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A Neuro-Psychological Model of Emotion

Introduction

A standard approach in physiological and neurological psychology is to try to find "neural correlates" to various folk-psychological and scientific-psychological phenomena. For instance, we believe we have some understanding of "consciousness" or "working memory" or "components of emotion". Then we look to see what "centers" and "circuits" and "neurotransmitters" underlie those processes. This traditional approach is to move from the psychological to the neurological. This approach has been quite successful.

But as our understanding of neuroscientific mechanisms unfolds at an accelerating pace, we find frequent occasions where our new understanding of *neural* mechanisms challenges the ways we put together our *psychological* constructs. As I noted in an extensive review of the psychological correlates of five major brain systems (Faw, 2003), we are gaining a strong sense that psychological "faculties" such as "attention" and "working memory" are at best operational definitions for what is assumed to be happening in particular experiments. This essay is an attempt to re-examine traditional "components" of emotion in light of recent understandings of brain mechanisms involved.

My treatment of emotion "components" comes from my having taught the course "Psychology of Emotions", over a period of years. My understanding of brain mechanisms comes from my training as a bio/cognitive psychologist and my attempts to articulate the brain mechanisms involved in mental imagery (Faw, 1997), consciousness and emotion (Faw, 2000a,b) and perception, working memory, attention, long-term memory, motor control, and thinking (Faw, 2003). While this essay draws upon my earlier work, I am putting things together in a completely different way than I have before in print.

Purpose of Emotion

Most human and animal responses have an emotional dimension to them. That is what makes the responses "personal". A robot/computer can only make unemotional responses. The realm of emotional responses constitutes the personal sphere wherein you interact with your environment, your past, your random thoughts, your reasoning and planning thoughts, other persons and your immediate and ultimate values (Faw, 2000a).

William James wrote in his "Variety of Religious Experiences" (1902/1958 p. 128): "Conceive yourself, if possible, suddenly stripped of all the emotion with which your world now inspires you, and try to imagine it as it exists, purely by itself, without your favorable or unfavorable, hopeful or apprehensive comment. It will be almost impossible for you to realize such a condition of negativity and deadness. No one portion of the universe would then have importance beyond another; and the whole character of its things and series of its events would be without significance, character, expression or perspective. Whatever of value, interest, or meaning our respective worlds may appear endowed with are thus pure gifts of the spectator's mind." In a somewhat similar vein, the contemporary philosopher Robert Solomon (1976, p. xvii) advocated a view of emotions "...as our own judgments, with which we structure the world to our purposes, carve out a universe in our own terms, measure the facts of Reality, and ultimately «constitute» not only our world but ourselves."

Motivation, Moods, Feelings and Emotion

Any model of emotion needs to distinguish among motivation, mood, feelings and emotion. I have developed the following definitions in my course in Psychology of Emotion. Consider them working definitions for the substance of the report, which follows. Each of these definitions needs much further analysis in order to deal with all of its philosophical implications.

„Motivation" is a much wider concept than „emotion". Motivation is inferred in any goal-directed behavior, as opposed to the seemingly random behavior found in twitches, ticks and much of the movement of disorganized and catatonic schizophrenics. „Motivated responses" is a much wider concept than „intentional actions", which include only the most conscious deliberate tip of motivated responses.

„Motivations" can be seen as the *set of internal drives and external pulls to behavior*. Internal states of an organism — such as hunger or pain — *drive* or

push the organism to action, while environmental targets — such as the visible availability of a preferred food or a phobic object — *impel* or *pull* the organism to action. A variety of pushes and pulls interact in almost every motivated act.

Obvious primary drives include hunger, thirst, pain and sex. But organisms have very specific drives for maintaining scores of homeostatic states, such as the proper range of water, sugar, sodium, chloride, potassium, temperature and various hormones in the blood, a major theme in Ralph Ellis' target article. More controversial are a number of proposed psycho-social motives, such as the alleged "need" for power, achievement, intimacy, meaning, inspiration (one of Ellis' main concerns) and the like. Drive states either are generalized or specific energizers.

