

Affective Computing and Interaction: Psychological, Cognitive and Neuroscientific Perspectives

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Chapter 2

Functions of Unconscious and Conscious Emotion in the Regulation of Implicit and Explicit Motivated Behavior

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ABSTRACT

In this chapter the objective is to taxonomize unconscious and conscious affective and emotional processes and provide an account of their functional role in cognition and behavior in the context of a review of the relevant literature. The position adopted is that human affect and emotion evolved to function in motivational-cognitive systems and that emotion, motivation and cognition should be understood within a single explanatory framework. A 'dual process' account that integrates emotion, motivation and cognition, is put forward in which emotion plays different functional roles in implicit motivations and explicit motivations.

INTRODUCTION TO THE BIOPSYCHOLOGY OF MOTIVATION

Biopsychological research on emotional and motivational processes has undergone an unprecedented growth spurt in the last couple of decades (Schultheiss & Wirth, 2008). Biopsy-

chology is an insightful and fruitful discipline one for understanding the nature of human affect and motivation, and provides a theoretical foundation for understanding the functioning of not only emotional, motivational and cognitive processes that are shared with other higher mammals, but also those that may be uniquely human. A strategy of this chapter will be to develop a novel dual-process theoretical account of human

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motivation, emotion and cognition through the data and theoretical insights of biopsychology, and then assess this theory in the light of social and cognitive psychological research.

Biopsychology combines affect and motivation within a common explanatory framework, providing explanations of both in terms of specific functions of the brain in control of behavior. There is extensive use of mammalian animal models such as rats, mice and monkeys, with the assumption that brain functioning for basic motivational and affective processes is highly similar across species. This assumption is justified in as far as the functional architecture; neurotransmitter and endocrine systems implicated in motivated behaviors are highly similar across different mammalian species. Many mammalian motivations are readily explained in common evolutionary terms. They are *adaptive*, directing organisms towards or away from stimuli of obvious significance for survival and reproduction. This is true not only of basic motivations like hunger and thirst but also of motives such as paternal care, affiliation, dominance and sex. There is a clear evolutionary *continuity* of motivations. Either human motivations are close homologues of motives that exist in other mammals, or they are obviously derived from such motives. Humans' hunger for a wider and more culturally informed selection of foods than other apes, and human sexual motivations are independent of the biological need to reproduce. Human dominance motivations are more complex than the socially motivated dominance behaviors of our closest relatives the chimpanzees (Wrangham & Peterson, 1996). But there are obvious continuities that enable us to explain and predict human brain function and behavior, and theorize in evidence-based ways about how such motives have become more complex in the course of human evolution.

Approach and Avoidance Motivation

Central to biopsychological theories of motivation is the idea that motivated behavior comes in two modes: *approach* mode aimed at attaining incentives or rewards, and *avoidance* mode aimed at avoiding aversive disincentives or punishments. Rewards and punishments can be understood as the *unconditioned stimuli* towards which all Pavlovian and instrumental learning is ultimately directed. In the case of punishments or disincentives, these include poisons or rancid food, sources of disease, physical injury and pain, defeat in intra or inter-sex competition, or social rejection. In the case of rewards, these include nutrients for hunger motivation, water for thirst, orgasm for sexual motivation, social closeness for affiliation motivation, and being on top of a social hierarchy for dominance motivation.

These rewards and punishments are critical to an organism's genetic survival. Animals need to find food for energy, drink to quench thirst, and mate to pass on their genes to offspring. In order to do this they need to compete with and dominate other same-sex members of their species. These are recurrent adaptive goals in mammalian life over millions of years of evolutionary history. All mammals desire the rewards associated with fulfilling these functions, feel compelled to attain them repeatedly, and show invigorated responding where their behavior can be instrumental to attaining them. Evolution has equipped mammals with specialized neurobiological systems to coordinate and support the attainment of these classes of incentives. They have been described by biopsychologists in considerable detail for drinking, feeding, affiliation, dominance and sex (review, Schultheiss & Wirth, 2008).

Physiological Needs and Goal Object Incentives

Motivated behavior is complex and *dynamic* due to the interaction of several factors that determine it.

These include the interplay of competing motives, and the presence of cues in the environment that predict the availability or presence of rewards or punishments. Of particular interest for our current topic is a dissociation common to all specialized motivation systems: motivated behavior can be determined by both (1) the animal's physiological *need state* – for example how deficient in nutrients or water an animal is; and (2) the *incentive (or disincentive) value* of the goal object or state – that is, the 'goal status' of the reward governing instrumental performance which may exert an effect independently from need state. A need state is not necessary for the motivation to eat: rats will gorge themselves on hamburgers even when they are sated (Panksepp, 1998). Thus an animal may become motivated to eat either because of a state of nutrient depletion indicated by hunger, because it recognizes or experiences a food as tasty or desirable, or a combination of both. Moreover, the incentive value of a goal object is not fixed; it may change dynamically for an individual depending on the individual's need state.

Wanting and Liking

Biopsychological research has revealed two consecutive and functionally dissociable phases or aspects of motivational processes: 1. A *motivation phase* during which the organism works instrumentally to attain a reward or avoid a punishment. This motivated action could be as simple as taking steps to a water hole and starting to drink, or as complex as socially coordinated hunting of an elusive prey in a tree canopy. 2. A *consummation phase* in which there is an evaluation of the hedonic (pleasure-pain or 'affective') qualities that accompany the consumption of – or contact with – the incentive or disincentive (Berridge, 1996; Craig, 1918). Berridge (1996) has labeled these separable aspects of motivation *wanting* and *liking* respectively. While it seems intuitive that you want what you like and like what you want, research shows that both aspects of motivation

are dissociable. Drug addicts, for example, may feel compelled to obtain and take their drug even though they no longer take any pleasure from the act – a case of wanting without liking (Robinson & Berridge, 2000). And people respond both subjectively and objectively to eating tasty food with signs of liking and pleasure, irrespective of whether they are hungry and have been motivated to find the food in the first place or not – i.e. same liking with differences in wanting (Epstein et al., 2003).

Related to this distinction is the dissociation of a goal's *instrumental incentive value* from its *hedonic value*. For example, when a hungry rat is trained to respond for food by pressing a lever, and is then sated before being tested again in extinction (in the absence of food), it will lever press just as vigorously as a hungry rat (i.e. exhibit just as much *wanting*) even though it does have a physiological need for the food, *until* the point it experiences the reduced hedonic value of the food due to the fact it is sated (Balleine & Dickinson, 1991). After this direct hedonic ('liking' or 'disliking') experience, the incentive value will recalibrate appropriately with the motivational state of the animal, but without the direct hedonic experience, the two 'value' systems can operate independently.

Rats' hedonic reactions fluctuate in similar ways to human subjective pleasure in response to changing need states (Berridge, 2000). Just as food is more pleasurable to us when hungry, sweet tastes elicit more 'liking' reactions when rats are hungry than when full, as exhibited in oro-facial reactions (Steiner et al., 2001). Regular chow for a rat will have a higher hedonic value when it is starving than when it is sated – a phenomenon Cabanac (1971) has termed *alliesthesia*, i.e. the changing subjective evaluation of the same reward over time. In functional terms, *alliesthesia* can be seen as tracking the utility of a given reward depending on the changing need states of the animal.

These two aspects of motivation – 'wanting' and 'liking' – are subserved by different brain

circuits. Evidence suggests that the motivation phase is mediated by the mesolimbic dopaminergic system, while the consummation phase is subserved by circuitry integrating ‘liking’ hotspots involve the orbitofrontal cortex for subjectively felt hedonic experience (Bozarth, 1994; Schultheiss & Wirth, 2008; Smith et al., 2009). Along with the amygdala in the temporal lobe that functions to form associations between affectively neutral stimuli that predict affectively charged events or stimuli, these systems constitute the core of the brain’s *incentive motivation network* (Berridge, 1996)¹. Figure 1 shows the location of the structures in this circuit in the human brain. For interested readers, a detailed look at the components of this network is presented in appendix. In their review of the field, Schultheiss & Wirth (2008) summarize the basic operation of this network as follows: “motivational processes rely on these three structures to act in concert so that cues that

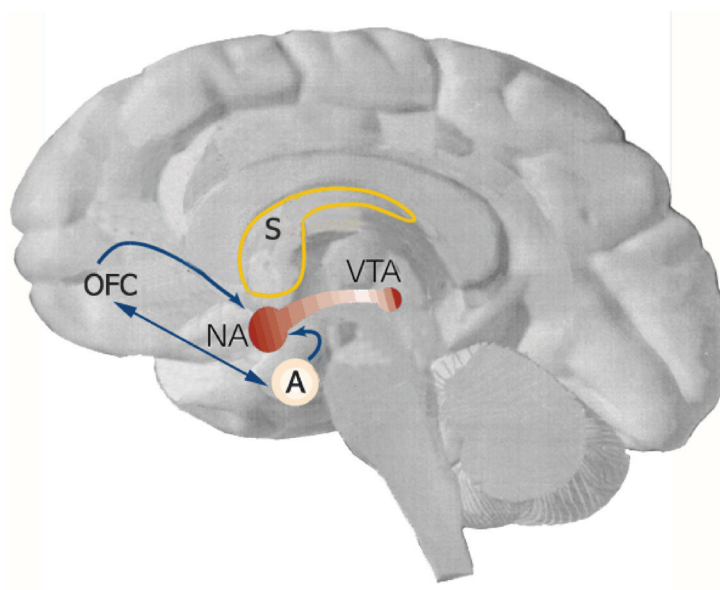
predict (amygdala) stimuli that have been experienced as pleasant (orbitofrontal cortex) elicit behavioral invigoration (mesolimbic dopamine system) directed at reward attainment” (p. 28).

