- 64  
ioral pattern was repeatedly demonstrated: 65

“When anyone makes a loud noise or attempts to 66  
examine, feed or bathe him, he immediately expresses 67  
clenched-teeth, rigid extremities, and produces a high 68  
pitched noise that sounds like a maximal screaming 69  
rage. During these attacks his skin color flushes, and 70  
his blood pressure rises” (pp. 1931). 71

The authors likened this coordinated response 72  
pattern to the “sham rage” which Cannon (1927) 73  
was able to elicit in brainstem-transected cats. While 74  
metabolic levels were severely reduced through- 75  
out this patient’s cerebrum, the reduction was less 76  
marked in a network of brain areas the authors 77  
conjectured to be involved in affective response. 78  
Further evidence that autonomous neural subnet- 79  
works can operate in the absence of global integra- 80  
tion and conscious awareness comes from the study 81  
of NREM parasomnias (non-rapid eye movement, 82  
slow wave sleep). In a SPECT imaging study of pre- 83  
sumably unconscious ambulation during sleepwalk- 84  
ing, isolated activity was observed in a mini-network 85  
including the thalamus, cerebellum, and posterior 86  
cingulate cortex—while global activity was signifi- 87  
cantly depressed throughout most of the cortex 88  
(Bassetti et al., 2000). 89

Recall that “affect” and “emotion” were earlier 90  
defined as complex coordinated syndromes of 91  
valence-based subjective, physiological, and behav- 92  
ioral components. In the global workspace frame- 93  
work, consciousness itself is viewed as equivalent to, 94  
or closely linked with, the system-wide integration 95  
of many component processors, ranging widely over 96  
modalities, dimensions, and response mappings. In 97  
this setting, the binary question—Can emotion 98  
be unconscious?—is seen to approximate a more 99  
continuous question: To what extent can various 100  
subsets of processors in the neural emotion network 101  
operate in an internally coherent fashion, without 102  
themselves being integrated with the various other 103  
processors in the global workspace? How big can a 104

1 coherent network of affective processors become—  
2 and hence how elaborate can affect-congruent  
3 behaviors and physiological reactions become—  
4 without being recruited into the coherent brain-  
5 wide network of activity that is the presumed neural  
6 correlate of normal subjective experience?

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

#### 15 *Sleep Murders and Other Dissociations*

16 The question of “complex yet unconscious emo-  
17 tional actions” is posed in an especially striking form  
18 by the numerous putative instances of “sleep-  
19 murder” (reviewed in Broughton et al., 1994). In  
20 one important Canadian medico-legal case, Kenneth  
21 Parks was acquitted of murder and attempted  
22 murder after a defense that attributed his actions  
23 to “nonsane automatism”—several sleep experts  
24 argued, and the jury accepted, that Parks left his  
25 home, drove 10–15 minutes to his in-law’s house,  
26 and assaulted them in an elaborate unconscious  
27 automatism during an episode of sleepwalking  
28 (Broughton et al., 1994). For a case in which a  
29 highly similar sleepwalking defense was rejected  
30 by an American jury see Cartwright, 2004. For  
31 other examples of remarkably complex behavior  
32 during apparent sleepwalking, see Schenck and  
33 Mahowald (1995) and Siddiqui et al. (2009).

34 The question of complex unconscious actions  
35 also arises in the longstanding debate between  
36 “credulous” and “skeptical” views (Sutcliffe, 1961)  
37 of putative functional dissociations in experimental  
38 hypnosis (Knox et al., 1974) and dissociative iden-  
39 tity disorder (Putnam, 1989). What is the maximum  
40 possible level of sub-total neural integration—  
41 and correspondingly, how much internal coher-  
42 ence can complex behavioral and physiological  
43 responses exhibit in the absence of unified conscious  
44 awareness?

#### 45 *Experimental Psychology*

46 Thought the neuroscientific evidence for the possi-  
47 bility of unconscious emotion is rather compelling,  
48 it is not enough. After all, much of it comes from  
49 animal studies and studies of brain-damaged  
50 patients, thus it is unclear how it applies to typical  
51 individuals. Further, in many laboratory studies

physiology (rather than behavior) is the primary 52  
dependent variable. Thus, it is unclear whether 53  
physiological activations observed in well-controlled 54  
empirical studies have meaningful behavioral conse- 55  
quences. Fortunately, in recent years, psychology 56  
has begun to explore these questions with a variety 57  
of paradigms, often using a combination of behav- 58  
ioral and physiological methods. 59

#### *Unconscious Affective Reactions to Facial Expressions*

60  
61  
62 What about ordinary people with fully intact brains?  
63 Can they have “unconscious emotions” too? There  
64 are now several studies which explored unconscious  
65 emotion using subliminal facial expressions. In one  
66 of the initial studies, participants were asked to rate  
67 neutral Chinese ideographs preceded by sublimi-  
68 nal happy or angry faces (Winkielman, Zajonc, &  
69 Schwarz, 1997). During the task, some participants  
70 were asked to monitor changes in their conscious  
71 feelings. They were also told not to use their feelings  
72 as a source of their preference ratings. Those partici-  
73 pants were given instructions containing plausible  
74 alternative explanations for why their feelings might  
75 change (e.g., background music, flashing pictures).  
76 In effect, these instructions encouraged corrective  
77 attributions that typically eliminate the contami-  
78 nating influence of conscious feelings on evaluative  
79 judgments (Clore, 1994). However, even for partici-  
80 pants who knew to disregard their “contami-  
81 nated” feelings, the subliminal happy faces increased,  
82 and subliminal angry faces decreased preference rat-  
83 ings. Most relevant to the question of unconscious  
84 emotion, participants did not remember experienc-  
85 ing any changes in their mood when asked after the  
86 experiment about their emotions.

