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# What is an unconscious emotion? (The case for unconscious ''liking'')

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Ever since William James, psychologists of emotion have tended to view affective states as intrinsically conscious. We argue that nonconscious affect also exists, and focus specifically on the possibility of unconscious ''liking''. We present evidence that positive and negative affective reactions can be elicited subliminally, while a person is completely unaware of any affective reaction at all (in addition to being unaware of the causal stimulus). Despite the absence of any detectable subjective experience of emotion, subliminally induced unconscious ''liking'' can influence later consumption behaviour. We suggest that unconscious ''liking'' is mediated by specific subcortical brain systems, such as the nucleus accumbens and its connections. Ordinarily, conscious liking (feelings of pleasure) results from the interaction of separate brain systems of conscious awareness with those core processes of unconscious affect. But under some conditions, activity in brain systems mediating unconscious core ''liking'' may become decoupled from conscious awareness. The result is a genuinely unconscious emotion.

We begin with apologies to William James for having stolen the title of our paper from his classic article, ''What is an emotion'' (James, 1884). Worse still, by inserting ''unconscious'' as a modifier, our title distorts his concept of emotion in a way that renders it almost nonsensical. This is because an unconscious emotion was a contradiction in terms, according to James' (1884) definition. For James, emotion was a conscious experience or subjective feeling

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belonging to the ''aesthetic sphere of the mind, its pleasure and pains, and its emotions'' (p. 188). The subjective feeling of emotion has remained an essential part of its definition for many psychologists ever since.

In this paper we recognise the reasons for viewing emotion as subjective feeling, but also present theoretical and empirical arguments why an unconscious emotion may actually exist. As the topic of this journal issue is about *pleasure*, we focus especially on the possibility of unconscious ''liking''.

Before we start, a few clarifications are in order. We use the term *emotion* throughout the paper primarily to refer to stimuli, processes, or responses that involve *affect*, or *the property of being good/bad* (Zajonc, 1998). We acknowledge that particular emotions, such as hope, love, or envy, are differentiated and based in elaborated appraisals, and we do not propose to talk about their unconscious forms. Rather, we will restrict our discussion to more general unconscious affective reactions, such as ''liking'' and ''disliking''. We return to definitional issues later in the paper.

## Traditional view: Emotion defined as subjective experience

James' famous treatise dealt with the *causation* of emotion, based upon feelings of sensory feedback from involuntary reactions to events. By emotion itself, however, James made clear that conscious ''feelings of pleasure and displeasure'' caused by bodily changes were the essence of an affective state. His famous phrase, ''*that our feeling of the same changes as they occur IS the emotion*'' (pp. 189–190, original italics, James, 1884), captures this essential subjectivity of the feeling as well as its hypothesised causation in bodily changes.

That feelings were necessarily conscious was further emphasised by James in the thought experiment he posed to eliminate emotionality from subjective experience: ''If we fancy some strong emotion, and then try to abstract from our consciousness of it all the feelings of its characteristic bodily symptoms, we find that we have nothing left behind, no 'mind-stuff' out of which the emotion can be constituted . . .'' (p. 193, James, 1884). In the taxonomy of emotions, ''Rapture, love, ambition, indignation, and pride, considered as feelings, are fruits of the same soil with the grossest bodily sensations of pleasure and of pain'' (p. 201). Emotions all were feelings, on a continuum with sensory pleasures. By definition, all feelings were subjectively felt.

Contemporary scholars of James have reopened the issue of emotional causation, but have kept the identification of emotion itself with conscious feeling. For example, in a centennial analysis of cognitive appraisal in James' classic paper, Ellsworth reassessed the causation sequence that led to a consciously felt emotion: ''He was never very clear on whether the physiological feedback was a cause or a component of the emotion; he seemed to argue that the *bodily sensations create a feeling*, which is different from the sensations

themselves, and that *this feeling is the emotion*'' (Ellsworth, 1994b; italics added). Then and now, the traditional Jamesian theory of emotion is viewed as asserting that ''feeling is the emotion''.

## Contemporary re-evaluation: Conscious experience remains key

Modern cognitive theorists of emotion have continued to focus primarily on *conscious experience* as affect's defining feature. A straightforward common-sense definition of affect has been offered by Frijda. '' 'Affect' here primarily refers to hedonic experience, the experience of pleasure or pain'' (p. 194, Frijda, 1999). Many cognitive theorists who view emotion as information take a similar position on the intrinsic subjectivity of emotional processes (Clore, 1994; Ellsworth, 1994a; Ellsworth & Scherer, in press). Although cognitive appraisals of events are granted to sometimes be unconscious, the emotions that result from those appraisals are typically viewed as necessarily conscious. As Clore put it in a chapter entitled ''Why emotions are never unconscious'', ''In agreement with Freud, I would argue that it is not possible to have an unconscious emotion because emotion involves an experience, and one cannot have an experience that is not experienced'' (p. 285). And ''emotions cannot be unconscious because they must be felt, and feelings are by definition conscious'' (p. 290, Clore, 1994).

Other cognitive appraisal theorists of emotion have been more willing to entertain at least the possibility of unconscious emotion, even if unsure as to its actual existence. For example, Ellsworth, while noting that, ''I have always found the idea of unconscious emotions extremely difficult to think about ... (as) in most definitions of emotion ... a subjective experience of feeling is an essential component'' (Ellsworth, 1995, p. 214), nonetheless, explicitly left open the possibility for future examination. Similarly, Ellsworth and Scherer declined to close the door entirely on unconscious emotion: ''Most appraisal theorists would probably agree with Frijda that 'one knows, generally that one has an emotion', and have reserved the vexing question of unconscious emotions for future exploration. While many appraisal theorists may in fact be agnostic on the question of unconscious emotions, their initial goal was to account for the person's subjective experience of emotion at the time it is felt'' (Ellsworth & Scherer, in press). This position suggests that a focus on conscious experience by contemporary appraisal theorists has been one of explanatory priorities rather than definitional necessity and that an unconscious emotion might still be possible.

## Implicit emotion and unconscious affect

A new look at the question of unconscious emotion is prompted by recent developments regarding other unconscious psychological processes in cognition, perception, etc. The ''cognitive unconscious'' has been suggested by Kihlstrom

as a label to subsume a variety of psychological phenomena where cognitive processes demonstrably occur in the absence of conscious awareness (Kihlstrom, 1999). One of the most studied manifestations of the cognitive unconscious is implicit memory, as revealed, for example, by the effect of previously encountered words on participants' performance on a word stem completion task without any explicit memory of those words (Clark & Squire, 1998; Schacter, 1996). Another well-documented manifestation of the cognitive unconscious is implicit perception, such as blindsight, the ability to make visual discriminations among stimuli that are not consciously seen (Weiskrantz, 1996). Similarly, Bargh and colleagues and others have described a number of automaticity phenomena, in which behaviour is influenced by automatic reaction to masked stimuli in the absence of conscious awareness (Bargh, Chen, & Burrows, 1996; Tiffany & Carter, 1998). Related phenomena involving unconscious perception of evaluative aspects of social stimuli also have been discussed under the label of implicit attitudes (Greenwald & Banaji, 1995; Wilson, Lindsey, & Schooler, 2000).

Just as ''cognitive unconscious'' refers to implicit cognitive operations, Kihlstrom has suggested ''emotional unconscious'' and ''implicit emotion'' as corresponding labels for unconscious *affective* reactions (Kihlstrom, 1999; Kihlstrom, Mulvaney, Tobias, & Tobis, 2000). As Kihlstrom puts it, ''paralleling the usage of these descriptors in the cognitive unconscious, 'explicit emotion' refers to the person's conscious awareness of an emotion, feeling, or mood state; 'implicit emotion', by contrast, refers to changes in experience thought or action that are attributable to one's emotional state, independent of his or her conscious awareness of that state'' (p. 432, Kihlstrom, 1999).