Motivations must have some coding for „valence" and „salience" — such that a certain response has some positive or negative importance for the survival, well being, or pleasure of the organism — but motivated acts may have little or no *emotion* attached to them. Indeed, much of the motivated behavior mentioned in the previous paragraph comes from completely non-emotional, non-conscious homeostatic control. Your need to maintain a certain blood level (and thus cellular and extra-cellular level) of sodium and chloride begins to motivate your consumption of Sports Drink instead of just water, but only develops an "emotional" dimension in extremis - like when you are riding in a desert on a horse with no name.

Moods are something like self-sustaining emotions that affect all of your responses. Moods are diffuse and longer lasting than emotional episodes. Obviously, an emotional episode can trigger a mood, so that you fester over the insult received earlier from a co-worker and then "take out" that hurt and anger against someone else much later. Or, happiness from hearing that your article has been accepted by the editor can "make your day" and trigger a happy mood. Indeed, emotional dreams can set your mood for the morning! But you often find yourself in a mood, without knowing of anything that might have triggered it. We know from mood disorders like major depression, bipolar (manic-depressive) disorder, seasonal affective disorder (being depressed in winter months) and pre-menstrual dysphoria that hormone and neurotransmitter balances can set your mood. Your emotional responses then unfold within the overcast mood. At the other time-course extreme from moods are moment-by moment *"feelings",* barely noticeable, fleeting impressions, which seem to come from evaluations of the events you encounter.

The experience of an *emotional episode* is a *current experience of your own emotional response,* with relatively intense feelings of limited duration (compared to moods). *Emotional "traits"* are characteristic ways for a specific person to respond. "Emotionality" (sometimes crudely called „neuroticism") is seen as a general trait of frequent and/or intense emotional responses, compared to the

average; often seen to be a trait dimension almost as basic as the extrovert- introvert dimension. In addition to "general emotionality", there are vast individual differences in specific emotional traits, such as "angry" or "depressed".

"Emotions" can be seen as genetic and acquired motivational predispositions to respond experientially, physiologically, cognitively and behaviorally to certain internal and external variables. This definition points to the interaction between genes and life experiences. It links emotions to "motivational predispositions". It integrates internal drives and their triggering external pulls. The "predisposition" to respond is in contrast to actual responses; in that you may suppress, transform, or deny your emotions.

Perhaps most important is that the definition points out a *multi-component view of emotion,* in the words to respond experientially, physiologically, cognitively and behaviorally. The insult that "hurts you to the quick" triggers hormonal, autonomic and instinctive responses, rapid changes of facial expression and posture, and feelings and thoughts of hurt, confusion and anger. Some philosophers limit the term "emotion" to refer to the conscious experience of emotion — and thus maintain that it is illogical to talk about "unconscious emotions". While this choice to so limit the meaning of "emotion" is basically semantic - and thus philosophically tenable (in philosophy you can define words any damn way you wish!) - it seems quite artificial to me. What are such physiological, expressive, cognitive and behavioral responses if not part of an "emotional episode" or event? It may be that "emotions" must have an *experiential component* to them — in distinction to non-emotional motivations — but the experiential component is only one of many components of an emotional episode. Next, we will look at several of the components of emotion as suggested by neuroscientific findings regarding emotional responses.

Components of an Emotional Event and Their Mechanisms

A full model of Emotion would deal with several elements or components. Which of these occur and their order of occurrence in an emotional event may differ slightly.

Representation of a Real or Imaginary Object

The "object" of the emotion "triggers" the emotion. Carrie Figdor (2003) has given a very interesting recent treatment to the question: "can mental representations be triggering causes?" As you will see, my position is that *only* mental representations can be triggering causes of emotions. The so-called *object*

of an emotion can be an *objectively-present object* in your environment, such as a wild bear charging at you; a *memory object,* such as a memory of your last exciting date; an *imaginal object,* a mental image, dream, or hallucination, such as imagining a bear chasing you; or a *verbal-thought object,* such as thinking about an upcoming job interview. But, in each of the above cases, the "object" must be in the form of a mental representation in the subcortical or posterior- cortical perceptual or verbal-thought pathways - for it to "trigger" an emotional response. It seems to be these pathways that trigger emotional responses. Note in each of these components the underlying emphasis on emotional *responses.* After analyzing these components, we will tackle directly the issue of passivity versus activity of emotions.