87 A more compelling evidence for unconscious  
88 emotion would show that cognitively able and  
89 motivated participants are *unable to report a con-*  
90 *scious feeling* at the same time their behavior reveals  
91 *the presence of an affective reaction*. Ideally, the affec-  
92 tive reaction should be strong enough to change  
93 even behavior that has real consequences for the  
94 individual. To obtain such evidence, Winkielman,  
95 Berridge, and Wilbarger (2005) assessed consump-  
96 tion behavior after exposing participants to sev-  
97 eral subliminal emotional facial expressions (happy,  
98 neutral, or angry). Each of the subliminal expres-  
99 sions was masked by a clearly visible neutral face  
100 on which participants performed a simple gender  
101 detection task. Immediately after the subliminal  
102 affect induction, some participants rated their feel-  
103 ings (mood and arousal) and then consumed a fruit

1 beverage. Other participants performed consump-  
2 tion behavior and feeling ratings in opposite order.  
3 In Study 1, the consumption behavior involved  
4 pouring themselves a cup of a novel drink from a  
5 pitcher and then drinking it. In Study 2, partici-  
6 pants were asked to take a small sip of the drink  
7 and rate it on different dimensions (e.g., monetary  
8 value). In both studies, there was no evidence of any  
9 change in conscious mood or arousal, regardless of  
10 whether participants rated their feelings on a simple  
11 scale from positive to negative or on a multi-item  
12 scale asking about specific emotions. Yet partici-  
13 pants' consumption behavior and drink ratings were  
14 influenced by those subliminal affective stimuli,  
15 especially when participants were thirsty. Specifically,  
16 after happy faces thirsty participants poured signifi-  
17 cantly more drink from the pitcher and drank more  
18 from their cup than after angry faces (Study 1).  
19 Thirsty participants were also willing to pay about  
20 twice as much more for the drink after happy, rather  
21 than angry expressions (Study 2). That is, sublimi-  
22 nal emotional faces evoked affective reactions that  
23 altered participants' consumption behavior and eval-  
24 uation of the beverage, but produced no mediating  
25 change in their conscious feelings at the moment the  
26 affective reactions were caused. Since participants  
27 rated their feelings of mood immediately after the  
28 subliminal affect induction, these results cannot be  
29 explained by the failure of affective memory.

30 One can wonder, however, whether such uncon-  
31 scious emotional reactions can drive a more com-  
32 plex social behavior. After all, a decision to pour and  
33 drink a novel beverage is relatively simple and could  
34 be driven by activation of basic approach-avoidance  
35 tendencies. Would an abstract and cognitive incen-  
36 tive, such as an investment prospect that requires an  
37 active decision whether to allocate money, also be  
38 increased in attractiveness by a subliminal positive  
39 prime, similar to the drink? To address this concern,  
40 we have recently used the same priming para-  
41 digm but asked participants to make more complex  
42 financial decisions (for overview, see Winkielman,  
43 Knutson, Paulus, & Trujillo, 2007). For example, in  
44 one study participants decided whether to gamble  
45 \$1 for a 50% chance of winning \$2.50 or whether  
46 to simply pocket the dollar. Participants primed  
47 with subliminal happy faces were more likely to  
48 choose the investment than participants primed  
49 with angry faces, presumably reflecting a more  
50 favorable evaluation of the bet.

51 One can wonder, however, to what extent the  
52 reactions elicited by unconscious affective faces are  
53 truly "affective," in the sense of involving "hot"

54 representation of valence in the systems tradition-  
55 ally associated with emotion. Perhaps they are only  
56 "evaluative," in the sense of activation of certain  
57 meaning components (Clore, 1994). Our recent  
58 studies addressed this concern in two ways. First,  
59 as mentioned earlier, physiological and neuroimag-  
60 ing studies suggest that subliminal angry and fearful  
61 faces activate the amygdala and related limbic struc-  
62 tures. Thus, one should be able to find psychophys-  
63 iological traces of emotion in the just-described  
64 ideograph-rating and drinking studies. Indeed, we  
65 found that subliminal emotional facial expres-  
66 sions cause weak but detectable changes in response  
67 of low-level physiological systems. Specifically, we  
68 found congruent facial EMG responses (smiling  
69 to happy faces and frowning to angry faces) and  
70 emotion-congruent startle modulation, suggesting  
71 that the primes activate emotional channels that  
72 produce valenced expressions (Starr, Linn, &  
73 Winkielman, 2007). Another way to distinguish  
74 between the cold "evaluative" and "hot" affective  
75 aspects of emotion is by the use of different materi-  
76 als for emotion induction. Specifically, affective  
77 words have long been known to prime evaluative  
78 processes (e.g., as assessed by priming). On the other  
79 hand, affective pictures are more efficient than  
80 words in eliciting physiological reactions, which  
81 reflect changes in core affective systems (Larsen,  
82 Norris, & Cacioppo, 2003). This is true even if  
83 words and pictures are matched on self-reported  
84 valence and frequency. Consistent with these obser-  
85 vations, we found that subliminal (and supraliminal)  
86 emotional facial expressions influence consumption  
87 in an affect-congruent way, whereas words do not  
88 (Starr, Winkielman, & Gogolushko, 2008). Thus, it  
89 appears that even though the reaction induced by  
90 the emotional facial expressions is unconscious, it  
91 works via modification of a low-level emotional  
92 response, rather via high-level evaluative priming.  
93 In sum, we propose that all these results demonstrate  
94 unconscious affect in the strong sense—a genuine  
95 affective process strong enough to alter behavior,  
96 but of which people are simply not aware.