But what exactly constitutes an unconscious emotional state? There are various degrees of being unaware. Some weak instances merely involve inaccurate *labelling* of the exact nature of one's emotion, as when one angrily denies that one is angry (Ellsworth & Scherer, in press). Other weak instances are mere errors of attention, as when one realises only later that one had been gripped by an emotional state at an earlier time. But in such cases one is fully conscious of events that cause the emotion, and one may be conscious of many effects of the emotion. Moreover, the actual emotional state is presumed *capable of being made conscious* if only the person's full attention is directed to the emotional experience, and the right label is provided. Instances of mistaken or unnoticed emotion are by no means unconscious in a strong sense of unconscious affect. These are not intrinsically inaccessible.

Unconscious affect requires a much stronger demonstration of implicitness. The strongest type of unconscious affect would be an exact parallel to strong implicit memory or implicit perception. That is, *truly implicit affect* would require the demonstration of *an affective reaction of which one was simply not aware, even upon introspection*. Does truly implicit affect exist? Kihlstrom and colleagues suggest that this question has not yet been settled (Kihlstrom, 1999;

Kihlstrom et al., 2000). They conclude that no convincing evidence has yet been demonstrated for implicit emotion in the strongest sense of an affective reaction that is not experienced at the moment of its occurrence. Still, Kihlstrom proposes, it is possible that real implicit emotion exists: ''But while the hypothesis of unconscious emotional states has not yet garnered convincing support, it can no longer be rejected out of hand. If we are willing to speak of implicit percepts, memories, and thoughts that are dissociated from their explicit counterparts, then we must be willing to speak of implicit emotions in the same terms'' (p. 433, Kihlstrom, 1999).

## Unconscious causes of emotion: Zajonc, Oehman, and colleagues

Among the strongest formulations of unconscious emotion are those from studies by Robert Zajonc and colleagues (Zajonc, 1980, 1998, 2000). In the mere-exposure effect, repeated presentation of an object increases subsequent liking for it even when participants are completely unaware of the repetition (Kunst-Wilson & Zajonc, 1980; Moreland & Zajonc, 1977; Monahan, Murphy, & Zajonc, 2000). Similarly, in subliminal affective priming, preference ratings for an object can be influenced by unconsciously (e.g., 10 ms) presented affective stimuli, such as smiling or angry faces (Murphy & Zajonc, 1993; Winkielman, Zajonc, & Schwarz, 1997). Zajonc and colleagues have interpreted such results as demonstrating the operation of unconscious affective processes. In a recent review of 20 years of work, Zajonc recounts that: ''In seeking to establish the independence of affect and cognition, I relied on the assumption that emotions are often unconscious . . .'' (p. 32, Zajonc, 2000).

It is worth noting, however, that Zajonc only has asserted the *causation and assignment* of affect to be unconscious. The elicited *affective state* itself is always assumed to be *consciously* experienced (Zajonc, 2000). Providing a prototypical example, Zajonc asks, ''What happens when we induce nonconscious affect?'' He answers: ''Nonconscious affect has been recognized in clinical psychology in the form of the phenomenon of free-floating anxiety. Free-floating anxiety is a state—a feeling—a mood, in which the person has no idea of the origin of the feeling. It is a sort of fear, but the person does not know what he or she is afraid of, and has no idea of how to escape it. It is diffuse and nonspecific'' (pp. 47–48, Zajonc, 2000). In other words, in Zajonc's prototypical example, a free-floating anxiety is a conscious fear—the person experiences ordinary subjective anxiety, but is unaware of its cause, and is afraid of ''everything''.

More systematically, Zajonc has defined unconscious emotion in this partly implicit sense as possession of three features (Zajonc, 2000). First, it is *caused by an unconscious event*, such as a subliminal stimulus. Second, unconsciously caused affect is experienced as *diffuse*. Third, unconsciously caused affect *can*

*be assigned to any target* that comes along, such as a visual ideograph or the person's own mood (Kunst-Wilson & Zajonc, 1980; Monahan et al., 2000; Murphy & Zajonc, 1993; Winkielman et al., 1997). These aspects of the emotion are unconscious, but the emotion itself remains a felt feeling.

Oehman and his colleagues make a similar use of the term ''unconscious emotion'' to refer primarily to unconsciously caused occurrences of conscious affective states (Oehman, Flykt, & Lundqvist, 2000). They express the similarity of their use to Zajonc's view of unconscious emotion in a recent review: ''In this chapter we address *unconscious emotion in the sense that emotion can be activated without conscious recognition of the eliciting stimulus*. This may happen when an emotionally relevant stimulus, which is presented outside conscious attention, automatically redirects attention to become its focus, or when a stimulus that is prevented for reaching conscious awareness through backward masking nonetheless elicits psychophysiological responses suggesting emotional activation. These lines of evidence suggest that emotions can be activated independently of consciousness, much as in Zajonc's (1980) slogan that 'preferences need no inferences' '' (p. 298, emphasis ours, Oehman et al., 2000). Thus, for both Zajonc and colleagues and Oehman and colleagues, unconscious emotion is most generally expressed as an unconsciously caused emotion that is nonetheless consciously felt. The positions of Zajonc and Oehman do not rule out unconscious emotion in an even stronger sense of an unfelt affective reaction. They merely do not go so far as to assert that implicit emotion exists in this strongest sense.

## Unremembered subliminal feelings: Unconscious or forgotten?

Given that a consciously felt feeling seems to be virtually everyone's criterion of emotion, it is not surprising that there has not been much research on unconscious emotion in the strongest sense of an unfelt affective reaction. Yet there is some evidence. In one attempt to probe whether subliminally induced affective reactions were unconscious, Winkielman and colleagues asked participants to evaluate Chinese ideographs that were preceded by subliminal happy or angry facial expressions, and warned them that their conscious feelings might be influenced by external factors, such as ''hidden pictures'' or background music (Winkielman et al., 1997). This warning was meant to alert participants to attend to their own affective responses, and lead them to discount the subliminally induced reactions in their preference ratings, as suggested by the feeling-as-information hypothesis (Schwarz, 1990). But, in fact, warnings did not protect the participants from subliminal affective priming effects on their ratings. Further, when asked afterwards, participants strongly denied experiencing any conscious affective reactions during the experiment.

However, failure to discount or remember is not conclusive evidence for unconscious affect, and could have been due to errors of attention, motivation, or memory. Participants may simply have failed to notice their subtle, but conscious affective reactions, because they were focused on the task of rating the ideographs (Gasper & Clore, 2000; Lane et al., 1998). Further, participants may have failed to discount the ''subliminally caused'' affective reactions because they did not care about the unimportant Chinese ideographs (Tetlock & Lerner, 1999). Perhaps most important, retrospective reports of hedonic experiences are often simply wrong (Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993; Kahneman & Snell, 1992; Mook & Votaw, 1992; Redelmeier & Kahneman, 1996; Wilson & Schooler, 1991). Participants might have experienced a conscious affective change the moment after presentation of a subliminal affective stimulus, but simply failed to remember it later.

## Genuine unconscious affect: On-line demonstration

Let us be clear on what is needed to demonstrate true unconscious emotion. Our view on criteria is essentially that of Kihlstrom and colleagues (Kihlstrom et al., 2000). For an emotion to be unconscious, people must not be able to report their emotional reaction at the moment it is caused. Yet there must be clear evidence of the emotional reaction either in their behaviour, or physiological response, or subsequent subjective impressions of an affect-laden event.

We believe we have produced such a demonstration in recent experiments (Winkielman, Berridge, & Wilbarger, 2000). In two studies, we asked participants to *rate their momentary feelings of subjective emotional experience* (subjective emotion) immediately after exposure to a series of subliminal happy or angry emotional facial expressions (rather than at the end of the experiment). If participants do not report any change in subjective emotion at the moment right after the subliminal stimulus, it is hard to argue their failure is due to deficits of attention, motivation, or memory, especially if they subsequently go on to demonstrate behavioural and judgemental consequences of their emotional reaction.