Reflexive Motor Responses to the Object

Conscious perception of an external-world object that might cause an emotional response (treated as the next component) is not necessarily the first step in response to the object. Objects that suddenly intrude upon us trigger very quick (within a few milliseconds) reflexive responses that *precede* conscious perception of the objects. The most primitive of these reflexive responses is a quick response to potentially painful tactile tissue-damage stimuli. When your finger comes in contact with a flame, the pain-carrying neurons activate spinal inter-neurons, which then activate motor neurons, which pull your finger away from the flame. This happens very quickly and independently of the pathways that are carrying that same pain information to the cortex to make you conscious of that pain. Such reflexes will happen even in quadriplegic patients, even though they can never "feel" the pain because the pathways to the cortex are cut. Those with intact spinal chords will eventually become conscious of the *perceptual* aspect of that pain (in about 300 ms) and then, after a further delay (perhaps a matter of seconds), conscious of their own *emotional* responses to that pain. Thus the reflex motivates very direct behavior — independently of consciousness and emotional responses. Perceptual consciousness and emotional consciousness then make available additional motivated behavior — with successively longer-term perspectives.

Each of the other sensory systems (visual, auditory, etc. have similar reflex mechanisms in the brainstem to also pull you out of harm's way before there is more tissue damage. These are processed by the superior and inferior colliculus of the brainstem's dorsal midbrain. You "orient" to some new visual or auditory change; you "hit the deck" when a fast ball is coming toward your head; or you turn away from a loud noise or an acrid smell. All of these responses are faster than any signals to consciousness or emotional response mechanisms. You do

this because the cochlea, retina and the like, send information to the colliculi for reflex responses, as in the spinal reflexes, independently of their projections to the thalamus to cortex for conscious responses. Thus, much of your motor responses are handled at a non-conscious and pre-emotional level, even though most of them can then subsequently, through other pathways, lead to awareness and conscious response.

Because of these reflexes, emotion scholars see "startle" as a pre-emotional response, rather than as an emotion. In our folk psychology we tend to say, "you *scared* me when you suddenly walked in the room"; but, technically, we should say "you *startled* me" — fear, anger, relief, or some other emotional response then follows the startle. Your mood, emotional traits and previous experience can, of course, raise or lower the threshold for startle and affect the intensity of the startle response — so that the "high strung" individual or the person with post-traumatic stress disorder might act quite violently in response to mild intrusions. I include these instinctive responses as a set of the wired-in motivational systems that can be a component in some emotional episodes.

Perception or Imaging of the Object

The representation that IS the "object/trigger of emotional response" may come into the system through *exteroceptive sensory input,* such as the fact that you are seeing, hearing, smelling or touching the bear activates your sensory receptors. Each of the sensory systems, except smell, activates specific sensory-processing nuclei in the thalamus before projecting to the primary perceptual centers in the posterior lobes of the cortex; while smell input is given first to the cortex and then to the thalamus and back to the cortex.

But, the so-called „object" that triggers an emotional response does not need to be outside of your body. Bodily feelings such as physical pain, hunger, thirst, and the like - many of which were mentioned above as representing motivational systems that don't necessarily have an emotional aspect to them - may themselves trigger emotional responses as they activate emotional-response circuits through *interoceptive pathways* (in contrast to the exteroceptive pathways that bring in sensory input from the external world).

A third category of „objects that trigger emotional responses" are neither in the external world nor in the bodily tissue and organs that send interoceptive input into your central nervous system. This is the category of „mental objects", the *memory objects, imaginal objects* (mental images, dreams, and hallucinations), and *verbal-thought object* mentioned above. But the fact that these are „mental objects" does not at all mean that they have any less physical rootage in the brain. There is considerable evidence that major parts of the posterior cortical

areas activated by perceptual input from external objects are also activated when one forms *memorial or imaginal images* of those objects (Farah, 1984; Kosslyn, 1994; Faw, 1997, 2000). Thus, perceptual, memorial, and sensory- and verbal- thought-images all stimulate the brain structures involved in subsequent components of an emotional episode. It seems to be the case that for any real or imaginary "object" to trigger an emotional response, it must activate these thalamic and/or posterior-cortical perceptual pathways. These perceptual pathways are thus necessary, but not sufficient for the activation of an emotional response.