### Challenges and Limits to Unconscious Emotion

97 Findings like the one just described constitute some  
98 evidence for the independence of affect and conscious  
99 experience. But, there are several challenges to be met.  
100

#### *How does unconscious affect work?*

101 One challenge involves specifying the mechanisms  
102 by which affect can influence behavior towards an  
103  
104

1 object without eliciting conscious feelings. One possibility is that unconscious affect directly modulates  
2 the object's ability to trigger affective and motivational responses via a "front-end" or perceptual-  
3 attentional mechanism. That is, instead of triggering  
4 feelings, the affect could modify the position of the  
5 relevant target object on the organism's "incentive  
6 landscape." For example, we speculate that subliminal  
7 facial expressions might activate the amygdala,  
8 which then might project to the adjacent accumbens  
9 and related structures responsible for processing  
10 of incentives (Berridge, 2003; Rolls, 1999; Whalen  
11 et al., 1998). Altered neuronal activity in the nucleus  
12 accumbens (constituting unconscious "liking") could  
13 then change the human affective reaction to the  
14 sight of an incentive (drink, money) leading to differential  
15 behaviors, all without eliciting conscious  
16 feelings (see Winkielman et al., 2008 for a more  
17 comprehensive discussion).  
18  
19

#### 20 *Affect or emotion?*

21 There is now decent evidence for *unconscious affect*—  
22 changes in general positivity–negativity. But what  
23 about *unconscious emotion*—categorically different  
24 states such as fear, anger, disgust, sadness, joy, love,  
25 shame, guilt, or pride? Some skeptics doubt this  
26 possibility based on the argument that emotional  
27 states require sophisticated cognitive differentiation.  
28 For example, an emotion such as guilt requires  
29 entertaining several beliefs such as "I did something  
30 wrong to another person, I was responsible, I could  
31 have done something to prevent it." This argument  
32 may hold for higher-order social emotion, but not  
33 for basic emotions. After all, animals, even reptiles,  
34 appear to show categorically different reactions to  
35 situations demanding different emotional response  
36 (e.g., fear, rage, rejection, Pankseep, 1998). It is also  
37 interesting that human neuroimaging studies reveal  
38 unique patterns of amygdala activation to consciously  
39 presented facial expressions of fear, anger,  
40 sadness, and disgust (Phan et al., 2002; Whalen,  
41 1998). If future research shows that, say, masked  
42 facial expressions of fear, anger, sadness, or disgust  
43 can create different physiological reactions with  
44 different behavioral consequences, all without eliciting  
45 conscious feelings, then there might indeed be  
46 processes fully deserving the label "unconscious  
47 emotion." So far, we are not aware of such studies,  
48 but we believe the empirical challenges lie more in  
49 how to make the disgust or sadness stimuli convincingly  
50 "invisible" (which is difficult for faces but  
51 especially for complex pictures), rather than with  
52 the emotional reaction of disgust or sadness being

necessarily conscious. In fact, there are some intriguing  
53 hints from a series of studies using subliminal  
54 words related to guilt and sadness—two negative  
55 but qualitatively different emotions (Zemack-Rugar,  
56 Bettman, & Fitzsimons, 2007). When participants  
57 were primed with subliminal guilt words, they showed  
58 less indulgence in their behavior than participants  
59 primed with sad words. Unfortunately, it is unclear  
60 in these studies whether the words induced actual  
61 emotions (there was no evidence of any feeling  
62 changes on the self-report level, but also no physiological  
63 measure of actual emotion). Still, these results  
64 at least raise a possibility that basic triggers of social  
65 emotions can operate unconsciously.  
66

#### *Unnoticed, unverbilized, or unconscious affect?*

67 Another challenge comes from the difficulty of  
68 conclusively establishing the absence of feelings  
69 (as far as one can ever prove absence). The problem  
70 stems from the very nature of reporting on phenomenal  
71 states. Several writers pointed out the difference  
72 between the primary "experiencing" consciousness  
73 and the secondary "reflecting" consciousness  
74 (Lambie & Marcel, 2002; Schooler, 2002).  
75 Future research should address to what extent the  
76 absence of self-reported feelings in human studies  
77 represents a genuine absence of phenomenology, or  
78 inability to reflect on that phenomenology. Several  
79 writers have suggested that these questions could be  
80 addressed by providing participants with training in  
81 (i) introspection; (ii) use of beepers, ratings scales,  
82 or momentary-affect dials; or (iii) alternative, non-  
83 verbal ways of expressing emotion (Bartoshuk,  
84 2000; Lambie & Marcel, 2002; Nielsen & Kaszniak,  
85 2007; Schooler & Schreiber, 2004). Finally, neuroscience  
86 may be of help. If it's possible in the future to  
87 reliably identify a neural correlate of subjective  
88 experience, the presence of conscious feelings  
89 could be suggested by changes in relevant neural  
90 activation.  
91

### **Conscious and Unconscious Emotion in Social Behavior**

92 In the preceding section we have presented a variety  
93 of arguments for "unfelt" affect and emotion. So are  
94 conscious feelings just like "icing on the cake"—  
95 nice, but not necessary? We do not believe so. In  
96 the following section we offer some speculation  
97 on the role of conscious feelings in emotion, and  
98 the relation between conscious and unconscious  
99 components of emotion. We especially emphasize  
100 the critical role of conscious feelings in social  
101 behavior.  
102  
103

1 ***What Good is Conscious Feeling?***

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

31 ***What Makes Emotion Unconscious  
32 or Conscious?***

33 Given the many benefits, why then are humans  
34 sometimes unaware of their emotion? We suppose  
35 that a variety of neuroscientific and psychological  
36 factors play a role. Most of these factors probably  
37 apply regardless of whether the process is emotional  
38 or cognitive. Earlier in this chapter, we speculated  
39 that under some circumstances relevant neural processes  
40 could simply bypass the circuitry for subjective  
41 experience and feed directly into behavioral  
42 circuitry. That is, sometimes emotion can be unconscious  
43 for the same reason why vision can be unconscious.  
44 As documented in research on "vision for  
45 perception vs. vision for action" (Goodale & Milner,  
46 2004) and in research on "blindsight" (Weiscranz,  
47 1996), the relevant information can feed into the  
48 action system without ever reaching brain areas  
49 responsible for subjective experience. Further, sometimes  
50 rudimentary affective processes may be like  
51 other neural processes, such as thermoregulation,  
52 which are designed to run unconsciously and to

53 elicit conscious experience only rarely, when there  
54 is an important reason for intervention. Another  
55 important factor might be the brain's inability to  
56 construct a coherent percept, as when alternative  
57 sources of activation compete for interpretation  
58 (Crick & Koch, 2003).