CATEGORIZATION OF MOTIVATION

Implicit vs. Explicit Motivation in Humans

Building on previous work by McClelland and colleagues (1980; 1989; Weinberger & McClelland, 1990) within a biopsychological framework, Schultheiss (2001, 2008), has presented an account of *implicit* and *explicit* human motives that draws on the widely applied distinction between implicit and explicit modes of cognition and affect (Gazzaniga, 1985; LeDoux, 2002; Nisbett & Wilson, 1977; Squire & Zola, 1996). On this account,

Figure 1. Sagittal cut of the human brain at the midline, with approximate locations of key structures of the incentive-motivation circuit of the IMS. (Dopamine: DA, ventral tegmental area: VTA, nucleus accumbens: NA, amygdala: A, orbitofrontal cortex: OFC, S: striatum) The mesolimbic dopamine system originates in the ventral tegmental area of the midbrain, and projects to the nucleus accumbens. The amygdala and orbitofrontal cortex send projections to the nucleus accumbens. The OFC is densely reciprocally connected to the amygdala



implicit motives respond to *nonverbal cues and incentives* and have an impact on behavior and processes that are not controlled by, or accessible to, the individual's verbally represented goals or self-concept. Implicit motives are revealed using *non-declarative* measures that include physiological autonomic responses (e.g., changes in blood pressure, hormone release, muscle tone), and acquisition of new stimulus-stimulus associations and goal-directed behaviors through Pavlovian and instrumental learning of the type reviewed above. Explicit motives, by contrast, are more recently evolved and respond to *verbal symbolic cues* and influence measures that tap into a person's verbally represented sense of self and the attitudes, judgments, decisions, and goals that are associated with it. Declarative measures for this include valence judgments, decision making behavior, assessments of self-regulatory control, and reports of personal goals. The biopsychological basis of this system will be reviewed below.

In humans there are measurable trait differences in implicit motivational needs. Individuals high in a need for *power* (closely related to 'dominance' needs of other mammals and sharing much of the same brain circuitry) obtain pleasure from being dominant over or having an impact on others physically, emotionally or socially and are averse to social defeat or submission. Individuals high in the need for *affiliation* (another mammal-wide motivational need with shared brain circuitry) value affectionate or intimate relationships with others and experience rejection or self-directed hostility as alarming and unpleasant (McClelland, 1987; Schultheiss, 2008; Winter, 1996).

Not surprisingly, implicit motives influence a lot of interpersonal behavior (review, McClelland, 1987). For example, there is evidence that implicit motives for affiliation or power/dominance influence non-verbal interactions in a way that emerges dynamically from the interaction of the affective signaling of these motives through facial expressions (Hess, Blairy & Kleck, 2000; Stanton, Hall, & Schultheiss, *in press*).

Brain structures mediating implicit motivations in all mammals include as a functional core the incentive-motivation system reviewed above. In addition, there are motivation-specific endocrine, peptide and neuromodulator systems, such as those differentially controlling the release of testosterone, epinephrine & norepinephrine in those high in dominance / power motivation, or those controlling the release of oxytocin in those high in affiliation motivation needs (review, Schultheiss & Wirth, 2008). These implicit motive systems influence (i) what types of incentives are experienced as rewarding or aversive, (ii) what and in what way incentives are energizing or invigorating in motivated action and physiological response and (iii) cognitively, what incentives and cues to incentives are oriented to and selectively attended to, with cascading effects for memory and learning (McClelland, 1987; Schultheiss, et al. *in press*).

Unconscious vs. Conscious Motivation

A key finding that emerges in the human implicit motive literature is that implicit motives operate to a large extent unconsciously – an assumption that has guided the field from the 1950s onwards. Rolls (1999) suggests that most cognitive processing serves the purposes of non-conscious implicit affective-motivational processes rooted in programs for genetic survival; conscious, goal directed, explicit motivation is the exception rather than the rule, serving largely to override implicit processes.

In this context, 'unconscious motivation' means that people do not have introspective access to the incentives that are particularly rewarding for them and that motivate their behavior in a way that they do to the goals that underlie their explicit motivations (Schultheiss & Brunstein, 2001). Nor do they have introspective access to, or control over, the means adopted to attain the incentives. Even for as basic a motivational system as feeding, people have little accurate understanding or

awareness of what drives their appetites, or what makes them start or stop eating (Berridge, 1996). Self-reports of motivations contradict behavioral data and externally validated measures of individual differences in implicit motives (e.g. the Thematic Apperception Test (TAT), or the Picture Story Exercise (PSE)), do not correlate with scores from self report measures designed to measure the same motivational needs. It is striking that the variance shared between self-report and SE measures of implicit motives is *less than 1%* on average (Spangler, 1992).

Biopsychology of Implicit Motivation

Animal models of motivated behavior do not directly reveal the relationship between brain states and subjective affective or emotional states such as pleasure or pain that accompany aspects of motivation. The subjective impact of rewards as *felt* pleasure has been considered essential (Young, 1959) or irrelevant (Skinner, 1953) to their effect on behavior. Many contemporary biopsychologists accept the notion of subjective hedonic experience, at least at a *functional* level of description, just as cognitive representations and processes are conceived by cognitive scientists at a functional level of description that is distinct from what occurs in the neurocircuitry of the brain (Smith & Kosslyn, 2006). This position has been implicit in my review of the field.

From a functional perspective it is clear that affect or emotion in biopsychological theory is a valid psychological construct. In the absence of any experience of affective reaction to an outcome in a particular motivational state, it can be argued that animals have no basis on which to assign an incentive or disincentive value (Balleine & Dickinson, 1998), and that motivated behavior is initiated through associations with the pleasure induced by a reward or the pain (physical or psychological) induced by a punishment (Schultheiss et al., *in press*). Recent accounts consider physiological and nonverbal expressions in the face,

voice or movement as independent indicators of affect. All higher mammals show ‘liking’ affective responses to sweet, tasty food (lip licking) and ‘disliking’ responses to unpalatable food (nose wrinkle, tongue protrusion) (Berridge, 2004), but it remains controversial whether these behavioral indicators imply that the emotions are consciously experienced in a way that resembles human felt emotion.

In the human case, while individuals are typically not aware of the implicit motives that control their behavior, the extent to which the motives are or are not satisfied does impact conscious experience of wellbeing, satisfaction or pleasure. For example, women high in intimacy motivation report lower levels of gratification when living alone than women low in intimacy motivation (McAdams & Bryant, 1987). In general, individuals experience more emotional well-being to the extent that their personal goals and life situation gives them opportunities to satisfy their implicit needs (review, Schultheiss et al., *in press*). But this response is not an instantiation of the ‘liking’ that accompanies the consummation of an incentive. There are methodological difficulties in measuring momentary conscious affective responses in situations where implicit motives are frustrated or satisfied, but EMG measures of facial expressions have been used to demonstrate the hedonic ‘liking’ or ‘disliking’ in human implicit motives. Individuals high in the power motive exhibit more pronounced negative affective responses in the form of frown muscle activity when confronted with a dominant person than people low in power motivation (Fodor, Wick, & Hartsen, 2006). And individuals with a strong affiliation motive react with more frequent smiles to positive social interactions than do people low in affiliation motivation (McAdams, Jackson & Kirshnit, 1984). Various studies have shown that emotional experience is affected by intentionally adopting different facial emotional expressions (Adelmann & Zajonc, 1989; Matsumoto, 1987) and according to the facial-feedback hypothesis, facial muscle activity

is essential for the occurrence of emotional experience (Buck, 1980). It is parsimonious to assume that facial expressions accompany consciously felt emotional responses in implicit motivational contexts too. These emotions may also be detected by physiological (autonomic) responses such as blood pressure and electrodermal activity – both gauges of overall emotional arousal (Stern, Ray, & Quigley, 2001).