Memory Appraisal

While sudden changes in your perceptual fields can lead to *startle* responses, truly *emotional* responses seem to involve some sort of *memory appraisal.* You notice that the rock you placed your backpack on is really the back of a sleeping bear. You realize that the passengers behind you are saying that your train is heading in the opposite direction that you anticipated. You realize that the rare cologne you smell is that of your most dreaded counter-spy. Or, you realize that the person in the shadow near your front door — who just startled you — is really your younger brother trying to frighten you. Your emotional response will depend greatly upon your memory appraisal - who or what you take that external- world object to be.

The perceptual input that makes its way into the higher-processing areas of your cortical perceptual systems will be stored into at least *implicit memory.* Implicit perceptual memories represent characteristics that can potentially enhance, attenuate or otherwise bias later behavior, but which cannot be consciously retrieved (Tulving, 2000; Faw, 2003). Each new perceptual event seems to form new posterior-cortex memory traces by just activating perceptual pathways. This is analogous to walking through high grass once. It is unlikely that will create an explicit "trail" that someone else can consciously follow, but it might slightly bias another person to choose parts of that same path. In similar manner with an implicit perceptual memory, the mere reactivation of parts of the pathway of implicitly stored memory traces by a new experience (Martindale, 1991) brings a non-conscious enhancement, attenuation, or biasing of performance, resulting in the need for less or more activation of pathways to process current perceptions (Squire & Knowlton, 2000).

Explicit perceptual memories represent characteristics that can be consciously retrieved. With the involvement of the middle-temporal lobe's rhinal cortex and underlying hippocampal complex, the memory traces, formed in the perceptual pathways, become explicit memories that can potentially be consciously recalled. In encoding explicit memories, the rhinal/hippocampal mechanisms undergo rapid

modification of synaptic connectivity and provide massive backward signals to modality-specific perceptual areas, in order to guide reorganization of circuits there through long-term potentiation (Miyashita, 2000). This would be analogous to deliberately cutting a path through the tall grass, so that your tardy hiking companion can find the right path.

Memories of *emotional* events tend to be even stronger than of more mundane events. The amygdala is essential for encoding the emotional context of semantic and episodic memories (Murray, 2000) and thus enhancing memory storage. The amygdala supercharges the hippocampus to encode emotional episodes, through norepinephrine neurotransmitter pathways.

While the hippocampal complex/rhinal cortex are most clearly involved in *forming* new explicit memories, they also seem to be involved in this *memory assessment* of explicit memories, perhaps by comparing new experiences with episodes of the past. The hippocampus seems to store certain links that bring back various elements of the contexts of restored memories, while the specialized pathways actually store the individual memory elements that are thus linked (Faw, 2003).

Significance Appraisals of Stimuli/Events

Making a *memory appraisal* that the "rock" is really a bear, that the train is going a certain direction, that the cologne belongs to a specific person, or that the "shadow" is your younger brother, will not in itself lead to an emotional response. The next crucial component is to *appraise the significance* of these stimuli or this event. Each of these examples of memory appraisals can lead to no emotion or to a variety of emotional responses, depending upon the very specific significance of these events.

This simple fact has become the central truth in modern cognitive therapy, which has rediscovered the Stoics' central truth that a specific object or situation does not *make* you angry, fearful, etc. Instead, it is your evaluation of that situation that makes you angry or fearful or happy or relieved. (Robert Solomon, 1976, has a very thorough and powerful treatment of the links between such appraisals and specific emotional responses.) In this very limited sense the old saw that "sticks and stones can break my bones, but words can never hurt me" is true. It is your evaluation of those words that can trigger the hurt responses. Of course, mockers who "have your number" can accurately predict the effects their words may have!

Not all significance appraisals are made on the same cognitive or neural level. All creatures have *"wired-in appraisals"* which trigger unconditioned (or unconditional) emotional responses (Ivan Pavlov & John Watson), such as fear of falling, of height, of snakes; aversion to certain kinds of smells; and positive

responding to human smiling faces, little kittens and such things. Some of these wired-in appraisals appear in all newborns, while other objects just have an increased chance of triggering such responses more often than other objects.

Another category of emotional responses is based on cognitive appraisals made long ago in your personal experience (in distinction to your DNA's evolutionary history) — *well-learned conditioned emotional responses* (Watson, 1920). For example, someone looking like your new boss may have been mean to you when you were a child, resulting in your current "irrational" ill-at-ease feelings toward your boss; or you respond with phobic fear at even pictures of dogs because you were bitten by a dog as a young child. In such cases you may have even forgotten what appraisal you made back then. All you know now is that you seem to respond "instinctly" in such situations. (Pavlov talked about conditional responses being like learned instincts.) With all the talk about a *cognitive* role in triggering emotions (such as "bad thoughts make you depressed"), many of your cognitive appraisals are *unconscious* or barely conscious. You often have to work hard to find out what your appraisals are.