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

71 Unfortunately, there is little empirical work on  
72 factors that determine the emergence of conscious  
73 emotional feelings. Future work could make some  
74 progress by, for example, systematically examining  
75 what determines whether subliminal stimuli elicit  
76 conscious mood. As we discussed earlier, in our  
77 work, subliminal facial expressions did not elicit  
78 feeling (Winkielman et al., 2008). However, many  
79 studies observed feeling changes after subliminal  
80 bloody pictures (Robles, Smith, Carver, & Wellens,  
81 1987) or mere-exposed ideographs (Monahan,  
82 Murphy, & Zajonc, 2000). These findings suggest  
83 that perhaps simple or highly practiced stimuli, like  
84 happy and angry faces used in our studies, are less  
85 likely to elicit feelings than more complex or novel  
86 stimuli, like visual scenes or ideographs. The impact  
87 on feelings could also depend on the individual's  
88 sensitivity to a particular emotion inducer. For  
89 example, subliminally presented snakes increased  
90 conscious anxiety in phobic, but not typical,  
91 participants (Öhman & Soares, 1994). Similarly,  
92 introspectively sensitive participants are better at  
93 detecting impact of subliminal stimuli and use  
94 their own reactions in behavior (Katkin, Wiens, &  
95 Öhman, 2001). Another interesting factor is the  
96 salience of the self representation. That is, when  
97 the self is salient, a change in an affective state  
98 might lead to a reportable conscious feeling, rather  
99 than be channeled to a representation of an external  
100 object (Lambie & Marcel, 2002). In sum, the  
101 emergence of conscious feelings may be determined  
102 by a host of stimulus, personal, and motivational  
103 factors. Though little is known at this point, it  
104 seems clear that the question of when and how  
105 emotion becomes conscious can be fruitfully empirically  
investigated,

1 especially now given all the new experimental and  
2 neuroscientific techniques.

### 3 **Concluding Summary**

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

### 19 **References**

20 Adolphs, R., Damasio, H., Tranel, D., Cooper, G., &  
21 Damasio, A. R. (2000). A role for somatosensory cortices in  
22 the visual recognition of emotion as revealed by 3-D lesion  
23 mapping. *Journal of Neuroscience*, *20*, 2683–2690.  
24 Anderson, A. K. & Phelps, E. A. (2002). Is the human  
25 amygdala critical for the subjective experience of emotion?  
26 Evidence of intact dispositional affect in patients with  
27 lesions of the amygdala. *Journal of Cognitive Neuroscience*, *14*,  
28 709–720.  
29 Baars, B. (1993). How does a serial, integrated and very limited  
30 stream of consciousness emerge from a nervous system that is  
31 mostly unconscious, distributed, parallel, and of enormous  
32 capacity? In G.R. Bock & J. Marsh (Eds.). *Experimental and*  
33 *theoretical studies of consciousness* (pp. 282–290), New York:  
34 Wiley.  
35 Baars, B. J. (1997). *In the theater of consciousness: The workspace of*  
36 *the mind*. New York: Oxford University Press.  
37 Bartoshuk, L. M. (2000). Psychophysical advances aid the study  
38 of genetic variation in taste. *Appetite*, *34*, 105.  
39 Bassetti, C., Vella, S., Donati, F., Wielepp, P., & Weder, B.  
40 (2000). SPECT during sleepwalking. *The Lancet*, *346*,  
41 484–485.  
42 Berke, R. L. (September 12, 2000). Democrats See, and Smell,  
43 Rats in G.O.P. Ad. New York Times.  
44 Berridge, K. C. (2000). Measuring hedonic impact in animals  
45 and infants: Microstructure of affective taste reactivity pat-  
46 terns. *Neuroscience & Biobehavioral Reviews*, *24*, 173–198  
47 Berridge, K. C. (2003). Comparing the emotional brain of humans  
48 and other animals. In R. J. Davidson, H. H. Goldsmith, &  
49 K. Scherer (Eds.), *Handbook of affective sciences* (pp. 25–51),  
50 Oxford: Oxford University Press.  
51 Berridge, K. C. & Pecina, S. (1995). Benzodiazepines, appetite,  
52 and taste palatability. *Neuroscience and Biobehavioral Reviews*,  
53 *19*, 121–131.  
54 Berridge, K. C. & Robinson, T. E. (1998). What is the role of  
55 dopamine in reward: Hedonic impact, reward learning, or  
56 incentive salience? *Brain Research—Brain Research Reviews*,  
57 *28*, 309–369.