In Study 1 of this research, we also wished to provide evidence that an unconscious emotional reaction can control *actual consumption behaviour* in a real-life situation (i.e., not just control preference ratings or autonomic reactions). We gave participants a pitcher of fruit-flavoured drink, which they could physically interact with, pour and actually consume, after subliminal exposure. We wondered if participants' behaviour would be influenced by the valence of subliminal primes, even if their self-reports failed to reveal evidence of any conscious emotion.

In more detail, in Study 1 participants were first exposed to eight subliminal exposures of happy, neutral, or angry facial expressions (Winkielman et al., 2000). Conscious perception of the subliminal stimulus was prevented by

showing it for only 16 ms. Further, the emotional expression was masked by an immediately following second photograph of a neutral face shown for 400 ms, long enough to be seen consciously. Participants were told that their task was to guess the gender of the neutral face. That gave them something to concentrate upon and provided a plausible cover story. This procedure succeeded in keeping emotional presentations subliminal; later people denied having ever seen the emotional expressions, and performed at chance in a forced-choice task of face recognition. Immediately after the subliminal exposure to happy, neutral or angry facial expressions, participants rated their own subjective emotion at that moment on a 10-point hedonic scale ranging from ''very unpleasant'' to ''very pleasant''. Then they were presented with a pitcher of fruit-flavoured drink, and asked to pour themselves as much as they wanted, to drink it, and to evaluate it (the order of subjective emotion ratings and of drink presentation was counterbalanced for another group of subjects).

## Subliminal control of consumption behaviour with no subjective change

Our results showed that subliminal emotional expressions controlled people's pouring and drinking behaviour, but in a way that depended on participants' thirst. Subliminal exposure to happy facial expressions actually caused thirsty participants to *pour roughly 50% more* of the fruit-flavoured drink into their own cup than if they had seen only neutral facial expressions (Figure 1). Thirsty participants also *drank about 50% more* of what they poured after being exposed to subliminal happy expressions than after neutral expressions. By contrast, subliminal angry expressions caused thirsty participants both to pour less into their cup and to drink less of it than participants primed with subliminal neutral expressions. Thus, the effect of subliminal affective stimuli on real behaviour toward the drink was bivalent in that consumption could be driven either up or down by subliminal happy versus angry stimuli. Importantly, thirsty participants reported no conscious awareness of any intervening change in their subjective emotion even when asked before receiving the drink (Figure 1). Nonthirsty participants did not show any of these effects.

## Willingness to pay and subjective wanting to drink without subjective emotion

In Study 2, we presented people with the same series of subliminal happy or angry faces embedded in the gender identification task. After the primes, some participants first reported their subjective emotion on an expanded 20-question PANAS mood rating scale (Watson, Clark, & Tellegen, 1988). Other participants, however, were first given just a single sip of the fruit beverage, and asked to rate immediately how much they liked it, how much they wanted to consume, and how much they would be willing to pay for a hypothetical can of the

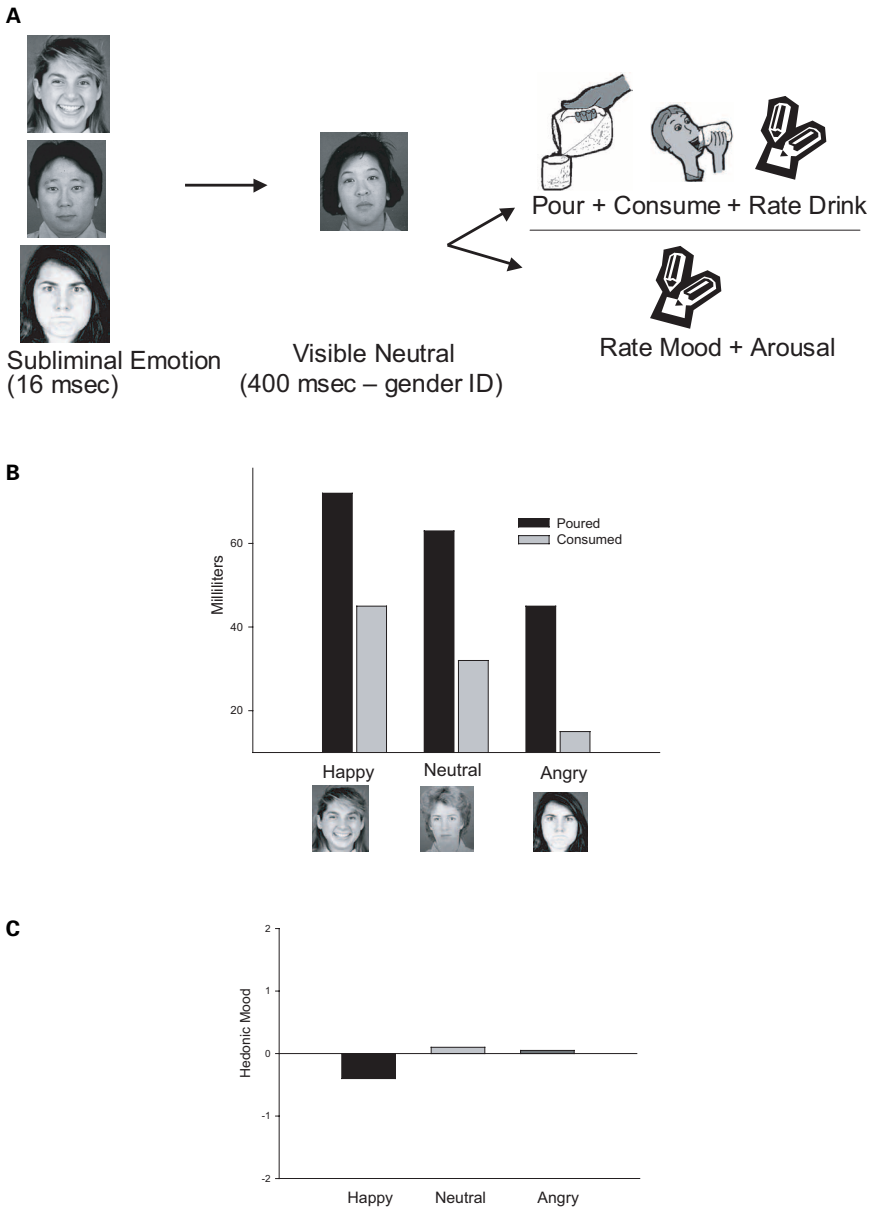



**Figure 1.** Unconscious subliminal affective reaction controls consumption behaviour. **(A)** Summary of experimental procedure: (1) subliminal emotional exposure; (2) gender identification task; and then (3) emotion self-report; and (4) behavioural consumption of drink (3 and 4 in balanced order). **(B)** Pouring and drinking behaviour by thirsty men and women was changed after subliminal exposure to happy facial expressions, neutral facial expressions, or angry facial expressions (amount poured of a fruit-flavoured drink, and amount actually consumed). **(C)** Ratings of subjective mood were not changed after same subliminal stimuli (''How do you feel right now at this moment, 10-point hedonic scale). (From Winkielman et al., 2000.)

beverage (again the order of drink presentation and mood ratings were counterbalanced). Subliminal emotional expressions altered these subjective ratings of the drink for thirsty participants in bivalent directions, and again had no effect on nonthirsty participants. For example, in answer to the question ''How much would you pay for a can of this drink?'', thirsty participants were willing to pay nearly double after seeing subliminal happy expressions than after seeing subliminal angry expressions (about 40 vs. 20 US cents per can). They also gave higher ratings to the question: ''How much of this drink do you want to drink right now?'' after the happy versus angry subliminal stimulus. Again, no changes in subjective emotion were produced in these thirsty participants, even when assessed by the sensitive 20-item PANAS questionnaire. Interestingly, however, a slight mood shift was found for *nonthirsty* subjects who never showed changes in their consumption behaviour or ratings of the drinks. Thus, the results provide a double dissociation (i.e., A occurs without B, and B occurs without A). Subliminal emotional expressions controlled drink evaluation but not subjective emotion ratings for thirsty participants, whereas they impacted subjective emotion ratings, but not drink evaluation for nonthirsty participants.