Of course, not everything is determined by the past. You constantly make new significance appraisals of new events. These appraisals help determine your immediate and future emotional responses. Finally, you can change your appraisals - even those made long ago; and when you change your appraisal, your emotional responses change, although the old emotional responses linger on. It lakes a while before you can "talk yourself into being happy" or „whistle a happy tune" and make the fear disappear. This shows how conservative your emotional response repertoire is.

We have talked about the amygdala as being crucial for more intense encoding of emotional memories, through its connections to the hippocampal complex. An amygdala complex has been found to be the central subcortical brain area for memory appraisals and for triggering emotional responses to external-world, bodily and mental-world representations (Aggleton, Burton & Passingham, 1980; Aggleton, 2000; Faw, 2000a, b, 2003).

Converging upon the amygdala are external-world-perceptual information input, internal-world-motivational-visceral information input and anterior motivational-autonomic control output (Aggleton, Burton & Passingham, 1980; Aggleton, 2000; Faw, 2000a, b, 2003). (See Faw, 2003 for details.) The amygdala complex and the nearby "reward circuits" seem to cooperate in significance appraisal — along with the hippocampal aid in memory appraisal — in determining whether a new object should be approached or avoided and what kind of approach or avoidance would be most helpful. Damage to these areas knocks out appropriate responses to predators and social objects.

Wired-in appraisals were likely programmed by evolution in fear, anger, and anxiety circuits in the amygdala and approach/reward circuits. We have seen

that each of the sensory systems activates specific sensory-processing nuclei in the thalamus and then project to the primary perceptual centers in the posterior lobes of the cortex. LeDoux (LeDoux et al, 1988; LeDoux, 2000) and others have discovered that there are two perceptual pathways projecting from the thalamus to the amygdala to activate significance appraisals and possible emotional responses - a fast non-conscious pathway directly from the thalamus to the amygdala and hippocampus (arriving at the latter at about 30-40 ms after stimulus onset) and a slow potentially-conscious pathway from the thalamus to posterior-cortical perceptual circuits and from there to the amygdala and hippocampus (arriving at the latter at about 200 ms after stimulus onset - Faw, 2003).

Both wired-in (unconditioned) and conditioned emotional responses are likely processed quickly through the direct route from the specific-perceptual-processing nuclei of the thalamus, giving us quick gut feelings and responses, even before more reasoned cortical cognitive appraisals. Emotional responses to simple stimuli can be conditioned in mammals through this direct thalamic input to the amygdala (Carlson, 1992). Even cortical cognitive appraisals may not be very conscious. As we make the still-quick perceptual cortex route to amygdala assessment, we may or may not realize why we don't like our new boss.

The orbitofrontal cortex (the base/floor surface of the frontal lobe, just above the eye socket "orbits") seems to be required to make new appraisals and responses when we already have strong pre-potent responses. Other parts of the prefrontal cortex seem crucial for integrating emotional responses with our basic beliefs, sense of right and wrong, and evaluation of the broader context (Aggleton, Burton & Passingham, 1980; Aggleton, 2000; Faw, 2000a, b, 2003). (See Faw, 2003 for details.)

Emotional Responses

We have mentioned the convergence upon the amygdala of external-world- perceptual information input and internal-world-motivational-visceral information input. In turn, the amygdala activates three main categories of emotional responses: projections to the brainstem's peri-acquaductal-gray area activate emotional behaviors such as startle, flinching and freezing (Kalat, 1998); projections to the lateral hypothalamus activate autonomic responses, such as increasing heart beat, blood pressure, and adrenaline rushes; and projections to the bed nucleus of the stria terminalis control medial hypothalamic activation of hormonal responses (LeDoux et al,1988; LeDoux, 2000; Adrianov, 1996; Faw, 2003). Notice the range of emotional responses: some involving voluntary muscles, some involving involuntary smooth musculature organs, and some involving hormonal release.