Berridge, K. C. & Winkielman, P. (2003). What is an uncon-  
scious emotion: The case for unconscious “liking.” *Cognition*  
*and Emotion*, *17*, 181–211. 58  
59  
60  
Broughton, R., Billings, R., Cartwright, R., Doucette, D.,  
Edmeads, J., Edwardh, M., et al. (1994). Homicidal som-  
nambulism: A case report. *Sleep*, *17*, 253–264. 61  
62  
63  
Cabanac, M. (1999). Emotion and phylogeny. *Journal of*  
*Consciousness Studies*, *6*, 176–190. 64  
65  
Cacioppo, J. T., Larsen, J. T., Smith, N. K., & Berntson, G. G.  
(2004). The affect system: What lurks below the surface of  
feelings? In A. S. R. Manstead, N. H. Frijda, & A. H. Fischer  
(Eds.), *Feelings and emotions: The Amsterdam conference*.  
New York: Cambridge University Press. 66  
67  
68  
69  
70  
Cannon, W. B. (1927). *Bodily changes in pain, hunger, fear and*  
*rage*, 2nd ed. New York: D. Appleton & Co. 71  
72  
Cartwright, R. (2004). Sleepwalking violence: A sleep disorder,  
a legal dilemma, and a psychological challenge. *American*  
*Journal of Psychiatry*, *161*, 1149–1158. 73  
74  
75  
Clore, G. L. (1994). Why emotions are never unconscious. In  
P. Ekman & R. J. Davidson (Eds.), *The nature of emotion:*  
*Fundamental questions* (pp. 285–290). New York: Oxford  
University Press. 76  
77  
78  
79  
Cosmides, L. & Tooby, J. (2000). Evolutionary psychology and  
the emotions. In M. Lewis & J. Haviland-Jones (Eds.)  
*Handbook of emotion* (2nd ed.) pp. 91–115. New York:  
Guilford Press. 80  
81  
82  
83  
Craig, A. D. (2003). Interoception: The sense of the physiologi-  
cal condition of the body. *Current Opinion in Neurobiology*,  
*13*, 500–505. 84  
85  
86  
Craig, A. D. (2009). How do you feel—now? The anterior insula  
and human awareness. *Nature Reviews Neuroscience*, *10*, 59–70.  
87  
88  
Crick, F. & Koch, C. (2003). A framework for consciousness.  
*Nature Neuroscience*, *6*, 119–126 89  
90  
Critchley H. D., Wiens, S., Rotshtein, P., Oehman, A., &  
Dolan, R. J. (2004). Neural systems supporting interoceptive  
awareness. *Nature Neuroscience*, *2*, 189–195. 91  
92  
93  
Cromwell, H. C. & Berridge, K. C. (1993). Where does damage  
lead to enhanced food aversion: The ventral pallidum/  
substantia innominata or lateral hypothalamus? *Brain*  
*Research*, *624*, 1–2, 1–10. 94  
95  
96  
Damasio, A. R. (1999). *The feeling of what happens: Body and*  
*emotion in the making of consciousness*. New York: Harcourt  
Brace. 97  
98  
99  
100  
Damasio, A. R., Grabowski, T. J., Bechara, A., Damasio, H.,  
Ponto, L. L., Parvizi, J., et al. (2000). Subcortical and cortical  
brain activity during the feeling of self-generated emotions.  
*Nature Neuroscience*, *3*, 1049–1056. 101  
102  
103  
104  
Davidson, R. J., Jackson, D. C., & Kalin, N. H. (2000). Emotion,  
plasticity context, and regulation: Perspectives from affective  
neuroscience. *Psychological Bulletin*, *126*, 890–909. 105  
106  
107  
Dehaene, S., Naccache, L., Cohen, L., Le Bihan, D.,  
Mangin, J.-F., Poline, J.-B., et al. (2001). Cerebral mecha-  
nisms of word masking and unconscious repetition priming.  
*Nature Neuroscience*, *4*, 752–758. 108  
109  
110  
111  
Dennett, D. C. (1991). *Consciousness explained*. Boston: Little,  
Brown and Co. 112  
113  
Descartes, R. (1649). The Passions of the soul. In J. Cottingham,  
R. Stoothoff, & D. Murdoch, (Trans.) (1985). *The*  
*philosophical writings of Descartes*, Volume 1. Cambridge:  
Cambridge University Press. 114  
115  
116  
117  
Dimberg, U., Thunberg, M., & Elmehed, K. (2000). Unconscious  
facial reactions to emotional facial expressions. *Psychological*  
*Science*, *11*, 86–89. 118  
119  
120