Although the ability of thirst to channel subliminal affective reactions is of interest itself, our focus here is on the implications of the lack of conscious emotion in thirsty people right after their subliminal exposure. Overall, happy subliminal faces did not create a conscious positive affective state in thirsty people, nor did subliminal angry faces create in them a conscious negative affective state. Instead, the subliminal stimuli altered their behaviour and evaluation of the affect-laden beverage they encountered later, without altering intervening ratings of subjective emotion.

Thus, we consider this pattern of findings a demonstration of *unconscious affective reaction.* It meets the criteria for a strong sense of truly implicit emotion. That is, a behaviourally demonstrable affective reaction of which the person is simply not aware, even when that person deliberately introspects and reports in detail on his/her own conscious emotional state. Our thirsty participants were unaware not only of the subliminal facial stimuli, but also of their own emotional reaction to those stimuli. Further, our results demonstrate that both positive affect as well as negative affect can be unconscious, as revealed in bivalent shifts from a neutral baseline.

## Unconscious emotion vs. unconscious information?

An alternative to the unconscious emotion interpretation of the above results would be to posit that the effects of subliminal stimuli were purely cognitive. Such a rhetorical move would allow an ''emotion is always conscious'' theorist to argue that our thirsty participants did not report an affective change is because there was no affective change to be aware of. However, such a position is

inconsistent with research showing that subliminal facial expressions elicit genuine affective changes, as revealed in a variety of physiological and behavioural effects, including activation of the amygdala and substantia innominata (Morris, Oehman, & Dolan, 1998; Whalen et al., 1998), spontaneous mimicry (Dimberg, Thunberg, & Elmehed, 2000), and skin conductance responses (Oehman et al., 2000).

But suppose for a moment that a subliminal smile or frown functions purely in a semantic fashion, just like a positive or negative subliminal word prime (Clore & Ortony, 2000). If so, the facial expression might elicit a ''free-floating'' cognitive belief that something good or bad is happening, and thus influence the interpretation of subsequent stimuli, via mechanisms discussed in the literature on knowledge accessibility (Higgins, 1996). If a ''free-floating belief'' can be assigned to any relevant object, including the drink, then one could argue that for thirsty participants, who may have been thinking about drinks, a subliminal happy expression led to their interpretation of the drink as ''good'', leading to the increased consumption. On the other hand, for nonthirsty subjects, who were not thinking about the drink and might be thinking about themselves, a subliminal smile expression led to interpretation of one's own subjective state as good, thus accounting for the difference in reports of mood. In short, the ''emotion-is-always-conscious'' theorists may try to account for findings like ours by viewing them as phenomena of unconscious cognition rather than unconscious affect (Clore, personal communication).

Although such a cognitive view might accommodate some of our findings, it cannot accommodate all. Most importantly, right after subliminal exposure some participants were asked to first focus their attention on themselves (subjective emotion rating) whereas other participants were asked to first focus their attention on the external stimulus (drink). If attention-driven *assignment of the free-floating belief* was the primary factor, then order of testing should have strongly determined which measure was influenced by the prime. Specifically, subjective emotion reports should have been influenced most for participants who were first asked to introspect about how they felt. That did not happen. Instead, the appetite state (thirst) was the overwhelming factor.

To us, the powerful role of the thirst appetite state suggests an explanation in terms of more basic motivational or affective mechanisms. Specifically, the initial appetite state (thirst) may directly enhance the initial value of the relevant affective stimulus (drink), as revealed by the fact that our thirsty participants found the drink generally more desirable (i.e., the phenomenon of alliesthesia, Cabanac, 1971). This enhancement in the initial drink value allows subliminal facial expressions to control consumption behaviour and ratings of thirsty participants while having no effects on nonthirsty participants, except for slight changes in mood. This interpretation is consistent with biopsychological theories of how physiologically based appetite states modulate perceptions of relevant reward stimuli (Berridge, 2001; Cabanac, 1971; Toates, 1986).

## What determines conscious manifestations of subliminally elicited emotion?

Interestingly, a recent study by Monahan et al. (2000) found a different result in that subliminal stimuli led to shifts in *conscious* mood. It is worth examining some differences between their study and ours, and highlight factors that may influence whether subliminally elicited emotion manifests in subjective experience.

Monahan and colleagues' study was based on the ''mere exposure'' phenomenon (Zajonc, 1968). Participants were subliminally presented with a series of 25 drawings, each for 5 ms, and followed by a 1 s mask of grey dots. Participants were then asked to rate their mood on a verbal or pictorial 5-point scale. Participants who had been presented with a subliminal series of five identical drawings repeated five times each gave reliably higher mood ratings than subjects who had been presented with 25 distinct drawings (Monahan et al., 2000). Monahan and colleagues interpreted their results to indicate that repeated exposure of the same subliminal stimulus elicited a diffuse and positive affective state, which was experienced consciously even though its causation was unconscious (similar to interpretations by Zajonc discussed above).

Why were mood effects reliably found in participants studied by Monahan and colleagues (2000), but not in thirsty participants studied by Winkielman and colleagues (2000)? The difference may be due to several factors. One factor already mentioned are appetite states such as thirst. In the study by Winkielman et al. (2000), only nonthirsty participants showed mood effects, whereas only thirsty participants showed changed reactions to drinks. This suggests that physiologically based appetite states can modulate the channelling of subliminal effects, perhaps similar to the way anxiety has been suggested to facilitate extraction of the valence of subliminal stimuli (Oehman & Soares, 1994). Appetite states may also determine whether the valence cues conveyed by subliminal affective stimuli will automatically influence action (e.g., for thirsty people, change consumption behaviour without concurrent subjective emotion), or whether it will become consciously available (for nonthirsty people, change subjective emotion without changing consumption) (Mandler & Nakamura, 1987).

Second, the nature of eliciting stimuli might be important. Subliminal presentation of emotional facial expressions activate subcortical limbic circuits (Whalen et al., 1998), and might be more potent than simple abstract drawings at influencing action via unconscious core affective processes (Winkielman & Cacioppo, 2001).

Finally, procedural differences, such as the masking task, could be crucial. For example, Monahan et al. (2000) masked subliminal drawings with a visual dot pattern, which participants passively watched. In contrast, Winkielman et al. (2000) masked subliminal facial expressions with a consciously seen neutral face, and asked participants to actively identify its gender identification. Any

''extra'' conscious affect might have been screened out by the active task, or absorbed by the neutral face (Niedenthal & Showers, 1991), without dissipating the underlying affective core process that changed consumption behaviour. Such possibilities deserve to be addressed by future studies.

It is important to note that our conclusion from the Winkielman et al. results is not that subliminal stimuli *never* influence conscious experience of emotion (see, e.g., Robles, Smith, Carver, & Wellens, 1987). Instead, it is that *changes in subjective emotion need not be related to the strength of subliminally induced changes in affective reactions to subsequent events*. The double dissociation between the effects of subliminal emotional expression on subjective experience (only in nonthirsty subjects) versus behavioural and evaluative reaction to drinks (only in thirsty subjects) indicates changes in subjective emotion did not mediate changes in affective reactions to the drinks. The change in affective reaction to the drink and in consumption behaviour was essentially unconscious, in that it was unrelated to the subjective component of emotion (feeling ratings) at the moment it was caused. That behaviourally expressed-but-unfelt change reflected an unconscious core affective process.

## Unconscious core affective processes

It is easier to illustrate the existence of unconscious affect than to provide a comprehensive definition. Empirical studies, not a priori definition, will offer the best way to an accurate understanding of core emotional processes. However, below we discuss some critical features of unconscious core affective processes, contrast them with conscious emotions, and address their relation to brain systems. In our discussion, we focus especially on the relation between unconscious ''liking'' and conscious pleasure. We do not pretend that our ideas are complete, but we hope that they might be useful in framing the issue.