The *autonomic nervous system* enacts motor responses over which you have little conscious control, like heart rate, blood pressure, and routine breathing. You can, then, become conscious of your adrenaline rush, breathing, and pounding heart, through interoceptive feedback, just as you can become conscious of your voluntary muscle movements through proprioceptive feedback. Presumably, the quick thalamus-to-amygdala feed can produce quick emotional responses even prior to conscious awareness and emotional experience. This must underlie many of the "gut feelings" and emotional intuitions that we have. And yet, these responses are still based on perceptual appraisals at the thalamus level and memory and significance appraisals at the amygdala level.

Emotional Experiences

We have seen that the *autonomic nervous system* enacts motor responses over which you have little conscious control, but that you can, then, become conscious of the products of your autonomic responses through interoceptive feedback. It is interesting to note that the same amygdala, which triggers the hypothalamus to trigger autonomic nervous system activation, also receives feedback of bodily feelings, including autonomic nervous system arousal.

There has been a lot of debate within the neurosciences of motivation and emotion over the last 125 years over the role of such autonomic feedback in the *conscious experience* of emotion. William James (1884) and Carl Lange (1885) postulated that the conscious awareness of one's own jump in adrenaline, heart rate, etc., is itself (or a major part of) one's "experience" of emotion.

James' son-in-law Walter Cannon (1929) pointed out several problems with such theories, since the autonomic feedback is too slow to be the cause of an emotional experience and too generalized to allow one to discriminate the emotion one is having from other possible emotions that also trigger sympathetic nervous system response. Because of the course nature of autonomic responses, it seems to be far more likely that feedback from your own autonomic responses plays a greater role in the perceived *quantitative intensity* of an emotional experience, rather than in the *qualitative differences* between various emotions.

Later, Schachter and Singer (Schachter, 1964) demonstrated that the cognitive assessment of a situation can determine how one "labels" one's emotion — so that subjects unknowingly injected with adrenaline who were in a humorous situation interpreted their adrenaline arousal as „humor": while those in an angry situation interpreted their arousal as „anger". Their set of ingenious experiments opened the door to cognitive theories of emotion.

Many studies show that the amygdala can be activated by subliminal and "masked" stimuli, which the subject never consciously perceives Akin t this

are many cases of amygdala-triggered autonomic responses to familiar faces by prosopagnosic patients who cannot consciously distinguish familiar from unfamiliar faces (surveyed in Faw, 1997). Thus, it is very doubtful that the amygdala is at the level where conscious emotional experience occurs.

Following the recent suggestion of Lambie and Baker (2003) and a distinction I have found helpful for some time, I think we need to consider "a two-level view of emotion experience: that having an emotion experience and being aware of it are two distinct processes" (Lambie & Baker, 2003, p. 35). This differentiates between having a *first-order emotional experience* and having a *second-order awareness of having an emotional experience.* Panksepp (2000) is probably correct that many species without reflexive introspective consciousness are capable of emotional experience, in addition to their clear capability of emotional expression. Lambie and Baker (2003) propose that first-order emotional experience is necessary for intentional action based on the emotion (but not for pre-conscious elements of emotional response); but that second-order awareness of such experience is crucial for explaining and understanding our own behavior in emotional terms.

Lambie and Baker claim that you need to focally attend to your emotional experiences before you can report them. This is akin to a distinction I made in Faw, 1997, between having mental images and even word thoughts — Freud's "primary processing" and cognitive therapy's "self-talk" — and becoming reflexively or introspectively aware of them.

Having first-order emotional experiences probably involves many of the mechanisms activated by the amygdala in its downstream activation of emotional responses. There is evidence that specific areas of the brainstem and their subcortical pathways represent distinct emotions (Panksepp, 2000). This may be somewhat analogous to an array of different instruments or the electronic equivalents of them on a keyboard. „Fearful" responses play certain combinations of the brainstem-subcortical instruments, while „hurting" responses play other combinations, while „angry" play others, while „joyful" play still other combinations. There may be something like eight basic instruments, with the myriad of various emotional experiences based on the specific ensemble of instruments played on any occasion. Autonomic feedback from adrenaline rushes and heart acceleration probably represents an *amplifier* that changes the volume and tempo for the emotional experiences.