- 1 Drogosz, M. & Nowak, A. (2006). A neural model of mere  
2 exposure: The EXAC mechanism. *Polish Psychological*  
3 *Bulletin*, 37, 7–15.
- 4 Enns, J. T. & DiLollo, V. (2000). What's new in visual masking.  
5 *Trends in Cognitive Sciences*, 4, 345–352.
- 6 Frank, R. (1988). *Passions within reason. The strategic role of the*  
7 *emotions*. New York: Norton.
- 8 Freud, S. (1950). *Collected papers* (J. Riviere, Trans. Vol. 4).  
9 London: Hogarth Press and The Institute of Psychoanalysis.
- 10 Frijda, N. H. (1999). Emotions and hedonic experience. In  
11 D. Kahneman, E. Diener, & N. Schwarz (Eds.), *Well-being:*  
12 *The foundations of hedonic psychology* (pp. 190–210).  
13 New York: Russell Sage Foundation.
- 14 Goodale, M. A. & Milner, M. A. (2004). *Sight unseen: An explo-*  
15 *ration of conscious and unconscious vision*. Oxford: Oxford  
16 University Press.
- 17 Goodson, J. L. & Bass, A. H. (2001). Social behavior functions  
18 and related anatomical characteristics of vasotocin/vasopressin  
19 systems in vertebrates. *Brain Research Reviews*, 35, 246–265.
- 20 Heimer, L. & Van Hoesen, G. W. (2006). The limbic lobe and its  
21 output channels: Implications for emotional functions and  
22 adaptive behavior. *Neuroscience & Biobehavioral Reviews*, 30,  
23 126–147.
- 24 Heyes, C. M. & L. Huber, (Eds.) (2001). *Evolution of cognition*.  
25 Cambridge, MA: MIT Press.
- 26 Insel, T. R. & Fernald, R. D. (2004). How the brain processes  
27 social information: Searching for the social brain. *Annual*  
28 *Reviews: Neuroscience*, 27, 697–722
- 29 James, W. (1884). *What is an emotion. Mind*, 9, 188–205.
- 30 Jennett, B. (2002). *The vegetative state: Medical facts, ethical and*  
31 *legal dilemmas*. Cambridge: Cambridge University Press.
- 32 Katkin, E. S., Wiens, S., & Öhman, A. (2001). Nonconscious  
33 fear conditioning, visceral perception, and the development  
34 of gut feelings. *Psychological Science*, 12, 366–370.
- 35 Kihlstrom, J. F. (1999). The psychological unconscious. In  
36 L. A. Pervin & O. P. John (Eds.), *Handbook of personality:*  
37 *Theory and research* (2 ed., pp. 424–442). New York: The  
38 Guilford Press.
- 39 Knox, V. J, Morgan, A. H., & Hilgard, E. 1974. Pain and suffering  
40 in ischemia: The paradox of hypnotically suggested  
41 anesthesia as contradicted by reports from the “hidden  
42 observer.” *Archives of General Psychiatry*, 30, 840–847.
- 43 Knutson, B., Adams, C. M., Fong, G. W., & Hommer, D.  
44 (2001). Anticipation of increasing monetary reward select-  
45 ively recruits nucleus accumbens. *Journal of Neuroscience*,  
46 21, 1–5.
- 47 Knutson, B., Bjork, J. M., Fong, G. W., Hommer, D. W.,  
48 Mattay, V. S., & Weinberger, D. R. (2004). *Amphetamine*  
49 *modulates human incentive processing. Neuron*, 43, 261–269.
- 50 Knutson, B., Wimmer, G. E., Kuhnen, C. M., & Winkielman, P.  
51 (2008). Nucleus accumbens activation mediates the influ-  
52 ence of reward cues on financial risk taking. *NeuroReport*,  
53 19, 509–513.
- 54 Koch, C. & Tsuchiya, N. (2007) Attention and consciousness:  
55 Two distinct brain processes, *Trends in Cognitive Sciences*,  
56 11, 16–22.
- 57 Konorski, J. (1967). *Integrative activity of the brain: An interdis-*  
58 *iplinary approach*. Chicago: University of Chicago Press.
- 59 Kringelbach, M. L. (2005). The human orbitofrontal cortex:  
60 Linking reward to hedonic experience. *Nat Rev Neurosci*, 6,  
61 691–702.
- 62 Kringelbach, M. L. (2010). The hedonic brain: A functional  
63 neuroanatomy of human pleasure. In: M.L. Kringelbach &  
K.C. Berridge (Eds.), *Pleasures of the brain* (pp. 202–221). 64  
Oxford: Oxford University Press. 65
- Lambie, J. A. & Marcel, A. J. (2002). Consciousness and the 66  
varieties of emotion experience: A theoretical framework. 67  
*Psychological Review*, 109, 219–259. 68
- Lane, R. D. (2000). Neural correlates of conscious emotional 69  
experience. In R. D. Lane and L. Nadel (Eds.), *Cognitive*  
70 *neuroscience of emotion* (pp. 345–370). New York, NY:  
71 Oxford University Press. 72
- Lang, P. J. (1968). Fear reduction and fear behavior: Problems 73  
in treating a construct. In: J. Schlien, J. (Ed.), *Research in*  
74 *psychotherapy III*. Washington DC: APA. 75
- Larsen, R. J. & Fredrickson, B. L. (1999). Measurement issues 76  
in emotion research. In D. Kahneman, E. Diener, &  
77 N. Schwarz (Eds.) *Well-being: Foundations of hedonic*  
78 *psychology* (pp. 40–60). New York: Russell Sage. 79
- Larsen, J. T., Norris, C. J., & Cacioppo, J. T. (2003). Effects 80  
of positive affect and negative affect on electromyographic  
81 activity over zygomaticus major and corrugator supercilii.  
82 *Psychophysiology*, 40, 776–785. 83
- Laureys, S., Faymonville, M. E., Peigneux, P., Damas, P., 84  
Lambermont, B., Del Fiore, G., et al. (2002). Cortical  
85 processing of noxious somatosensory stimuli in the persistent  
86 vegetative state. *NeuroImage*, 17, 732–741. 87
- Lazarus, R. S. & McCleary, R. A. (1951). Autonomic discrimi- 88  
nation without awareness: A study of subception. *Psychological*  
89 *Review*, 58, 113–122. 90
- LeDoux, J. (1996). *The emotional brain: The mysterious underpin-*  
91 *nings of emotional life*. New York: Simon & Schuster. 92
- Martinez-Garcia, F, Martinez-Marcos, A, & Lanuza, E. (2002). 93  
The pallial amygdala of amniote vertebrates: Evolution of  
94 the concept, evolution of the structure. *Brain Research*  
95 *Bulletin*, 57, 463–469. 96
- Merikle, P. M. & Daneman, M. (1998). Psychological investiga- 97  
tions of unconscious perception. *Journal of Consciousness*  
98 *Studies*, 5, 5–18. 99
- Miyawaki, E., Perlmutter, J. S., Troster, A. I., Videen, T. O., & 100  
Koller, W. C. (2000). The behavioral complications of  
101 pallidal stimulation: A case report. *Brain & Cognition*, 42,  
102 417–434. 103
- Monahan, J. L., Murphy, S. T., & Zajonc, R. B. (2000). 104  
Subliminal mere exposure: Specific, general and diffuse  
105 effects. *Psychological Science*, 11, 462–466. 106
- Morris, J.S., DeGelder, B., Weiskrantz, L. & Dolan, R.J. (2001) 107  
Differential extrageniculostriate and amygdala responses to  
108 presentation of emotional faces in a cortically blind field.  
109 *Brain*, 124, 1241–1252. 110
- Morris, J. S., Öhman, A., & Dolan, R. J. (1999). A subcortical 111  
pathway to the right amygdala mediating “unseen” fear.  
112 *Proceedings of the National Academy of Sciences*, 96,  
113 1680–1685. 114
- Niedenthal, P. M., Barsalou, L., Winkielman, P., Krauth-Gruber, S., 115  
& Ric, F. (2005). Embodiment in attitudes, social percep-  
116 tion, and emotion. *Personality and Social Psychology Review*,  
117 9, 184–211. 118
- Nielsen, L. & Kaszniak, A.W. (2007). Conceptual, theoretical, 119  
and methodological issues in inferring subjective emotion  
120 experience: recommendations for researchers. In J. A. Coan  
121 and J. J. B. Allen (Eds.), *The handbook of emotion elicitation*  
122 *and assessment*. New York, NY: Oxford University Press. 123
- Ochsner, K. N. & Gross, J. J. (2004). Thinking makes it so: 124  
A social cognitive neuroscience approach to emotion regula-  
125 tion. In R. F. Baumeister & K. D. Vohs (Eds.), *Handbook of*  
126