Unconscious core affective processes can be basically defined as valenced good/bad reactions that occur in the absence of conscious awareness (Berridge, 1999; Kihlstrom et al., 2000). These reactions can be triggered unconsciously, and, once triggered, can persist and unconsciously influence perception and behavior to value-laden events. How can an unconscious core affective process be recognised? Primarily, by features it shares with ordinary conscious emotion (Kihlstrom et al., 2000). First, these include *stimuli* for elicitation (e.g., emotional facial expressions) that ordinarily induce conscious affective feelings. Second, they include valence in *reaction* direction (e.g., reaction to stimulus as good vs. bad). [In passing, we note debate exists regarding whether good and bad valenced reactions can both exist simultaneously or are mutually exclusive (e.g., Berridge & Grill, 1984; Cacioppo, Gardner, & Berntson, 1999; Russell & Carroll, 1999; Tellegen, Watson, & Clark, 1999; Winkielman, Berntson, & Cacioppo, 2001). For our purposes here, it is enough that either good, bad, or both be manifest to count as an affective reaction].

Third, the valenced process must *persist* for at least a short time after the eliciting stimulus and be *expressed* later either behaviourally, physiologically (e.g., galvanic skin response), or neurally (e.g., fMRI) in response to a value-laden event. Fourth and last, in order to be considered ''unconscious'', of course, an affective core process must not be accessible to subjective reports at the moment it is caused. For example, in the Winkielman study, all these criteria were met: affective behavioural reactions were triggered by subliminal happy or fearful faces, they caused participants to later drink either more or less of the fruit beverage, and they could not be subjectively reported by participants at the moment of causation.

The above discussion makes clear that our view of unconscious emotional reactions is similar to that of several other psychologists and affective neuroscientists who have argued that the essential purpose of emotional processes is to influence perception and action, and that these effects can be distinguished from changes in subjective awareness (Berridge, 1999; Cosmides & Tooby, 2000; Damasio, 1999; Ekman, 1999; Frijda, 1999; Lane et al., 1998; Lang, 1993; LeDoux, 1996; Oehman & Soares, 1998; Shevrin et al., 1992; Zajonc, 1998). For example, regarding unconscious fear processes, Le Doux writes: ''When we use the term 'fear', we are naturally inclined to think of the feeling of being afraid. [But] As important as subjective feelings like fear are to our lives, it seems likely that these were not the functions that were selected for in the evolution of the fear systems or other emotion systems'' (p. 130, LeDoux, 2000).

Most discussions of the possibility and evolutionary significance of unconscious affective reactions has usually been limited to negative affect. However, we would apply similar arguments to *positive* affect, especially liking. In fact, one could argue that as important as conscious pleasure is to our lives, it was not the primary reason for evolution of brain liking systems (cf. Cabanac, 1996). Rather, evolutionary pressures primarily acted to shape appropriate behavioural reactions to positive events. Accordingly, Berridge and Robinson and colleagues have introduced the apostrophic terms ''liking'' and ''wanting'' to refer to unconscious core processes of affect and motivation generated by the brain, which influence behaviour towards incentives—without necessarily being felt. The apostrophes around ''like'' and ''want'' denote the difference between these intrinsically unconscious affective core processes versus the ordinary subjective sense of liking and wanting as conscious pleasure and conscious desire (Berridge, 1999; Robinson & Berridge, 1993). [For clarity, in this paper we use the unmodified word *pleasure* to denote only *conscious liking*. However, just as it makes sense to talk about unconscious ''*liking*'', it makes sense to talk about *unconscious ''pleasure''*.]

As is the case with mechanisms underlying unconscious negative affects (LeDoux, 1996), most of the experimental work on core ''liking'' and ''wanting'' systems has been conducted in animals (Berridge, 1999, in press b). However, we propose that these distinctions bear on human reactions involved in pleasure. Specifically, we suggest that an unconscious ''liking'' (and ''dis-

liking'') is indicated by our finding that subliminal emotional faces modified positive (and negative) behavioural reactions to drinks in the absence of any conscious intervening effect of the faces on subjective experience of emotion (Winkielman et al., 2000). Related instances of an unconscious affective core process modifying behaviour without conscious awareness have been observed in certain clinical examples. For example, drug addicts will work for drug rewards even when the drug dose is so low that they do not experience it as consciously pleasurable (Fischman & Foltin, 1992; Lamb et al., 1991).

## What is a conscious emotion?

Although core affective processes are intrinsically unconscious, they may in turn cause conscious emotions by acting on other processes of conscious representation. Conscious pleasure and unconscious ''liking'', for example, are by no means mutually exclusive. Unconscious core ''liking'' can typically cause conscious liking—but the two are not identical. An analogy to visual sensation may be useful here. When one is consciously aware of a visual sensation, activation of core visual sensory processes causes in turn the subjective event. The core process is not sufficient by itself to cause a corresponding conscious experience, as is exemplified by the phenomenon of blindsight in human patients after brain damage to occipital cortex (Weiskrantz, 1996). An additional mechanism of conscious awareness, requiring sufficient occipital cortex participation in the case of vision, must take the core process as its input and transform it into subjective awareness. Perhaps related, the clinical condition of alexithymia has been described by Lane and colleagues as a form of emotional blindsight (blindfeel), in which people are unable to describe emotional feelings even when they have strong physiological reactions to events (Lane, Ahern, Schwartz, & Kaszniak, 1997).

The difference between an unconscious core affective process, such as ''liking'', and a conscious affective experience, such as subjective pleasure, thus is similar to the difference between blindsight and conscious vision. Both unconscious ''liking'' and conscious pleasure are affective processes, just as blindsight and a conscious visual perception are both visual processes. The difference in both cases is a *difference of conscious awareness* (involving mechanisms of consciousness)—not a difference in the underlying emotional or visual process (involving core processes of affective reaction or of visual processing).

## Relation of unconscious core processes to conscious emotions

Importantly, unconscious core affective processes need not always bear a one-to-one relation to conscious emotions (Berridge, 1999). Although some core affective processes may be specific to a particular conscious emotion (e.g., negatively valenced fear reactions, Esteves, Dimberg, & Oehman, 1994;

LeDoux, 2000), others may be more general in function, such as ''liking'' for diverse sensory pleasures (Cabanac, 1992).

Perhaps less intuitively, some core processes may participate in several different subjective emotions. For example, conscious desire and conscious fear may both share a similar core process of incentive salience or ''wanting'', involving brain mesolimbic dopamine systems and nucleus accumbens (Berridge, 1999; Reynolds & Berridge, 2001). Attribution of incentive salience to cues for ''liked'' events causes those cues to become attractive, sought after, and able to trigger pursuit of the ''liked'' reward (Berridge & Robinson, 1998; Wyvell & Berridge, 2000). However, hyperpolarisation of other accumbens neurons, near those that attribute attractiveness to perceived cues, may cause cues to instead be perceived as frighteningly salient, and trigger defensive behavioural reactions instead of approach (Reynolds & Berridge, 2001). Thus, a similar mesolimbic core process may cause either a positive or a negative motivated response, combining aspects of both appetitive motivation and fear into one psychological core process and the same brain structure (Berridge, 1999; Gray, Young, & Joseph, 1997; Horvitz, 2000; Reynolds & Berridge, 2001; Salamone, 1994). If so, it means that the same psychological core process is used as a building block to construct two emotional reactions that are consciously experienced as opposite to each other (negative fear vs. positive desire). This position seems related to psychological composite theories and appraisal theories, which allow a single subjective emotion to contain multiple components (Clore & Ortony, 2000; Ellsworth & Scherer, in press; Russell & Barrett, 1999).

## Brain mechanisms of conscious vs. unconscious core processes

Any attempt to distinguish brain substrates for unconscious emotional core processes versus conscious emotion is necessarily speculative. However, we will sketch some possibilities below.