But critically these emotional experiences of pleasure or pain are not self-consciously labeled, declaratively encoded, and explicitly related to the actions resulting in them. This kind of emotional response I will propose is *phenomenally* conscious in the sense of subjectively experienced or ‘felt’, but not *reflectively* conscious and accessible to verbal report, reasoning and executive processes. This distinction parallels the philosopher Ned Block’s influential distinction between *phenomenal consciousness* and *access consciousness* (Block, 1997). Phenomenal consciousness (P-consciousness) is experience, and the phenomenally conscious aspect of a state is what it is like to *be* in that state. Access consciousness (A-consciousness), by contrast, is availability for use in reasoning and rational guidance of speech and action (Block, 1995).

While orbitofrontal / limbic cortex mediated hedonic responses (‘liking’) may be subjectively experienced in this phenomenal sense, subcortical, mesolimbic DA system affective activation (‘wanting’) seems not to require conscious experience of any sort. Evidence for this is suggested by results from a study by Winkielman, Berridge & Willbarger (2005) in a widely cited and theoretically provocative paper on ‘unconscious affect’. The implicit motive they looked at was thirst. In the first experiment, thirsty and non-thirsty participants were informed they were doing a gender discrimination task, in which a male or female face (with a neutral emotional expression) would appear on the monitor and the participant had to press a key as soon as they had identified the gender. But this task was a foil. Unknown to

the participants, happy, angry or neutral face *subliminal* primes - of which they had no conscious awareness - were presented for a brief 16 msec just before being replaced by the neutral male or female faces. After 8 trials participants were offered a sweet beverage and were asked to rate their mood and arousal level. Thirsty participants poured more than twice the amount of the beverage after happy subliminal primes than angry primes, and after pouring, they drank 171% more of the beverage after happy primes than after angry primes. A follow up experiment showed that subliminal primes also strongly affected participants’ willingness to pay for a drink and their ratings of how much they wanted to drink more. Despite the large impact of the happy vs. angry affective primes on thirsty participants’ drinking behaviour, there was no impact of these primes on participants’ ‘deliciousness’ or ‘sweetness’ ratings of the drink after tasting it. Moreover, there were no observed differences between happy vs. angry prime groups in mood or arousal ratings before and after priming: subjective experience did not change, despite marked behavioural-motivational changes.

The results of this study suggest that the subliminal primes did not affect the drink’s *hedonic value* for thirsty participants – i.e. how much it was consciously ‘liked’. If they did, the happy face primes would have caused higher ratings of ‘deliciousness’ than angry faces, but there was no such difference. The observed differences in ‘willingness to pay’ and ‘wanting more beverage’ are more obviously indices of the ‘wanting’ aspect of motivation than the ‘liking’ aspect. Thus we can conjecture that there was no OFC activation difference due to the subliminal primes; rather, the primes affected how much participants were invigorated in their motivation to consume the reward (how behaviourally ‘turned on’ they were) by the affective prime - a function mediated by the mesolimbic DA system. And this affective response was entirely *unconscious*.

In summary, the evidence suggests that emotion has a functional role in both the motivational ‘wanting’ phase, and the consummation ‘liking’ phase for implicit motives, and that these roles can be dissociated (Berridge, 1996). On the account proposed here, conscious emotion is confined to the cortically mediated ‘liking’ phase of the incentive-motivation system. It is not self-reflexive, introspectable, and accessible to control processes. This kind of emotion has a function in determining incentive values, and guiding behavior through hedonic anticipation. Unconscious emotion – as a low level ‘valence’ or ‘affective’ cue – exerts its effects by activating the mesolimbic DA system in the ‘wanting’ phase of the implicit motivation.

Biopsychology of Explicit Motivation

Unlike implicit motivation, explicit motivation – voluntary, goal directed action with self-attributed motivations – is conscious and accessible to introspection and executive control. If you are motivated to learn how to make wine or learn Chinese you know what goal is motivating you, what the satisfaction conditions are, what instrumental actions you may adopt to attain the goal, and whether or not you are progressing with respect to that goal. You can spontaneously and voluntarily pursue such goals, and know that you are doing so. Explicit motives respond to *verbal symbolic cues* and have an effect on measures that tap into a person’s verbally represented sense of self and the attitudes, judgments, decisions, and goals that are associated with it. The lateral prefrontal cortex (LPFC) plays a central functional role in explicit motivation. The human LPFC supports a number of ‘higher level’ brain functions, including speech (Broca’s area), working memory, prepotent response inhibition, memory encoding and retrieval and motor planning (Tanji & Hoshi, 2008). The LPFC subserves self-regulation through the formulation of explicit, verbally represented, goals and plans for their enactment. The human LPFC is a more recently evolved and differentiated part of

the prefrontal cortex – that is itself more elaborated in primates relative to other mammals. The LPFC guides behaviour through the formulation of verbally represented goals and plans for their enactment. Individuals with LPFC lesions find it difficult to initiate and execute voluntary behaviour, particularly if it is complex (Luria, 1973). In the influential ‘goal maintenance model’ of prefrontal working memory function (Braver, Cohen & Barch, 2002; Miller & Cohen, 2001), this brain region is proposed to serve both a representational / storage and control function: it maintains representations in the form of rules or goals, and has a ‘top-down’ influence that coordinates perception, attention and action to attain those goals. Feedback connections *bias* the associations activated in response to perceptual input, in a way that can override default automatic, implicit responses that may be in competition for control of thought and behaviour. This model is consistent with a wide range of both human and primate data (Miller & Cohen, 2001), and has been implemented in computational models that simulate human and primate performance in working memory tasks (O’Reilly et al., 2002).

The human LPFC represents and enacts verbally programmed goals that can regulate or override implicit motivations. Nonverbal stimuli with strong incentive properties, such as facial expressions, elicit activation of the amygdala in humans (Adolphs & Tranel, 2000), and activate the mesolimbic DA system (Critchley et al., 2000). However, as soon as the participant is able to verbally label the expression, the LPFC becomes activated and amygdala activation decreases (Ochsner et al., 2002). Engagement of the LPFC’s verbal-symbolic functions in dealing with an emotionally arousing stimulus appears to dampen down activity in the implicit motivational responses driven by the amygdala and the mesolimbic DA system (Lieberman, 2003), shielding explicit goals from interference by incentive driven implicit motivational impulses. This ‘damping down’ of affective-motivational

reactivity – particularly in the context of competitive dominance motives – is consistent with an evolutionary account developed by evolutionary anthropologist Brian Hare. On this account selective pressures in the course of human evolution have specifically targeted the amygdala and associated limbic motivational systems, exerting a ‘self-domesticating’ effect that has enabled the evolution of uniquely human cognitive flexibility and control (review, Hare, 2007).

DUAL PROCESS THEORIES

In the remainder of this chapter I will develop the thesis that the implicit versus explicit motivation distinction provides the basis of a comprehensive dual-process account of human behavior that integrates motivation, emotion and cognition. Dual processing accounts have been developed to account for behavioral dissociation data in learning (e.g. Reber, 1993), attention (Schneider & Shiffrin, 1977), reasoning (Evans, 2003), decision making (Kahneman & Frederick, 2002) and social cognition (Chaiken & Trope, 1999). In these accounts a cognitive mode that is rapid, automatic, parallel and effortless is contrasted with one that is slow, sequential and controlled / voluntary. Both modes are understood as independent, and often conflicting, sources of control for behavioral response. Dual processes have been labeled in a number of ways: implicit-explicit (Evans & Over, 1996; Reber, 1993), experiential-rational (Epstein, 1994), emergence-control (Carver & Scheier, 1998), heuristic-systematic (Chen & Chaiken, 1999), and associative-rule-based (Slovman, 1996; Smith & Decoster, 2000). According to Smith & Decoster’s dual process model, the fast versus slow distinction is reversed in the *learning* process: an ‘associative processing mode’ slowly learns general Pavlovian and operant regularities, while the ‘rule based processing mode’ engages in intentional retrieval of explicit / declarative, symbolically represented information to guide

processing and can quickly form representations as episodic or semantic representations of unique or novel events (e.g. Tulving, 2002). On this account, the rule based mode uses culturally transmitted knowledge as its ‘program’ (Smolensky, 1988), and since only one rule can guide behavior at a time, it is more effortful and time-consuming than associative processing. According to Stanovich’s (1999) conceptualization, what he calls ‘System 1 thinking’ is heavily contextualized and not subject to logical-normative constraint, while ‘System 2 thinking’ is abstract, decontextualized and logically constrained. The automatic system is often described as evolutionarily old, shared with other mammals and independent of individual differences in intelligence, whereas the controlled system is evolutionarily recent, uniquely human and related to heritable differences in fluid intelligence and working memory capacity (review, Evans, 2006).