- 1 *self-regulation: Research, theory, and applications* (pp. 229–255).  
2 New York: Guilford Press.
- 3 O'Doherty, J., Deichmann, R., Critchley H. D., & Dolan R. J.  
4 (2002). Neural responses during anticipation of a primary  
5 taste reward. *Neuron*, 33, 815–826.
- 6 Öhman, A., Flykt, A., & Lundqvist, D. (2000). Unconscious  
7 emotion: Evolutionary perspectives, psychophysiological  
8 data and neuropsychological mechanisms. In R. D. Lane,  
9 L. Nadel & G. Ahern (Eds.), *Cognitive neuroscience of*  
10 *emotion* (pp. 296–327). New York: Oxford University Press.
- 11 Öhman, A. & Soares, J. J. F. (1994). "Unconscious anxiety":  
12 Phobic responses to masked stimuli. *Journal of Abnormal*  
13 *Psychology*, 103, 231–240.
- 14 Panksepp, J. (1998). *Affective neuroscience: The foundations of*  
15 *human and animal emotions*. Oxford, U.K.: Oxford University  
16 Press.
- 17 Panksepp, J. (2005). Affective consciousness: Core emotional  
18 feelings in animals and humans. *Consciousness & Cognition*,  
19 14, 19–69.
- 20 Pecina, S. & Berridge, K. C. (2000). Opioid eating site in  
21 accumbens shell mediates food intake and hedonic "liking":  
22 Map based on microinjection Fos plumes. *Brain Research*,  
23 863, 71–86.
- 24 Pecina, S. & Berridge, K. C. (2005). Hedonic hot spot in nucleus  
25 accumbens shell: Where do mu-opioids cause increased  
26 hedonic impact of sweetness? *Journal of Neuroscience*, 25,  
27 11777–11786.
- 28 Pessoa, L. (2005). To what extent are emotional visual stimuli  
29 processed without attention and awareness? *Current Opinion*  
30 *in Neurobiology*, 15, 188–196.
- 31 Pessoa, L. & Adolphs, R. (2010). Emotion processing and  
32 the amygdala: from a 'low road' to 'many roads' of evaluat-  
33 ing biological significance. *Nature Reviews Neuroscience*,  
34 November;11:773–83.
- 35 Peyron, R., Laurent, B., & Garcia-Larrea, L. (2000). Functional  
36 imaging of brain responses to pain. A review and meta-  
37 analysis. *Clinical Neurophysiology*, 30, 263–288.
- 38 Phan, K. L., Wagner, T., Taylor, S. F., & Liberzon, I. (2002).  
39 Functional neuroanatomy of emotion: A meta-analysis of  
40 emotion activation studies in PET and fMRI. *Neuroimage*,  
41 16, 331–348.
- 42 Plum, F., Schiff, N., Ribary, U., & Llinas, R. (1998). Coordinated  
43 expression in chronically unconscious persons. *Philosophical*  
44 *Transactions of the Royal Society, B: Biological Sciences*, 353,  
45 1929–1933.
- 46 Porges, S. W. (1997). Emotion: An evolutionary by-product  
47 of the neural regulation of the autonomic nervous system.  
48 In C. S. Carter, B. Kirkpatrick, & I.I. Lederhendler (Eds.),  
49 *The integrative neurobiology of affiliation*, Annals of the  
50 New York Academy of Sciences, 807, 62–77.
- 51 Putnam, F. W. (1989). *Diagnosis and treatment of multiple*  
52 *personality disorder*. New York: Guilford Press.
- 53 Rauch, S. L., Shin, L. M., Dougherty, D. D., Alpert, N. M.,  
54 Orr, S. P., Lasko, M., et al. (1999). Neural activation during  
55 sexual and competitive arousal in healthy men. *Psychiatry*  
56 *Research*, 91, 1–10.
- 57 Robles, R., Smith, R., Carver, C. S. & Wellens, A. R. (1987).  
58 Influence of subliminal images on the experience of anxiety.  
59 *Personality and Social Psychology Bulletin*, 13, 399–410.
- 60 Rolls, E. T. (1999). *The brain and emotion*. Oxford: Oxford  
61 University Press.
- 62 Russell, J. A. (2003). Core affect and the psychological construc-  
63 tion of emotion. *Psychological Review*, 110, 145–172.
- Schenck, C. & Mahowald, M. (1995). Polysomnographically  
64 documented case of adult somnambulism with long distance  
65 automobile driving and frequent nocturnal violence:  
66 Parasomnia with continuing danger as a non-insane automa-  
67 tism? *Sleep*, 18, 765–772.
- Schooler, J. W. (2002). Re-representing consciousness:  
69 Dissociations between experience and meta-consciousness.  
70 *Trends in Cognitive Sciences*, 6, 339–344.
- Schooler, J. W. & Schreiber, C. A. (2004). Consciousness, meta-  
72 consciousness, and the paradox of introspection. *Journal of*  
73 *Consciousness Studies*, 11, 17–29.
- Schumann C. M. & Amaral D. G. (2009). The human amygdala  
75 and autism. In: P. Whalen and E. Phelps (Eds.), *The human*  
76 *amygdala*.(pp. 362-381) New York: Guilford Press, New York.
- Schwarz, N. & Clore, G. L. (2003). Mood as information:  
78 20 years later. *Psychological Inquiry*, 14, 296–303.
- Searle, J. (1997). *The mystery of consciousness*. New York, New York  
80 Review Press.
- Siddiqui, F., Osuna, E., & Chokroverty, S. (2009). Writing  
82 emails as part of sleepwalking after increase in Zolpidem.  
83 *Sleep Medicine*, 10, 262–264.
- Simons, D. J. & Chabris, C. F. (1999). Gorillas in our midst:  
85 Sustained inattention blindness for dynamic events.  
86 *Perception*, 28, 1059–1074.
- Smith, K. S., Tindell, A. J., Aldridge, J. W., & Berridge, K. C.,  
88 (2009). Ventral pallidum roles in reward and motivation.  
89 *Behavioral Brain Research*, 196, 155–167.
- Starr, M. J., Lin, J., & Winkielman, P. (2007). *The impact of*  
90 *unconscious facial expressions on consumption behavior involves*  
91 *changes in positive affect: Evidence from EMG and appetitive*  
92 *reflex-modulation*. Poster presented at 47th Annual Meeting  
93 of Society for Psychophysiological Research. Savannah, GA.
- Starr, M. J., Winkielman, P., & Gogolushko, K. (2008). *Influence*  
94 *of affective pictures and words on consumption behavior and*  
95 *facial expressions*. Poster presented at Society for Psycho-  
96 physiological Research, Austin, TX.
- Steiner, J. E. (1973). The gustofacial response: Observation on  
100 normal and anencephalic newborn infants. *Symposium on*  
101 *Oral Sensation and Perception*, 4, 254–278.
- Steiner, J. E., Glaser, D., Hawilo, M. E., & Berridge, K. C.  
103 (2001). Comparative expression of hedonic impact: Affective  
104 reactions to taste by human infants and other primates.  
105 *Neuroscience and Biobehavioral Reviews*, 25, 53–74.
- Sutcliffe, J. P. (1961). "Credulous" and "skeptical" views of hyp-  
107 notic phenomena: Experiments on esthesia, hallucination,  
108 and delusion. *Journal of Abnormal and Social Psychology*, 62,  
109 189–200.
- Tindell, A. J., Smith, K. S., Pecina, S., Berridge, K. C., &  
111 Aldridge, J.W. (2006). Ventral pallidum firing codes hedonic  
112 reward: When a bad taste turns good. *J Neurophysiol*, 96,  
113 2399–2409.
- Watson, D. & Tellegen, A. (1985). Toward a consensual struc-  
115 ture of mood. *Psychological Bulletin*, 98, 219–235.
- Weiskrantz, L. (1996). Blindsight revisited. *Current Opinion in*  
117 *Neurobiology*, 6, 215–220.
- Whalen, P. J. (1998) Fear, vigilance and ambiguity: Initial neuro-  
119 roimaging studies of the human amygdala. *Current Directions*  
120 *in Psychological Science*, 7, 177–188.
- Whalen, P. and Phelps, E. (2009), *The Human Amygdala*,  
122 New York: Guilford Press, New York.
- Whalen, P. J., Rauch, S. L., Etcoff, N. L., McInerney, S. C.,  
124 Lee, M. B., & Jenike, M. A. (1998). Masked presentations  
125 of emotional facial expressions modulate amygdala activity 126