Many parts of the brain are activated by emotional events. These include several regions of the *neocortex*, such as the ventromedial or orbitofrontal parts of prefrontal cortex, anterior cingulate cortex, parietal cortex, and temporal cortex. The emotional brain also includes important *subcortical structures* beneath the neocortex, such as amygdala, nucleus accumbens, mesolimbic dopamine system, ventral pallidum, hypothalamus, and structures deep in the brainstem. For reviews of brain systems of affect and emotion see (Berridge, in press, a, b; Damasio, 1999; Davidson, Jackson, & Kalin, 2000; Everitt, Cardinal, Hall, Parkinson, & Robbins, 2000; LeDoux, 1996; Panksepp, 1998a; Rolls, 1999; Shizgal, 1999).

Both neocortex and subcortical structures participate in affective processes, but cortical and subcortical systems may play very different causal roles

(Berridge, in press a; Damasio, 1999; LeDoux, 1996; Rolls, 1999; Stone, 1999). A detailed description is beyond the scope of this article, but evidence indicates that although neural activation in *cortical* structures is often *correlated* to pleasant affective reactions, it may be relatively unimportant in *causing* them (Berridge, in press b). By contrast, changes in activity in *subcortical* structures are more likely to *cause* basic affective reactions.

Although cortical structures, such as orbitofrontal and cingulate areas, show activation to emotional stimuli in human neuroimaging studies and animal electrophysiological recording studies (Damasio, 1999; Davidson et al., 2000; Rolls, 1999), brain damage in those cortical regions typically does not *abolish capacity for an emotional reaction.* Nor can *activation* of these cortical regions generally suffice to *produce* a strong emotional response. Instead, damage to those cortical regions alters cognitively mediated emotional anticipation, decisions, and action strategies based on emotion, as well as subtle aspects of the cognitive representation of emotion (e.g., Bechara, Damasio, & Damasio, 2000; Damasio, 1999). This suggests that when the cortex participates in basic affective reactions, it does not function as their primary cause, but rather does something more hierarchical in nature (Berridge, in press a; Hughlings-Jackson, 1958). Specifically, the cortex might mediate *conscious experience of emotions* and other psychological processes by hierarchically monitoring and re-representing lower core processes. Further, cortical causation might be restricted to cognitive aspects of emotion induction, cognitive decisions based on emotion, and to voluntary regulation of emotional state via modulation of lower brain structures that more directly cause affective reactions (Bechara et al., 2000; Damasio, 1999; Davidson et al., 2000; Rolls, 1999).

## Subcortical brain mechanisms cause core processes of emotion

By contrast, much evidence indicates that manipulations of *subcortical* brain systems are highly effective at *causing* basic affective reactions themselves (Berridge, in press a, b; Damasio, 1999; LeDoux, 1996; Panksepp, 1998a). The ability to *cause* an affective reaction, whether conscious or unconscious, is exactly the property we expect to be possessed by any brain structure that mediates a core process of emotion. Subcortical brain structures may therefore be the best candidates to mediate unconscious core affective processes.

Similar suggestions for subcortical mediation of unconscious core emotional processes have been made by Le Doux and by Damasio, Bechara and their colleagues (Damasio et al., 2000; LeDoux, 1996). For example, LeDoux distinguishes between basic fearful reactions (i.e., an emotional core process) and the conscious feeling of fear, and suggests that the unconscious reaction component of fear is mediated by the subcortical amygdala (LeDoux, 1996, 1998). His proposition is based on many studies showing that damage to amygdala

disrupts basic fearful reactions, such as behavioural freezing, startle responses, etc. (Davis & Shi, 1999; Everitt et al., 2000; Kagan & Schulkin, 1995; Killcross, Robbins, & Everitt, 1997; LeDoux, 1992, 1998; Maren, 1999). Similarly, Damasio, Bechara, and colleagues suggest that deep brain structures participate in generating an unconscious stage of fear, anger, happiness, and sadness reactions (Bechara, 2000, personal communication; Damasio, 1999; Damasio et al., 2000).

How the brain generates *pleasure* has traditionally received less attention than fear in affective neuroscience. That is in part because there are fewer recognisable *positive affective reactions* to pleasant sensations available for study than there are fearful reactions to frightening stimuli. However, brain mechanisms of positive affective reaction and reward have recently received increasing attention (Berridge, 1996; Davidson et al., 2000; Everitt et al., 2000; Panksepp, 1998a; Rolls, 1999; Shizgal, 1999). Just as for fearful reactions, the evidence available indicates that basic core ''liking'' reactions to pleasant sensations are caused primarily by subcortical brain structures.

## Infant/animal affective reactions reveal core ''liking'' for pleasant tastes

Understanding unconscious core ''liking'' takes us into the affective neuroscience of positive affective reactions to pleasant events. First, it is helpful to note a useful behavioural measure that has been employed in some affective neuroscience studies of core ''liking'' reactions, namely, affective facial expression to the sensory pleasure of taste. For example, a newborn human infant has distinct positive versus negative patterns of affective facial reactions to tastes (Steiner, 1973; Steiner, Glaser, Hawilo, & Berridge, 2001). Sweet elicits positive facial reactions from newborns, whereas bitter elicits negative reactions, even on the first experience (Figure 2). The positive reaction to pleasure includes tongue protrusions and lip sucking movements, plus facial relaxation, and the occasional smile. By contrast, the negative facial reaction to bitter comprises a very different pattern of gapes, nose wrinkling, and head shaking (Steiner, 1979; Steiner et al., 2001).

Positive facial reactions to sweetness might plausibly be accompanied by conscious feelings of pleasure for normal human infants. But there are reasons to think that the facial reaction to pleasure reflects a core process of ''liking'' rather than the consciousness *per se* of the pleasant sensation. One reason is that positive affective facial reactions also occur in infants whose consciousness status may be more suspect, such as ''anencephalic'' infants (Steiner, 1973). Anencephalic infants are born with a brainstem but no cortex and little else of the forebrain, due to a birth defect that prevents prenatal development of forebrain structures (i.e., no amygdala, hippocampus, nucleus accumbens, thalamus, etc.). Yet sweet tastes still elicit strong positive facial reactions. Although core

''liking'' and conscious liking both might be reflected in the positive affective facial expression of a normal newborn infant, that of an anencephalic might arguably reflect only the unconscious core process of ''liking''—without full felt feeling of normal subjective pleasure. Such examples provide further basis for a distinction between ''liking'' and liking. It also provides a relatively direct way to measure ''liking'' for a basic sensory pleasure in infants and animals: Watch the face (Berridge, 2000).

No one would use human infants in an affective neuroscience experiment. But animals also have affective reactions to pleasant tastes, which are similar in both facial pattern and evolutionary origins. For example, chimpanzees, orang-utans, and gorillas have facial reactions to sweet versus bitter tastes that are highly similar to those of human babies (Steiner et al., 2001). Old World monkeys (primate relations which evolved in Africa and Asia), and New World monkeys (more distant primate relations which evolved in South America), have slightly less similar behavioural affective reactions tastes (Steiner et al., 2001). Finally, even rats have affective reactions to taste related to those of primates, such as tongue protrusions to pleasant sweetness and gapes and headshakes to unpleasant bitterness (Grill & Norgren, 1978a). The similarity across species of these affective reactions to pleasure permits one to use them to gain insight into underlying brain mechanisms of sensory pleasure (Berridge, 2000). Affective neuroscience studies in our laboratory have used the basic affective reactions of rats to identify the brain systems that generate positive ''liking'' reactions to pleasant tastes (Berridge, in press b).

## Subcortical forebrain site causes positive affective core process: Nucleus accumbens shell

Perhaps the most intriguing brain system of ''liking'' identified so far is in the nucleus accumbens. The nucleus accumbens lies at the front base of the brain, just below the prefrontal cortex, and contains two parts, the shell and the core. A recent affective neuroscience study in our laboratory showed that activation of neural circuits in the accumbens shell can cause ''liking'' for a pleasant taste (Peciña & Berridge, 2000). Specifically, a sweet taste elicited extra ''liking'' reactions from rats after a selective activation of opioid neurotransmitter receptors inside their nucleus accumbens shell. The selective activation was caused by microinjections of morphine (a drug that activates opioid receptors) directly into the brain structure (painless because the brain cannula had been implanted a week earlier while the rats were anaesthetised).