While there is broad agreement in the dual process literature of the existence of a rule based executive processing system subserved by the lateral prefrontal cortex and engaging a limited capacity working memory system, there is controversy surrounding labeling all forms of unconscious, automatic and rapid cognitive processes as belonging to the same alternative system (review, Evans, 2006). There are some processes (appraisals or skilled actions) that start off explicit under conscious control and later become automated – for example, in learning to drive a car. These processes have been investigated extensively in the *automaticity* literature on attention and skill acquisition (Bargh & Chartrand, 1999; Monsell & Driver, 2000; Schneider & Shiffrin, 1977). Explicit goals can also be primed unconsciously and automatically (review, Shah, 2005). But as reviewed above, other automatic and unconscious processes associated with implicit motives relating to, for example, affiliation or dominance interactions can continue to exert influence on behavior without engaging the rule-based, executive control system.

Dual Process Account of Motivational Systems

One way of circumventing these theoretical tensions, as well as providing an integrated motivation-emotion-cognition framework, is to reframe traditional dual process accounts with their information processing focus in terms of the duality of implicit and explicit *motivation*. On this reading, implicit vs explicit motivation systems may provide a more fruitful explanatory framework for taxonomizing the dual nature of cognition, rather than properties of the information processing such as automaticity and speed. The rationale for this taxonomy is that it is *behavior* that is targeted by selective forces, not the underlying information processing mechanisms, and for a complex behavior to be selected it must be *motivated*. The claim is that the explicit motivational system evolved in the context of relatively recent culturally-based, and normatively regulated, behaviors. This taxonomy also integrates motivation, emotion and cognition in a way that is not done in traditional dual process accounts that focus on cognition.

On this dual process account the ‘Implicit Motivation System’ (IMS) designates the set of implicit motives and their mediating information processing and affective neural-endocrinal mechanisms. This system incorporates a diverse collection of specialized, biologically evolved, motivational-emotional systems, subserving a variety of recurrent adaptive problems in our ancestral environment, with diverse phylogenetic origins. Brain structures mediating implicit motivations include as a functional core the incentive-motivation system mentioned in the first part of this chapter. In addition to this there are motivation-specific endocrine, peptide and neuromodulator systems, such as those mediating oxytocin release in affiliation interactions.

Some human implicit motives relating to hunger, affiliation, dominance and sexual attraction are elaborations of motives found universally in

all higher mammals. These have been studied extensively, both in mammals and humans (review, Schultheis & Wirth, 2008). Other implicit motives such as the ‘achievement’ motive (Thrash & Elliot, 2002) may be uniquely human, having evolved after the divergence with our common ancestor with modern day chimpanzees some 6–7 million years ago. Other contenders for uniquely human implicit motives which may be both universal and function implicitly without direct introspective access include conformity / group identification, ethnocentrism (review MacDonald, 2008), cooperation (Tomasello, 2007), or the need for coherence and meaning (Proulx & Heine, 2009). Importantly, many or all of these motives relate to the uniquely group-based nature of *Homo sapiens* socio-ecology.

IMS motives detect goal relevant cues, extract goal relevant instrumentally and classically conditioned contingencies in relevant environments, and produce biologically adaptive behaviors either through a combination of evolutionary hard-wiring and implicit learning. The cognition underlying this system is not introspectively accessible, nor under executive control. We may *infer* the operation of implicit motives, just as we may rationalize them, by observing our behavior and formulating plausible hypotheses. But the goals and motives we attribute are not encoded in a way that is accessible and controllable in the way that verbally mediated explicit motives are.

By contrast, the ‘Explicit Motivational System’ (what I shall call the ‘Normative Motivational System’ (NMS) for reasons described below) regulates behaviour via explicit, verbally encoded, motives – linguistically programmed rules or instructions, personal goals or standards, or culturally specified goals or norms. This uniquely human self-regulation system engages executive control processes, and depends on working memory and the capacity to reason through ‘if-then’ causal contingencies and counterfactuals. The goals and motivated behaviours in this system are introspectively accessible, self-attributed and subject to

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reflexive control. While contingencies and skills can be learned implicitly in the development of expertise in this mode, what distinguishes this kind of ‘implicit’ non-conscious and automatic cognition from implicitly-motivated cognition is that the latter is *gated* by executive, verbally explicit, processes involving self-attributed motivations, and is open to conscious ‘reprogramming’ in a self-reflexive, verbally reportable way.

On this account, the question of interest is not whether a cognitive process is conscious and slow or unconscious and fast, but how *normatively regulated, introspectively accessible* (open to conscious, verbal report) and subject to *intentional control and re-programming* it is.

Normativity is a critical concept on this account. Adopting a framework developed by the psychologist Charles Kalish (2006) who draws extensively from the philosopher John Searle’s analysis of normativity (2001), I define the normativity that regulates behaviour as any culturally based norm or standard that regulates action via verbally encoded representations that denote or

imply goodness, desirability, correctness or what ought to be (Kalish, 2006). The existence of a norm implies a *reason* for action (Searle, 2001), and embraces, on this account, not only moral norms (e.g. obligations or duties), and institutional norms (e.g. best practices for social roles, or standards of excellence for institutional performances), but also epistemic norms (e.g. the truth of an explanatory account), or any application of a rule, instruction or procedure involving correctness or appropriateness criteria (e.g. in learning how to drive). The extension of the term ‘normativity’ is thus very wide – and consequently controversial.

In broad terms the IMS-NMS distinction lies in how relatively ‘biological’ vs ‘cultural’ a motivated behaviour is – whether governed by innate and adaptive functions such as dominance or affiliation fitness promoting strategies, or by culturally mediated goals, norms and standards, such as ‘performing competently and ethically at work’. Defining characteristics of the IMS and NMS are listed in Figure 2.

Figure 2. The Implicit Motivation System, IMS and Normative (Explicit) Motivation System, NMS: A dual process account

Implicit Motivation System (IMS)	Normative Motivation System (NMS)
Implicit motive driven	Explicit motive driven
Non-verbally encoded	Verbally encoded
Inaccessible to introspection & verbal report	Accessible to introspection & verbal report
Non executive processing	Executive processing
Emotion as reinforcer in incentive-motivational system	Emotion as information in executive self regulation
Incentive value regulated	Normatively regulated
Biological adaptation: Modular & domain specific	Cultural adaptation: General purpose, flexible & domain general

The IMS and NMS may be mutually supporting, as when someone with strong affiliation motives works in a cooperative, caring profession. But often they may dissociate or be in conflict, such as when someone with a high affiliation needs adopts an explicit goal to lead an aggressive and competitive campaign in commerce. Individuals experience more overall emotional well-being to the extent that their explicit goals and life situation gives them opportunities to satisfy their implicit motives (review, Schultheiss et al, *in press*).

THEORIES ON INFORMATIONAL ASPECTS OF EMOTION

In developing the proposed dual process account I will now interpret three influential theoretical ‘emotion-as-information’ accounts of the function of emotion in IMS-NMS terms: 1. Damasio’s Somatic Marker Hypothesis for decision making, 2. Baumeister’s Feedback Theory of emotion, 3. Carver and Scheier’s Self-Regulation Theory of behavior. I will argue that two criteria for differentiating the NMS from the IMS are important in all of these accounts: 1. The principle of *emotion as information*. 2. The principle of *normative self-regulation*.

In ‘emotion-as-information’ theories the conscious ‘felt’ character of emotional experience is used as information to guide decision making and strategic, goal directed actions. In some inferential accounts, a person forms a judgment about something (an action, experience, object, or attribute) by asking ‘How do I feel about it?’ and uses the feeling as a short-cut to a judgment that guides subsequent behavior. In other inferential accounts, the role of emotion in decision making occurs because individuals perform actions to manage (maintain, change, remove) their emotional experience (for reviews, see Winkielman et al., 2007; Andrade, 2005; Erber & Markunas, 2006). In neither type of account does emotion act as a direct impulse

for behavior; rather, through feedback, emotion supplies information for cognitive processes that control behavior.

Damasio’s Somatic Marker Hypothesis

Antonio Damasio and colleagues have proposed an influential theory for the functional role of emotion in decision making they have called the ‘Somatic Marker Hypothesis’ (Damasio, 1994; Damasio, 1996; Naqvi, Shiv & Bechara, 2006). On this account the amygdala triggers emotional and autonomic bodily states in response to rewards and punishments caused by deliberate, goal directed actions. These emotional states become linked to representations of the actions that brought them about in the ventromedial prefrontal cortex (VMPFC)—a part of the orbitofrontal cortex. During decision making the DLPFC makes representations of different action possibilities accessible in working memory. Via connections with the VMPFC, these action representations reenact the emotional/bodily states that have been associated with them in past experience. In the process of forming ‘somatic markers’ used for subsequent decision making, the bodily states associated with different actions are either mapped to the insula cortex subserving conscious desires or aversions for deciding for or against a particular action, or to the mesolimbic DA system where affective biases on decision making are unconscious. In support of this model, humans with VMPFC damage are impaired on a number of tests of emotional reactivity to stimuli, and are unable to use emotions to aid in decision making in ‘personal, financial and moral arenas’ (Damasio, 1994).