- 1 without explicit knowledge. *Journal of Neuroscience*, 18, 23  
 2 411–418. 24
- 3 Whishaw, I. Q. & Kolb, B. (1985). The mating movements of 25  
 4 male decorticate rats: Evidence for subcortically generated 26  
 5 movements by the male but regulation of approaches by the 27  
 6 female. *Behavioural Brain Research*, 17, 171–191.
- 7 Wicker, B., Keysers C., Plailly J., Royet J-P, Gallese V. and 28  
 8 Rizzolatti G. (2003). Both of us disgusted in my insula: The 29  
 9 common neural basis of seeing and feeling disgust. *Neuron*, 30  
 10 40, 655–664. 31
- 11 Wilbarger, J. L., McIntosh, D. N., & Winkielman, P. (2009). 32  
 12 Startle modulation in autism: Positive affective stimuli 33  
 13 enhance startle response. *Neuropsychologia*, 47, 1323–1331. 34
- 14 Williams, M. A., Morris, A. P., McGlone, F., Abbott, D. F., & 35  
 15 Mattingley, J. B. (2004). Amygdala responses to fearful 36  
 16 and happy facial expressions under conditions of binocular 37  
 17 suppression. *Journal of Neuroscience*, 24, 2898–2904. 38
- 18 Willis, W. D. & Westlund, K. N. (1997). Neuroanatomy of the 39  
 19 pain system and of the pathways that modulate pain. *Journal* 40  
 20 *of Clinical Neurophysiology*, 14, 2–31.
- 21 Winkielman, P. & Berridge, K. C. (2004). Unconscious emotion. 41  
 22 *Current Directions in Psychological Science*, 13, 120–123. 42
- Winkielman, P., Berridge, K. C., & Wilbarger, J. L. (2005). 23  
 Unconscious affective reactions to masked happy versus 24  
 angry faces influence consumption behavior and judg- 25  
 ments of value. *Personality and Social Psychology Bulletin*, 1, 26  
 121–135. 27
- Winkielman, P., Knutson, B., Paulus, M. P., & Trujillo, J. T. 28  
 (2007). Affective influence on decisions: Moving towards 29  
 the core mechanisms. *Review of General Psychology*, 11, 30  
 179–192. 31
- Winkielman, P., McIntosh, D. N., & Oberman, L. (2009). 32  
 Embodied and disembodied emotion processing: Learning 33  
 from and about typical and autistic individuals. *Emotion* 34  
*Review*, 2, 178–190. 35
- Winkielman, P., Zajonc, R. B., & Schwarz, N. (1997). Subliminal 36  
 affective priming resists attributional interventions. *Cognition* 37  
*and Emotion*, 11, 433–465. 38
- Wise, R. A. (1996). Addictive drugs and brain stimulation 39  
 reward. *Annual Review of Neuroscience*, 19, 319–340. 40
- Zemack-Rugar, Y., Bettman, J. R., & Fitzsimons, G. J. (2007). 41  
 The effects of nonconsciously priming emotion concepts on 42  
 behavior. *Journal of Personality and Social Psychology*, 93, 43  
 927–939. 44