A few minutes after the morphine microinjection, a bittersweet taste was infused into the rat's mouth and its behavioural affective reactions were video recorded (Peciña & Berridge, 1995, 2000). The rats responded behaviourally with a distinct shift towards positive affective reactions after the morphine microinjection, which indicated it made them ''like'' the taste more. Interest-

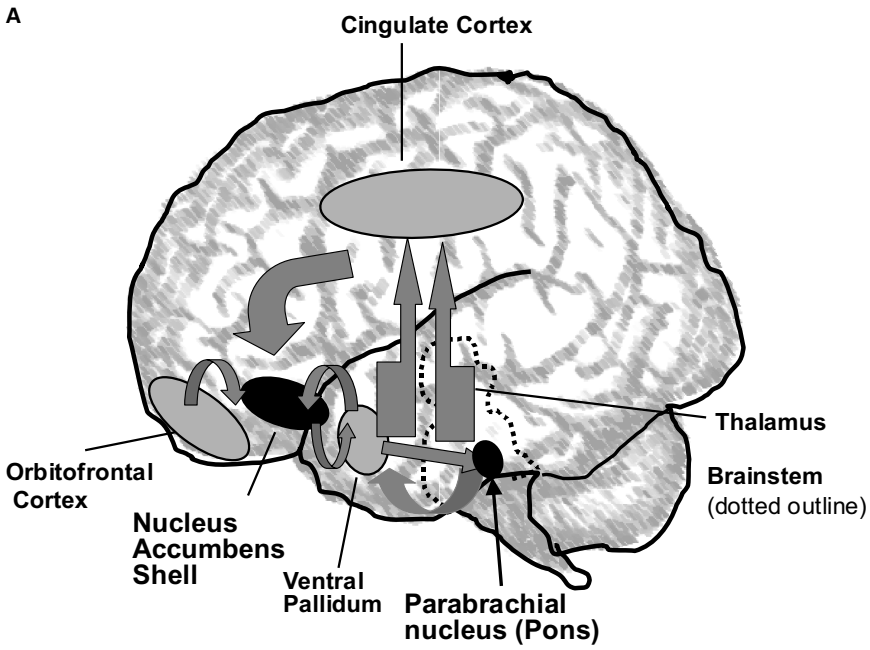

**Figure 2.** ''Like'' vs. ''dislike'' reactions to tastes. Positive affective facial reactions to pleasure of sweetness elicited from a human infant, an orangutan, and a rat (top). Displeasure reactions to bitterness (bottom). Human infant and orangutan photos from (Steiner et al., 2001). (Modified from Berridge, 2000.) To view this figure in colour, please see the online version of the journal.

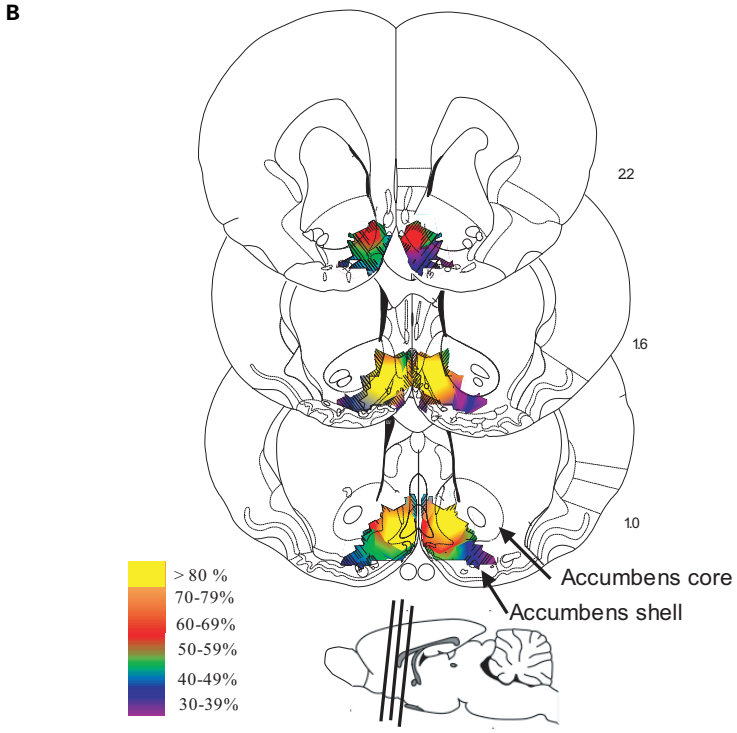
ingly, the morphine microinjection also caused the rats to eat more of a tasty food than they ordinarily would. This suggests that the accumbens shell activation may increase ''wanting'' for food, as a consequence of enhancing ''liking'' for it (Peciña & Berridge, 2000).

The nucleus accumbens is well positioned for crosstalk between unconscious core processes of ''liking'' and conscious feelings of liking. It receives extensive inputs both from deep subcortical systems that send ascending signals directly to it, and from prefrontal cortex regions involved in cognitive emotional appraisals (Kalivas & Nakamura, 1999; Zahm, 2000).

How does this research bear on the subliminal affective reactions to drinks in adult humans found by Winkielman and colleagues? We speculate that activa-

**Figure 3 (opposite).** (A) Brain sites that mediate core processes of sensory pleasure. The nucleus accumbens is in the bottom of the subcortical forebrain, and the parabrachial nucleus is in the pons portion of the brainstem. (Modified from Berridge, in press b.) (B) Opioid site in nucleus accumbens shell for ''liking'' and ''wanting'' taste pleasures, identified by map of morphine microinjections. Site shown in coronal slices (face on view). Position of slices shown by saggital brain in profile below. (Modified from Peciña & Berridge, 2000.) To view this figure in colour, please see the online version of the journal.


A
Cingulate Cortex
Thalamus
Brainstem
(dotted outline)
Orbitofrontal
Cortex
Nucleus
Accumbens
Shell
Ventral
Pallidum
Parabrachial
nucleus (Pons)


B
2.2
1.6
1.0
> 80 %
70-79%
60-69%
50-59%
40-49%
30-39%
Accumbens core
Accumbens shell

tion patterns in the shell of the human nucleus accumbens might well be altered by a subliminal happy facial expression. It is known that subliminal facial expressions activate brain structures closely connected to the accumbens (Morris, et al., 1998; Whalen et al., 1998). Emotional subcortical circuits are also activated by fear-related facial expressions even in blindsight patients (de Gelder, Vroomen, Pourtois, & Weiskrantz, 1999; Morris, DeGelder, Weiskrantz, & Dolan, 2001). Altered neuronal activity in the nucleus accumbens (constituting unconscious ''liking'') and related brain structures could then change the human affective reaction to a drink, just as morphine microinjection into a rat's shell of accumbens enhances its affective reaction to sweetness and leads to a behavioural reaction of greater ''liking''.

Further, to the degree that *conscious* feelings of pleasure might be influenced in turn by opioid activation in accumbens, the subjective feeling could be caused by accumbens-to-cortex signals that are relayed to cortical regions in just a couple of synapses, via the ventral pallidum and mediodorsal thalamus. Opioid activation in the nucleus accumbens is widely thought to partly mediate the intense pleasure of stimuli such as heroin for human drug users (Koob & Le Moal, 2001; Wise, 1998). Opioid activation also mediates normal human subjective feelings of pleasure caused by tasty food, as opioid-blocking drugs reduce the conscious pleasure (though the entire brain also is affected in such studies, which involve systemic drug administration; Yeomans & Gray, 1997). Finally, descending projections in the opposite direction might help explain how cognitive appraisals or deliberate voluntary intention can modulate basic emotional reactions (Davidson et al., 2000). The accumbens receives massive inputs back from the orbitofrontal region of the prefrontal lobe. This completes a loop between potential subcortical systems for unconscious affective core processes and cortical systems for cognitive, conscious representations of emotional events.