Interpreting the Somatic Marker Hypothesis in NMS Terms

According to the Somatic Marker Hypothesis, emotion plays a critical informational role in guiding decision making, contrary to the traditional

idea that emotion impairs decision making and is in conflict with rationality. Somatic markers may guide decision making unconsciously and automatically, but this automaticity is apparently conditional on executive ‘emotion-as-information’ processing driven by explicit motives – such as strategically attempting to make money in the Iowa gambling task, or in real-world contexts to be financially solvent, hold down a job, maintain relationships and a reputation (Bechara et al., 1994).

Although not discussed explicitly, Damasio and colleagues stress the significance of the normative. They observe that damage to the VMPFC impacts long-range outcomes in ‘interpersonal, financial and moral’ spheres – all areas strongly regulated by social norms and normative standards of ‘appropriate’ or ‘correct’ behavior. This emphasis on cultural life and the role of emotion in navigating interpersonal and normative complexities is also apparent in Baumeister and colleagues’ Feedback Theory which we will now review in some detail.

Baumeister and Colleagues’ Feedback Theory

Damasio’s Somatic Marker Theory finds a close parallel in Baumeister and colleagues’ Feedback Theory of emotion. His focus is on subjectively felt emotion – i.e. ‘full blown, conscious emotional experience’ (Baumeister et al., 2007). According to this account subjectively felt emotions function to stimulate reflective cognitive processing after some event or experience to aid ‘lesson learning’ and the ‘formation of associations between affect and various emotional responses’. While Baumeister and colleagues recognize the existence of unconscious, automatic affective processes that may directly impel behavior, full-blown, felt emotion, on their account, did not evolve to directly impel behavior. A review of the literature indicates that the evidence for a ‘direct causation’ function of emotional experience is weak (Schwarz & Clore, 1996). Emotion typically functions to

have an *indirect* impact on behavior by stimulating counterfactual reflection and evaluation, and enabling strategic anticipation of emotion. After a decision is enacted, emotional responses provide feedback for appraisal and cognition about the action that resulted in the emotion – or counterfactual actions and their emotional consequences (e.g. “if only I’d not done *this*, but done *that*, then I wouldn’t have ended up feeling so guilty”). This reflective process promotes learning by helping to ‘reprogram’ weightings for decision making and what Baumeister and colleagues call ‘if-then contingency rules’ for behavior. Positive emotions reinforce some rules, and negative emotions promote counterfactual thinking and rule reprogramming. Representations of if-then actions are left with ‘traces’ or ‘affective residues’ (analogous to Damasio’s ‘somatic markers’) of the positive or negative emotions that the actions caused. These function automatically and to a large extent unconsciously to guide subsequent decision making and planned action. This learning process, Baumeister points out, is similar to learning by reinforcement. But there is a crucial difference: the representational medium is symbolic and linguistic, allowing counterfactual thinking and means-ends reasoning.

According to the Feedback Theory, behavior is often determined by the flexible, strategic pursuit or avoidance of *anticipated* positive or negative emotional outcomes in an emotional self-regulatory way. For this reason anticipated emotions are typically more important than actual emotions in the ‘on-line’ regulation of behavior. As Baumeister and his colleagues formulate it: ‘behavior pursues emotion’ (Baumeister et al., 2007, p. 172). Pursuing anticipated positive emotions and avoiding negative ones is a useful heuristic for effective decision making and explicit goal pursuit. This kind of emotional self-regulation is strategic and mediated by executive processes, not automatic and impulsive; it is related to uniquely human autobiographical episodic memory systems and a domain general capacity for ‘mental

time travel' (Suddendorf & Corballis, 2007). It is a function of the NMS, on this dual-process account, not the IMS.

Evidence for the Feedback Theory of emotion is found in 'mood freeze' studies demonstrating that what appears to be direct effect of an emotion on behavior (such as sadness or anger) is, in fact, cognitively mediated and based on beliefs about what actions will result in mood repair. Manucia, Baumann & Cialdini (1984), for example, replicated the usual finding that people in sad moods help others more than those in neutral moods (Cunningham, Steinberg, & Grev, 1980). But they found that when participants were led to believe that a pill would immobilize their sad mood, and they did not expect to feel better by helping, they no longer helped. Subsequent studies have used the mood freeze procedure to examine a number of other emotion-behavior patterns and found a similar result (review, Baumeister et al., 2008).

The Feedback Theory predicts that emotions elicit counterfactual thinking and improve decision making. In her review of the literature, Roese (1997) concluded that negative emotional experience is the "chief determinant of the... activation of counterfactual processing" (p. 135). There is evidence for the impact of counterfactual thinking on 'learning lessons' (i.e. 'reprogramming' actions) to avoid repeating a misfortune in the future (Landman et al, 1995; Markman et al, 1993). Decision makers evaluate their outcomes relative to what *might* have been if they had chosen differently (Roese & Olson, 1995). In their review paper, Janis and Mann (1977) proposed that anticipated regret changes the decision making process towards greater vigilance and information gathering – leading to better decisions.

If emotion provides feedback to facilitate rule reprogramming then it should be most common when learning is taking place to facilitate memory. This prediction is supported by the evidence. Wood, Quinn & Kashy (2002) found that people reported more intense emotions when engaged in novel behaviors than when they performed

habitual ones. The heightened emotional intensity with novel behaviors is associated with a significant increase in thinking about what one is doing. And emotionally charged events are better remembered than neutral events (review, McGough, 2000). Memory is facilitated by both positive (Christianson, 1986) and negative (Christianson & Loftus, 1987) emotions.

Interpreting Baumeister's Feedback Theory in NMS Terms

Baumeister and colleagues distinguish between (i) simple positively and negatively valenced 'automatic affect' that is unreflective, fast-acting, and may be entirely unconscious, and (2) more complex 'full blown' conscious emotion that is slow to arise and is heavily saturated with cognitions and evaluations. They argue that the former may simply activate basic approach and avoidance systems, while the latter promotes reflection, learning and strategic self-regulation in the ways we have outlined above. Their Feedback Theory is an account of the latter, not the former. Since emotion on this account is an information source for working memory dependent *cognitive analysis* – with attributions, counterfactual thinking, and subsequent anticipation of behavioral options through mental stimulation, it can be interpreted in terms of the explicit NMS. According to Baumeister and colleagues, while emotional states are not in themselves explicit goals, they act in the service of attaining explicit goals and their functional role depends on "cognitive appraisal to become translated into specific programs for what, exactly, should be done" (2007, p. 170).

A recurring emotion given considerable weight in the Feedback Theory is *guilt* – a uniquely human 'self conscious' emotion, tied to the idea of personal responsibility or accountability, and playing a social-regulatory role in the context of social norms and interpersonal obligations. I believe this emotion is prototypical in the Feedback Theory. The relationship between guilt and

social regulation by normative standards is made explicit: “Guilt prompted the person to reflect on what he or she had done, to reevaluate the decision process in light of social norms and obligations, and possibly to extract lessons and conclusions about how a different course of action might have yielded better emotional outcomes” (Baumeister et al., 2008, p. 173). According to a sampling study by Baumeister, Reis and Delespaul (1995), people reported minor degrees (‘twinges’) of guilt on average about two hours per day, indicative of its critical regulatory function in human social-cultural life. People learn what will make them feel guilty and then change their behavior to avoid it; in this way behavior is brought in line with socially valued behaviors (Baumeister, Stillwell, & Heatherton, 1994).

Other emotions discussed in Baumeister and colleagues’ account such as anger are explained in the same social-normative way. While the emotion of *pride* is not explored in this account, it is similar to Baumeister’s prototype emotion guilt. It constitutes another uniquely human emotion that, like guilt, is understood relatively late in development. It is closely implicated in self-regulation by normative standards, and is associated with the notion of personal responsibility. Pride, as a pro-social, achievement-oriented emotion, is correlated with culturally advantageous traits such as agreeableness, conscientiousness and self-esteem (Tracy & Robins, 2007).

Baumeister and colleagues’ 2008 review paper concludes with the statement that conscious emotion evolved as “an advanced cognitive apparatus for figuring out how to negotiate...through the unique, remarkable opportunities and pitfalls of... intricate social and cultural systems” (p. 198). This framing of the topic is similar to Damasio and colleagues’ account, and finds an obvious interpretation in terms of the proposed NMS.

Carver and Scheier’s Self-Regulation Theory

In Carver and Scheier’s (1990; 1998) Self-Regulation Theory of behavior as a goal-directed feedback control process, both the *emotion as information* and the *normative self-regulation* principles are critical: “Positive and negative affects are posited to convey information about whether the behavior being engaged in is going *well* or *poorly*” (Carver, 2001, p. 345). ‘Well’ or ‘poorly’ is defined relative to an internally represented ‘reference value’ – a standard, norm or goal. And as the authors observe, “Much of human behavior is a matter of isolating a point of reference, and then trying to conform to it” (1998, p. 47).