There is converging evidence that the primitive dorsal-medial-cortical cingulate gyrus (to which both hippocampus and amygdala feed) may be crucial for various aspects of *awareness* (Faw, 2003). The *posterior* cingulate seems to be involved in monitoring pre-attentive peripheral vision (Raichle, 2001); the *posterior part of the anterior* cingulate for conscious motor functioning; the *middle anterior* cingulate for perceptual attention (Frith, 2001; Raichle, 2001);

and *anterior anterior* cingulate for self-focused attention upon one's internal feelings and emotions (Frith, 2001: Raichle, 2001; Posner & DiGirolamo, 2000), the latter being the so-called "affective cingulate".

My guess is that the "emotional anterior-anterior cingulate" is crucial for the second-order "awareness" of one's first-order emotional experience. Without that, one can "feel" the emotion but not note that fact nor reflect upon it. Whether this is because of the anterior cingulate's role in shifting attention or in some higher order reflexive-consciousness ability is not clear. It may well be that humans can introspectively reflect upon their emotional and other mental states because they alone (or together with some higher apes) can focus voluntary attention upon their own mental states — while all mammals and birds, say, can have mental states and emotional experiences but cannot shift attention to them, even though they can shift attention to perception of external objects.

Postlogue: are Emotions Passions or Active Responses

Some see motivated behavior as *active* but emotions as *passive*, with the assumption that we "suffer emotions" rather than "emit emotional responses". An alternate word for emotions, "passions", implies such "passivity", to Descartes (1649/1998) and others. Robert Solomon (1976) referred to this view as the „Myth of the Passions". This would suggest that emotions are part of, or on the same level as, the "perceptual/input/stimulus" systems, rather than the "motor/ /output/response" systems. Now, at any given moment the "mood" you are in might be perceived passively - through interoceptive receptors; but the emotion triggered by an event is your evaluation and multimodal response to that event.

The fact that emotions can be triggered very quickly - through thalamic routes - does not mean that they are not "responses". It just means that they do not need to be consciously- and intentionally-activated responses.

Conscious intentional control mechanisms can change emotional responses - like whistling a happy tune or trying to imagine a happy scene or counting to ten before exploding in anger. But, such emotion-changing processes seem to be the exception rather than the rule and, in fact, have had to be experimentally demonstrated to convince skeptics.

The norm seems to be either very quick thalamic-to-amygdala-induced changes or still-pretty-quick perceptual cortex-to-amygdala-induced changes. But these are still motor/output/response processes. This leads us to a ..motor theory of emotions", which, despite being much more complex and sophisticated than William James' motor theories of consciousness and emotion. is quite c consistent with the motor theory of emotions spelled out by Ralph Ellis in his lead article and in many other of his writings.

References

Adrianov, O.S. 1996. Cerebral interrelationships of cognitive and emotional activity: Pathways and mechanisms. *Neuroscience & Behavioral Physiology,* 26(4), 329-339.

Agggleton, J.P., Burton, M.J. & Passingham, R.E.. 1980. Cortical and subcortical afferents to the amygdala of the rhesus monkey (macaca mulatta). *Brain Research* 190, 347- -368.

Aggleton, J.P. 2000. (Ed). *The Amygdala: Second Edition: A Functional Analysis,* Oxford: Oxford University Press.

Cannon, W. 1929. *Bodily Changes in Pain, Hunger, Fear and Rage: An Account of Recent Researches into the Function of Emotional Excitement.* New York: D. Appleton.

Carlson, N.R. 1992. *Foundations of Physiological Psychology, 2"d ed.* Boston: Allyn & Bacon.

Descartes, R. 1649/1998. The Passions of the Soul. In J.F. Brennan (ed). *Reading in the History and Systems of Psychology,* 2nd ed., pp 53-65. Upper Saddle River, NJ: Prentice Hall.

Ellis & N. Newton (Eds.), *Caldron of Consciousness* (pp. 55-90), Amsterdam: John Benjamins Publishers.

Farah, M.J. 1984. Neurological basis of mental imagery: Componential analysis. *Cognition,* 18, 245-272.

Faw, Bill. 1997. Outlining a brain model of mental imaging abilities. *Neuroscience and Biobehavioral Reviews* 21(3), 283-288.

Faw, B. 2000a. Consciousness, motivation and emotion: Biopsychological reflections. In R.D.

Faw, B. 2000b. My amygdala-orbitofrontal-circuit made me do it. *Consciousness and Emotion,* 111, 167-179.