## Brainstem contributes to positive affective core process: Parabrachial nucleus of pons

Core ''liking'' for sensory pleasure is not contained in just one brain structure, but is mediated by a network distributed throughout the subcortical brain. For example, the nucleus accumbens is intimately connected to other structures extending deep into the brainstem (Kalivas & Nakamura, 1999; Zahm, 2000). Activation of those other structures also produces more positive affective reactions to sensory pleasure (Berridge, in press b).

Among these deep brainstem structures of ''liking'' is the parabrachial nucleus—located near the top of the pons, which is the upper portion of the hindbrain (Figure 3). In rats, the parabrachial nucleus receives signals ascending from many sensory modalities, including visceral signals regarding internal bodily functions, and also taste sensations from the tongue (Norgren, 1995).

Interestingly, in humans, the same brainstem parabrachial nucleus has been suggested to participate in generating what Damasio calls the ''protoself'', an unconscious but coherent representation of the momentary state of the body (Damasio, 1999). Damasio's protoself has several functions in common with our notion of unconscious core psychological processes. Both involve representations of significant stimuli that remain unconscious, and both can support generation of appropriate reactions. In addition, Damasio suggests that damage to the parabrachial region of the brain can impair consciousness itself. For example, deficits in awareness of extreme Alzheimer's disease, and the coma that follows certain brainstem damage, both involve disruption of this region of the brain (Damasio, 1999).

Specifically regarding pleasure, activation of a neurotransmitter receptor in the parabrachial nucleus causes increased ''liking'' reactions to a pleasant taste, just as does opioid activation of the nucleus accumbens. In this case, the specific receptors are called benzodiazepine receptors, and help facilitate the impact of an inhibitory amino acid neurotransmitter called gamma-aminobutyric acid or GABA. A recent study in our laboratory found that a microinjection of a benzodiazepine drug into the parabrachial nucleus caused enhanced ''liking'' for a sweet taste (Söderpalm & Berridge, 2000). The rats emitted more positive affective reactions than usual to a bittersweet taste after the benzodiazepine microinjection into their parabrachial nucleus. Our discovery of a core ''liking'' enhancement caused by parabrachial nucleus is consistent with earlier findings that similar microinjections cause enhanced eating behaviour of food. In other words, parabrachial receptor activation leads rats to also ''want'' the food it has made them ''like'' (Higgs & Cooper, 1996; Peciña & Berridge, 1996).

Perhaps not surprisingly, the parabrachial nucleus sends signals up to the nucleus accumbens. And the parabrachial nucleus can receive signals in turn from the nucleus accumbens, via a single synapse in the lateral hypothalamus (Zahm, 2000). Thus, the brainstem parabrachial nucleus is firmly embedded in a larger brain circuit for a core process of affective reaction to sensory pleasure, which loops recursively throughout the brain.

## Affective brainstem: Conscious affect or unconscious core process?

Clearly, the brainstem makes an important contribution to core processes of sensory pleasure, at least for taste ''liking''. Some theorists have suggested that *conscious* affective feelings arise from brainstem substrates too. For example, Panksepp argued, ''the most basic form of conscious activity . . . arises from the intrinsic neurodynamics of the PAG . . .'' (p. 314, Panksepp, 1998a). The PAG is the periaqueductal grey area, an opioid-rich site in the midbrain portion of the brainstem. He suggested, ''It is the PAG that allows creatures to first cry out in distress and pleasure'' (p. 314, Panksepp, 1998a). In a related paper on brain

mechanisms of consciousness, Panksepp pointed out that he does not suppose the PAG can ''explain higher forms of human consciousness'', but stipulates that: ''However, it might begin to explain the fundamental nature of e-qualia, the distinct affective states that arise from the arousal of the basic emotional systems of the brain'' (p. 569, Panksepp, 1998b).

Panksepp's suggestion that the brainstem generates the most basic forms of conscious pleasure follows from his conviction that all true emotional reactions must be intrinsically conscious (similar to the position of many psychologists discussed earlier). For example, for identifying brain systems of emotion, Panksepp suggests ''the basic criterion that emotional systems should be capable of elaborating *subjective feeling states* that are affectively valenced . . .'' (p. 48, italics added, Panksepp, 1998a).

Interestingly, in this respect Panksepp's proposal for an affectively conscious brainstem is similar to the most strictly conscious cognitive appraisal view of affect and emotion, as represented for instance by Clore (Clore, 1994). Both views agree that ''emotion is never unconscious''. An emotional reaction, for both Panksepp and Clore, is necessarily a conscious reaction (although these two views of emotion might agree on little else). The idea that deep brainstem activity might suffice for affective consciousness also seems to underlie the controversial but intriguing recent suggestion that anaesthetics should be routinely given to organ donors who are clinically brain dead (Young & Matta, 2000). Thus, there appear to be practical consequences of these theoretical positions.

That brainstem circuits themselves are capable of generating real consciousness remains a logically possible alternative, but it is *not* our suggestion here. Instead, as a working hypothesis we posit that subcortical brain circuits are truly affective, but only as unconscious core processes contained within ordinary emotion. Those unconscious affective processes do not give rise to conscious feelings by themselves. They are not even directly accessible to conscious introspection in a normal brain (as evidenced by people's inability to report subliminally induced emotional processes that later cause them to drink more of a fruit drink).

By this view of unconscious affective core processes, only an unconscious ''like'' or ''dislike'' is revealed when an anencephalic human infant, born without a forebrain, smiles to pleasant sweetness or gapes to bitterness (Steiner, 1973). And similarly, no more than unconscious ''liking'' is signified by positive affective reactions to sweet tastes of a decerebrated rat, whose brain has been surgically transected behind the hypothalamus (Berridge, 1988; Grill & Norgren, 1978b). The isolated brainstem is capable by itself of unconscious ''likes'' and ''dislikes'', which it reflects behaviourally in these cases, but not of conscious likes or conscious dislikes.

It is difficult to find evidence by which to choose conclusively between such hypotheses, and we acknowledge the case is not closed. On the one hand, as

others and we have suggested, it might be that subcortical brain systems generate only unconscious core affective processes. Other (perhaps cortical) brain systems must then elaborate those basic reactions into consciousness. On the other hand, it is conceivable that even deep subcortical brain systems participate directly in the generation of conscious feelings. If that were so, then the mechanism determining whether emotional processes were conscious or unconscious would be more subtle and complicated than a simple neuroanatomical division of labour between cortex and lower brain structures. Instead, the same neural structures might be capable of supporting both conscious and unconscious modes of emotional reaction. Still, it seems plausible that the ratio of conscious versus unconscious emotional representation might decline as one descends the brain.

In either case, the existence of unconscious ''likes'' and ''dislikes'' seems demanded by examples such as the subliminal priming of affective reactions to a drink we found in people who reported no emotional experience at the moment their reaction was caused (Winkielman et al., 2000). And the existence of unconscious emotional processes demands a generative explanation in terms of brain systems. The psychological difference between conscious feelings and unconscious emotional reactions should correspond to a difference in affective neuroscience terms. The nature of that difference remains to be elucidated.

## CONCLUSION

William James' (1894) theory defined subjective feeling as the essence of emotion. Yet he posited that conscious emotional feeling depended on an unconscious prior cause, namely, the bodily reaction to the emotional stimulus. That immediate neurobehavioural reaction was automatic, but shared certain features with the conscious emotion it enabled, such as the eliciting stimulus and a valenced response. This Jamesian reaction seems to encompass several features of what we have called unconscious core processes of emotion. Perhaps, after all, it is not such a contradiction of William James to ask: ''What is an unconscious emotion?''.

Although the contemporary psychology of emotion has tended to emphasise the view of emotion as intrinsically conscious, we propose that unconscious emotions also exist. To mediate unconscious emotion, there appears to be a subcortical network available to generate core ''liking'' reactions to sensory pleasures. In normal adults under some conditions, core ''liking'' reactions may influence a person's consumption behaviour later, without a person being able to report subjective awareness of the affective reaction at the moment it was caused. When the brain generates an affective response of which the mind is unaware, as we have described here, there exists a truly unconscious emotion.

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