On this account, consciously experienced valenced emotion is information for the effectiveness of ongoing, goal directed voluntary action. Essentially, emotions provide feedback as to how fast one is moving towards a valued goal: positive emotions signal progress that is considered appropriate or better than appropriate, while negative emotions signal progress that is slower than expected or desired. In this way, as in Baumeister’s Feedback Theory of emotion, pursuing emotional feedback can be a good heuristic for effective goal pursuit. Supporting evidence for this model is reviewed in Carver & Scheier, 1998, chapters 8 and 9, in experiments in which feedback of progress towards a goal is manipulated over an extended time while emotions are measured.

Goal pursuit on this account is conceived as coherent and hierarchical, with ‘program level’ goals (executed actions, such as ‘eat low fat foods’) at the lower levels of the hierarchy, and more abstract and motivating goals relating to an idealized, hoped-for, or ‘ought’ based, *sense of self* (such as ‘be fit and healthy’) at the highest level of the hierarchy. Thus on the Self-Regulation Theory, the principle of normative regulation is closely linked to the construct of the *self*. Self-serving goals can be both ‘private’ (personal values and standards, and private goals) and ‘public’ (com-

munal, collective or interdependent goals, such as being socially accepted) (Carver & Scheier, 1998; Wylie, 1968).

The Self-Regulation Theory of goal directed behavior, like the Somatic Marker Theory of decision making and the Feedback Theory of emotion, finds a clear mapping onto the proposed NMS in the motivational dual process account. It presupposes explicit motivational processes, and hinges on the *emotion as information* and *normative self-regulation* principles underpinning the hypothesized NMS.

The Biopsychological Basis of the NMS

Recent evolutionary accounts of the basis of uniquely human cognition as depending on collective intentionality and normativity (Moll & Tomasello, 2007; Tomasello & Rakoczy, 2003) are consistent with the hypothesis that the DLPFC functions as a ‘point of entry’ for the social-cultural regulation of behaviour. Following DLPFC lesions there may be a relative sparing of the ability to respond motivationally to innate or learned nonverbal social cues such as facial expressions, emotional tone in speech, or gestures – important cues for *implicit* motivational processes. But normatively regulated explicit goal pursuit is severely impaired, with a loss of the “ability to coordinate ... behavior with that of others flexibly through the pursuit of verbally shared goals or to adapt ... behavior to changing demands and expectations of their sociocultural environment” (Schultheiss & Wirth, 2008).

Thus in addition to the known working memory / executive function of the DLPFC, it can be hypothesized to have a function that is inherently socio-cultural and normative. Conscious human emotion is highly sensitive to social-normative standards, and the ability to track normative standards is arguably uniquely human. It may depend on what Tomasello and his colleagues have called a capacity for ‘shared intentionality’ or ‘collec-

tive intentionality’ – the ability to understand and participate in cultural activities, with normatively regulating standards and practices (e.g. Tomasello & Carpenter, 2007; Tomasello & Rakoczy, 2003). It is this ability that Tomasello believes is at the core of what distinguishes human from non-human cognition. This notion of collective intentionality is understood on Tomasello’s account to underlie not just the adoption of conventions of a moral or institutional sort, but also the ability to use artefacts and to the linguistic symbols that are the basis of human communication.

A well known class of experimental task that reveals DLPFC activation is the interference task in which a participant makes a forced choice to stimulus while simultaneously trying not to be influenced by an irrelevant stimulus dimension. In the Stroop task, participants have to name the ink colour of a list of colour words such as ‘red’ or ‘blue’. When the colour of the ink and the colour word are different (‘incongruent’) performance is slower and less accurate than when the colour and word match (‘congruent’). This is because word reading is relatively more automatic than colour naming and the since the word is hard to ignore it activates the associated response. During incongruent trials, responses associated with the colour compete with those associated with the word, and DLPFC mediated attentional control is required to overcome the conflict, selectively maintaining representations of the task requirements and biasing downstream processing towards what is appropriate. On the IMS-NMS dual process account, this conflict resolution in favour of acting according to an explicit instruction reflects the functioning of the NMS system. Following a rule, and being concerned with ‘correctness’ in this goal, is a normative and explicit process.

In response to the question ‘how is the DLPFC control itself regulated’ van Veen & Carter (2002; 2006) and Bongers and Dijksterhuis (2008) have argued that the amount of conflict occurring plays a central role in how much executive attentional control is exerted or withdrawn, and the brain

substrate for conflict monitoring is the anterior cingulate cortex (ACC). When conflict is detected the PFC is alerted to exert control and resolve the conflict in a ‘conflict control loop’. On the Stroop task, neuroimaging studies have shown that the ACC is activated both during error trials of the Stroop task, and during correct, incongruent trials (Kerns et al., 2004; van Veen & Carter, 2002).

In support of the thesis that normativity plays a central role in this type of regulatory executive process, there is evidence that the conflict-control loop operates for a diverse range of ‘conflicts’, all of which involve some normative standard of what is ‘appropriate’ or ‘valid’ (review van Veen & Carter, 2007). Green and his colleagues provide evidence that during *moral dilemmas* a subcortical ‘emotional’ response competes with a utilitarian ‘rational’ response, the ACC detects the conflict and engages the lateral PFC to resolve the conflict in favour of the cognitive response (Green et al., 2004). A conflict-control loop has also been suggested to play a role in the phenomenon of *cognitive dissonance*. The ACC detects conflicts between attitudes and behaviour (the dissonance) of the self and activates the PFC to reduce the dissonance to maintain a consistent self-image. Fugelsang & Dunbar (2005) have also suggested that in the domain of causal reasoning, when new data about causal relations conflicts with a model that is currently believed, this engages attention via an ACC-prefrontal cortex conflict-control loop.

Two inferences can be drawn from this conflict-control loop data: (1) The controlled conformity to explicit, verbally formulated rules (Stroop task), as well as causal reasoning, moral judgment and cognitive dissonance, are all *uniquely human* cognitive processes. (2) A common principle in all these cases of ACC-prefrontal conflict-control activation is that of a regulating evaluation based on some *rule* or *normative standard* – either what is *correct* in terms of following instructions in the Stroop task, what is *justified* with moral dilemmas, or what is *accountable* for the self concept in terms of cognitive dissonance, or what is *valid*

or *justified* in terms of causal mental models. We can predict that the same system will be activated in other normative domains – for instance when performance (measured by speed or quality) on a task does not match up to some benchmark standard – as described in Carver & Scheier’s Self-regulation Theory. While this conception of normativity, embracing rule following and epistemic validity, is broad – it is in keeping with accounts developed by both philosophers and psychologists (e.g. Kalish, 2006; Searle, 2001).

By virtue of mechanisms similar to overlearning in the automaticity literature, explicit motives might in time operate unconsciously and automatically, with goals of explicit origin being activated and running to completion outside of awareness (review, Shah, 2005). But on this biopsychological account there is nonetheless a continuous ACC monitoring for ‘error’. Evaluations of failures, mistakes, inappropriate actions or factual inconsistencies will render goal related information highly accessible, prompting conscious awareness of the goal, what has gone wrong, and how the situation might be corrected (for a related idea, see Bongers & Dijksterhuis, 2008).

How might emotion function in such ‘conflict-control loops’? Normative failures result in negative emotions – concern, irritation, guilt, anxiety or anger – depending on the nature of the goal and how central it is to the sense of self, represented in the MPFC (Zhu et al., 2007). This could occur either during goal pursuit in a performance monitoring mode consistent with Carver and Scheier’s Self-regulation Theory, or ‘after the event’ in a reflective feedback mode consistent with Baumeister and colleagues’ Feedback Theory. Depending on the normative significance of the conflict between the action and the standard, these emotions may become more or less consciously salient, compelling and arousing, with the most intense negative emotions eliciting more sustained and elaborate goal-focused evaluation, problem solving and counterfactual thinking as described in detail by Baumeister and colleagues (2007). Emotions in

this system motivate behavior, either via feedback for ‘how *well* am I performing in pursuing this goal’ or via the anticipation and avoidance of negative emotions in the way described by Baumeister and colleagues (2007). Felt emotions may become associated with representations of actions via the VMDLC, as proposed by Damasio and colleagues in their Somatic Marker Theory of decision making (Damasio, 1996). Although it has not been investigated in connection to anterior cingulate or limbic cortex functioning, when goal directed action results in an unexpected degree of accomplishment or normative success, it is likely that a monitoring process may result in feelings of satisfaction, elation, or pride, reinforcing the voluntary actions that led to those emotions. Studies investigating whether the anterior cingulate activates when normatively regulated performance is going *better than expected* are needed here.