Faw, B. 2003. Pre-frontal executive committee for perception, working memory, attention, long-term memory, motor control, and thinking: A tutorial review. *Consciousness and Cognition,* 12, 83-139.

Figdor, C. 2003. Can mental representations be triggering causes? Consciousness & Emotion. Vol 4/1, pp 43-61.

Frith, C. 2001. Attention to action and awareness of other minds. Paper at *5,11 Annual Meeting Association for the Scientific Study of Consciousness.* Durham, N.C.

James, W. 1884. What is an emotion? *Mind* 9:188-205.

James, W. 1902/1958. *The Varieties of Religious Experience.* New York: Mentor Books. Kalat,

J.W. 1998. *Biological Psychology, 6"' ed.* Pacific Grove: Brooks/Cole.

Kosslyn, S.M. 1994. *Image and Brain, the Resolution of the Imagery debate.* Cambridge, MA: Bradford/MIT Press.

Lambie, J.A. & Baker, K.L. 2003. Intentional avoidance and social understanding in repressors and nonrepressors: Two functions for emotion experience? *Consciousness & Emotion.* Vol 4/1, pp 17-42

Lange, Carl. 1885/1922. In James and Lange: *The Emotions.* Baltimore

LeDoux, J.E., Iwata, J., Cicchetti, P. & Reis, D.J. 1988. Different projections of the central amygdaloid nucleus mediate autonomic and behavioral correlates of conditioned fear. *Journal of Neuroscience,* 8, 2517-2529.

LeDoux, J. 2000. The amygdala and emotion: a view through fear. In J. P. Aggleton (Ed). *The Amygdala: Second Edition: A Functional Analysis,* Oxford: Oxford University Press, pp. 289-310.

Martindale, C. 1991. *Cognitive Psychology: Neural-Network Approach.* Pacific Grove, CA: Brooks/Cole.

Miyashita, Y. 2000. Visual associative long-term memory: Encoding and retrieval in inferotemporal cortex of the primate. In Gazzaniga, M.S. (Ed.) *New Cognitive Neurosciences: Second Edition.* Cambridge, MA: MIT Press, pp 379-392.

Murray, E.A. 2000. Memory for objects in nonhuman primates. In Gazzaniga, M.S. (Ed.) *New Cognitive Neurosciences: Second Edition.* Cambridge, MA: MIT Press, pp 753- -763.

Panksepp, J. 2000. Affective consciousness and the instinctual motor system: The neural sources of sadness and joy. In R.D. Ellis & N. Newton (Eds.), *Caldron of Consciousness* (pp. 27-54), Amsterdam: John Benjamins Publishers.

Posner, MI.& DiGirolamo, G.J. 2000. Attention in cognitive neuroscience: Overview. In Gazzaniga, M.S. 2000 (Ed.) *New Cognitive Neurosciences: Second Edition.* Cambridge, MA: MIT Press, pp 623-631.

Raichle, M. 2001. Default mode of brain function: Finding the neural baseline of consciousness. Paper at ^{5,h} *Annual Meeting Association for the Scientific Study of Consciousness.* Durham, N.C.

Schachter, S. 1964. The Interaction of cognitive and physiological determinants of emotional state. In Berkowitz L. *(ed.), Advances in Experimental Social Psychology, Vol 1. New York: Academic Press.*

Solomon, R. 1976. *The Passions.* Garden City, NY: Anchor Press/Doubleday.

Squire, L.R. & Knowlton, B.J. 2000. Medial temporal lobe, the hippocampus, and the memory systems of the brain. In Gazzaniga, M. (Ed.) *New Cognitive Neurosciences: Second Edition.* Cambridge, MA: MIT Press, pp 765-779.

Tulving, E. 1991. Concepts of human memory. In *Memory: Organization and Locus of Change,* (Eds.) Squire, L.R., Weinberger, N.M., Lynch, G. & McGaugh, J.L. New York: Oxford University Press.

Tulving, E. 2000. Introduction to the section on Memory In Gazzaniga, M. (Ed.) *New Cognitive Neurosciences: Second Edition,* Cambridge, MA: MIT Press, pp 727- 732.

Watson, J. & Rayner, R. 1920. Conditioned emotional reactions. *Journal of Experimental Psychology,* 3, 1-14.