Evolutionary Origins of the IMS and NMS

The dual process IMS vs NMS account proposed in this chapter can also be understood in terms of the contrast between domain general intelligence and domain specific mechanisms, or ‘informationally encapsulated modules’ (Fodor, 1983). While domain general systems are designed to attain evolutionary goals in uncertain, novel and changing environments, informationally encapsulated modules are specialized to handle specific inputs and generate particular solutions to recurrent adaptive problems, using highly stable patterns of evolutionarily significant information (Chiappe & McDonald, 2005). Implicit motive neuro-endocrine systems can be understood as predominantly domain specific mechanisms, having evolved over millions of years of mammalian competition for resources, inter and intra-sexual competition, pair-bonding and affiliation needs (Geary & Huffman, 2002). By contrast, the domain general, language based NMS has a primarily *cultural* function – enabling rapid assimilation,

innovation and transmission of cultural knowledge and skill, and the adoption of cultural norms (Tomasello, 1999). This co-evolution of this explicit mode of motivated cognition and behavior in conjunction with symbolic language may underpin the powerful bootstrapping process underlying human technical and institutional progress that has been called ‘cumulative cultural evolution’ (Tomasello, 1999; Moll & Tomasello, 2007). Explicit motives are inherently language mediated according to the biopsychologists Schultheiss and Wirth (2008). Language is well designed to encode and communicate normative evaluations and standards. In accordance with Tomasello’s conception of language, linguistic symbols are themselves tool-like devices and normatively regulated (Tomasello, 1999). In factor analytic studies of the underlying structure of word meaning, an *evaluative* (good vs bad) dimension comes out as the first factor, accounting for most of the variance (Osgood, Suci, & Tanenbaum, 1957).

We can further speculate that this normative affective and motivational system has its uniquely human origins in what Tomasello and colleagues call ‘collective intentionality’ – the ability to participate in a collective culture with shared meanings and goals – and the social approval and disapproval regulating behavior in a cultural context. Moreover, it may have been an adaptive advantage for the rapid, cumulative cultural evolution of knowledge and skill (Tomasello, 1999) that normative standards with a public, communal origin could become internalised‘ for self-regulation – for example, from public shame to private guilt or from external pride to internalized perfectionism.

Unconscious and Conscious Emotion

I will conclude this chapter with a closer look at how unconscious and conscious affect and emotion may be taxonomized in the context of the

dual process IMS-NMS account that has been presented.

A distinction is often drawn in the emotion literature between (1) *affect*, that is an automatic, simple, rapid (sub second), and valenced (positive/negative; liked/disliked), and (2) ‘full blown’ emotion as conscious feeling, typically characterized by physiological changes such as bodily arousal, and differentiated into specific subjectively felt unitary states, which may nonetheless be experienced as complex, with a blend of emotions. Emotions in this highly processed sense are slower to arise and dissipate than affective responses, and are heavily saturated with cognitions, including attributions, inferences and especially evaluations. Dual process accounts of emotion based on this distinction have been proposed that parallel dual process theories of automatic vs controlled modes of cognition (review, Baumeister et al., 2007). On the motivational dual process account I have presented, affect and emotion in these senses are not mapped one-to-one onto the IMS and NMS respectively, as will now be explained.

A helpful way to taxonomize consciousness has been formulated by the philosopher Ned Block. He distinguishes between ‘phenomenal consciousness’ and ‘access consciousness’. Phenomenal consciousness (P-consciousness) is experience, and the phenomenally conscious aspect of a state is what it is like to *be* in that state. Access consciousness (A-consciousness), by contrast, is defined as ‘availability for use in reasoning and rationally guiding speech and action’ (Block, 1995).

On our account, emotion in the ‘full blown’ sense is always both P-conscious in that it is experienced with a rich phenomenology, *and* A-conscious in that it functions as information for metacognition, domain general reasoning and executive control. This type of fully elaborated emotion is confined to the NMS, and – on this account – its ultimate origin is in the evolution of collective intentionality and culture. But not all emotion is conscious in this joint P-conscious and A-conscious sense in the NMS. In as far as emo-

tion guides decision making via ‘somatic markers’ (Damasio) or ‘traces’ or ‘affective residues’ (Baumeister) the emotion is affect-like. In this case it may not be P-conscious but it does, nonetheless, play an important role in A-consciousness to the extent that it helps constrain decision making and reasoning.

For the IMS, emotion as affect (automatic, rapid and valenced) encodes affectively significant perceptual cues to biologically based rewards or punishments that have been shown to play a critical role in subcortical, mesolimbic DA system activation – i.e. ‘wanting’. These domain and stimulus-specific affective processes are unconscious and inaccessible to introspection or verbal report, as Winkielman and colleagues have demonstrated in their affective subliminal priming study (1995). Affect here is neither P-conscious (i.e. subjectively felt), nor A-conscious (i.e. accessible to reasoning, decision making and speech). Conscious emotion can, however, play a functional role in the IMS as the hedonic ‘P-conscious’ experience that accompanies goal consummation. The evidence suggests this kind of emotional experience is not A-conscious however: it is non-reflective and is not utilized by executive processes in reasoning and planning. This hedonic response – which varies as a function of need state – is essential for determining a goal’s subsequent *incentive value* in instrumental behavior. This kind of emotion is likely to be mediated by the VMPFC, possibly in association with amygdala-hypothalamic-endocrine systems controlling autonomic arousal. It may be common to all mammals. Since VMPFC reward areas can become activated by conditioned as well as unconditioned incentives, stimuli *associated* with rewards during the ‘homing in’ process, can also elicit P-conscious, but non A-conscious, hedonic (pleasure or pain) feelings.

In summary, on this proposal human emotion is multifaceted in terms of its consciousness-related and executive processing properties. It plays a

central role in both the IMS and the NMS, and can be unconscious and conscious in both systems.

CONCLUSION

In the first half of this chapter I reviewed the literature on the functional and neurobiological basis of implicit motives, indicating the ways in which they can exert control over behavior. Emotion in this context is better understood either as associative cues integral to *reinforcement-motivational* mechanisms that operate unconsciously, or as *non-reflective* hedonic experience of pleasure or pain. By contrast, emotion functions as *information* for cognitive inference and executive control in the NMS. Three theories I have reviewed above provide accounts of emotion in this ‘explicit’ mode of cognition and behavior, not the ‘implicit’ mode. The role of emotion in implicit motives is neglected in these accounts, in part because of the traditional distance between the disciplines of biopsychology and cognitive / social psychology.

While there is an obvious biological basis of implicit motives and emotions, and the brain mechanisms of these motivational systems are relatively well understood, the claim that explicit, normatively regulated motives have their own distinct evolutionary origins and neural mechanisms is more controversial. It may plausibly be assumed that implicit motives relating to survival, reproduction, affiliation and competition for resources, ultimately account for all motivated behavior; that more cultural, abstract and explicit goals such as ‘getting qualified’ or ‘getting married’ are linked by chains of reinforcement to implicit motives such as dominance or sexual desire. But the IMS-NMS dual process account is making a different claim. The three theories reviewed above suggest that there may be more recently evolved explicit motivation-emotion system – interpenetrated with explicit cognition – that is to an extent *autonomous* from the implicit motivation system. This system is hypothesized to motivate behavior through self-

reflectively, consciously experienced emotional feedback, and the anticipation of felt emotional states in explicit goal directed behavior. In terms of anatomical localization, this more recently evolved circuitry interconnects the dorsolateral prefrontal cortex (DLPFC) and anterior cingulate cortex (ACC) in an executive process circuit for working memory and ‘conflict control’.

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KEY TERMS AND DEFINITIONS

Priming: An effect in which exposure to a stimulus influences response to a subsequent

stimulus. It can occur following perceptual, semantic, or conceptual stimulus repetition.

US: A stimulus evoking an unlearned, innate and often reflexive response CS - is previously neutral stimulus that, after becoming associated with the unconditioned stimulus, eventually comes to trigger a conditioned response.

ACC: Anterior cingulate cortex, is the frontal part of the cingulate cortex, that resembles a “collar” around the corpus callosum.

OFC: Orbitofrontal cortex, is the broad area in the lower (ventral) central (medial) region of the prefrontal cortex. Also referred to as the ventromedial prefrontal cortex (VMPFC).

DLPFC: Dorsolateral prefrontal cortex, is a major division of the prefrontal cortex, including the lateral portions of the upper region of the prefrontal cortex.

ENDNOTE

¹ In a classical fear conditioning experiment, a conditioned stimulus (For ex: CS=neutral tone) precedes an unconditioned stimulus (For ex: US=electric shock). After several trials, the conditioned stimulus alone is adequate to trigger the response given to the unconditioned stimulus.

APPENDIX: INCENTIVE MOTIVATION NETWORK

The Mesolimbic Dopamine System

The mesolimbic dopamine system originates with neurons in the dopamine producing ventral tegmental area (VTA) on the floor of the midbrain. The axons of these cells terminate in the bottom of pallidum and the nucleus accumbens of the lower striatum, and the limbic prefrontal cortex. The nucleus accumbens also receives inputs from the amygdala and orbitofrontal cortex (OFC), both of which assess affect-related sensory properties of a stimulus. The nucleus accumbens has been characterized as a gateway through which sensory information influences motivational motor response preparation in the basal ganglia (Mogenson, Jones, & Yim, 1980). Conditioned and unconditioned *reward* stimuli induce a brief release of DA in the nucleus accumbens and prefrontal cortex but the dopamine is released in the presence of the actual reward only initially. Once the US-CS link has been learned, the DA is released only to the reward predictive CS, and this ‘transference’ mechanism is iterated for second order conditioning, and so on (Schultz, Dayan & Montague, 1997). In this way the DA release in the nucleus accumbens is involved in learning chains of (Pavlovian) stimulus associations that ‘home in’ on a reward.

The mesolimbic DA system associates these learned chains with instrumental actions that are directed at the rewards they predict. While the nucleus accumbens is not needed for knowledge of the contingency between instrumental actions and their outcomes, it influences instrumental behavior strongly by allowing Pavlovian CSs to affect the level or intensity of instrumental responding, known as Pavlovian–instrumental transfer (Cardinal et al., 2002). Studies on rats in which the mesolimbic DA system is lesioned or genetically engineered to have higher than normal dopamine levels, or DA agonists or antagonists are used to manipulate the action of the DA neurotransmitter in the accumbens, reveal that this system functions to (a) facilitate learning that an action results in a reward; (b) invigorate reward directed instrumental behaviors once they have been learned; and (c) reduce distractibility during these actions (Ikemoto & Panksepp, 1999; Pecina et al., 2003). Moreover, neither DA reducing (or blocking) nor DA increasing manipulations had an effect on the rats’ affective ‘liking’ responses as measured by the amount of sucrose solution they consumed once they had reached the reward. Biopsychological research also shows that just as this system facilitates approach behaviors directed to rewards, it also facilitates avoidance behaviors – actions taken to avoid disincentives or punishments (Ikemoto & Panksepp, 1999; Salamone, 1994).

Synaptic activity in the accumbens has also been shown to be related to incentive seeking in humans. In brain imaging studies, increased brain activation in the nucleus accumbens has been observed in response to varied incentives including playing a computer game, beautiful opposite-sex faces, and listening to pleasurable music (Aharon et al, 2001; Blood & Zatorre, 2001; Koeppe et al, 1998). According to Depue and Collins’ (1999) influential theory of the personality trait ‘extraversion’, extraverts have a greater capacity for mesolimbic DA system activation, whether naturally stimulated by incentive signals or artificially induced through DA agonists – and are thus more ‘turned on’ and behaviorally invigorated by incentives. People high in extraversion respond with greater ‘wanting’ to incentives than introverts.

In summary the mesolimbic DA system functions to enhance goal directed instrumental learning and invigorate goal-directed behavior (‘wanting’ a reward). It facilitates behavior guided by incentives but it does not play a functional role in the hedonic response to the incentive itself (‘liking’ a reward).

The Orbitofrontal Cortex

The most likely candidate for the coding of the subjective ‘liking’ phase of motivation is the orbitofrontal cortex (OFC) (Kringelbach, 2005), although the causal circuitry involved is extensive, and other limbic forebrain areas such as the anterior cingulate and insula cortex may also play a role in subjective affect (Smith et al., 2009). Neurochemical signals in a number of ‘hedonic hotspots’ throughout the brain cause amplification of core ‘liking’ reactions to sweetness, including the nucleus accumbens, ventral pallidum, and brainstem. Hedonic circuits connect these ‘hotspots’ into integrated loops and relay them to limbic regions of prefrontal cortex, including the orbitofrontal cortex, and back again, for translation into feelings of pleasure and cognitive representations (Smith et al., 2009).

The OFC receives multimodal and highly processed sensory information and is densely reciprocally connected to the basolateral amygdala. Different types of reinforcers are coded by anatomically distinct areas of the OFC. Brain imaging studies on humans have shown that there are anatomically distinct reward areas for monetary gains (medial OFC) and monetary losses (lateral OFC) (reviewed in Rolls 2000; 2004). In humans the orbitofrontal cortex is activated by pleasant tastes and odors, pleasant touch sensations, and other pleasurable stimuli (de Araujo et al., 2003; Francis et al., 1999; O’Doherty, 2004; Rolls et al., 2003). Orbitofrontal cortex activity in rats, monkeys and humans also tracks changes in pleasure with constant food intake and the alliesthetic reductions in hedonic value caused by eating foods to satiety (Smith et al., 2009). For example, single neuron recording studies have shown that as a monkey becomes satiated on a given reinforcer (glucose syrup), neuronal firing rate in glucose specific cells in the OFC drops – a neural correlate of alliesthesia (Rolls, 2000; 2004). This evidence suggests that the OFC mediated hedonic response functions to reset the incentive values of goal objects, after an integration of information about the rewards’ preexisting incentive value with the animal’s need states.

OFC reward areas can become activated by conditioned as well as unconditioned incentives (e.g. sounds or sights that predict tasty food) indicating that stimuli associated with rewards can be just as liked as the actual goal of the instrumental action (Rolls, 2000; 2004). Stimuli that an animal learns are *predictive* of rewards (or punishments) – such as the sight of a food as well as the taste – can therefore have an incentive value as well as the rewards themselves. The OFC appears to be able to break or even reverse learned CS-reward associations very rapidly, as soon as the reward value of a conditioned incentive changes (Rolls, 2000; 2004). Lesions of the OFC destroys an individual’s ability to track changing CS-reward contingencies and emotional responses may become dissociated from changing stimulus conditions, and persevere for long periods (Rolls, 1999).

Consistent with this *consummation phase* interpretation of OFC function are the brain-stimulation reward studies in which an electrode is implanted into a brain region and the animal can activate the flow of current at the electrode tip by pressing a lever. If a brain area is found where the animal is observed to continue pressing the lever compulsively as if the stimulation produces a pleasurable sensation it is taken as an indication that a brain reward area has been found. Laboratory animals will lever press at high rates (over 6,000 times per hour) to obtain brief stimulation pulses to certain brain regions (Olds and Milner, 1954). Brain stimulation reward effects have been documented for many OFC sites, suggesting pleasurable (as well as rewarding and reinforcing) emotions are experienced if these sites are activated. The amount of lever pressing an animal does to stimulate food related OFC reward sites, unlike reward sites in subcortical areas such as the nucleus accumbens, has been found to vary with the need state of the animal: if the animal is hungry it presses the lever vigorously, but when the animal has eaten, lever

pressing ceases (Rolls, 1999). Thus the OFC integrates information about the reward's baseline incentive value with the animal's physiological need states, and this reflects the subjective experience of liking.

The Amygdala

The amygdala is the third major structure of the mammalian affective-motivational circuit, and it functions to form or strengthen associations between affectively neutral stimuli (CS) that reliably predict affectively charged events or stimuli (US). In the process the predictive stimuli take on affective significance themselves and via projections to the mesolimbic DA system can induce and invigorate motivated behaviors. According to Schultheiss & Wirth (2008), the amygdala can be characterized as a motivational 'homing-in' device allowing individuals to (a) learn rapidly about cues that signal proximity to a goal object, and (b) act in such a way that takes the individual from more distal to more proximal reward-predictive cues until the reward can be consumed – or conversely, to respond to punishment predictive warning signals either by freezing with increased vigilance or working actively at avoidance.

Loss of the amygdala leads to an inability to assess the motivational value of an object from a distance ('psychic blindness'). It is a key brain structure in Pavlovian conditioning, enabling Pavlovian associations to be formed between stimuli that do not initially carry any motivational meaning such as the sight of a juice drink (conditioned visual cue) with unconditioned rewards or punishers, if the former reliably predict the latter, such as the pleasant taste of the juice if it is drunk (UC reward) (LeDoux, 1996). It is also essential for second order reinforcement learning (Everitt, 1990). The amygdala receives input from almost all stages of sensory processing, and its response to lower level representations can guide motivated gaze – that is, enhanced focus on emotionally arousing features of the environment (Vuilleumier et al, 2004).

The amygdala is made up of a number of interconnected nuclei, two of which are key to emotional and motivated responses to CS and US. Through its central nucleus, the amygdala influences *emotional responses* mediated by hypothalamic and brainstem structures that can be characterized as physiological *arousal*. These responses include the release of stress hormones (e.g., cortisol) via the endocrine system, an increase in arousal and vigilance via activation of major neurotransmitter systems such as dopamine, and autonomic nervous system responses such as, pupil dilation, and increased blood pressure (LeDoux, 1996, 2002). Through its *basolateral nucleus* the amygdala influences the invigoration of *motivated action* to CS and UC through its projections to the nucleus accumbens. These two functions have been dissociated through lesion studies (Killross, Robbins & Everitt, 1997).

This concludes our review of what is known about the mammalian 'incentive motivation network'.