The Origins of Affect and Affective Neuroscience

And the misplacing of Affect in the Neo-cortex

This paper is really a preamble to B3 Part II, which has been updated, and originally appeared on this website as simply B3. During the last several decades Jaak Panksepp has shown that mammals and humans have seven Emotional Operating Neuro Circuits deep within the brain: this means that our basic affects are not neo-cortical in origin (Panksepp 1998; Panksepp & Biven 2012).

This has implications for our general well being; and it also has implications for education, psychology, medicine, society, and ethics. Yet the present medical and psychological conventional wisdom is often still operating within a limited paradigm that has yet to embrace the therapeutic implications of Affective Neuroscience.

Part II of B3 may be seen to have more immediate relevance to Stress, Affect Dysregulation, and Stress Management; Part I attempts to place Affective Neuroscience in an appropriate historical context; that historical context may have sown the seeds for an ongoing – and inappropriate – Mind Body split – which continues to cause problems (Dobbin & S. Ross 2012). Towards the end of this paper there are several illuminating diagrams / figures that emphasise recent developments in our understanding of the human brain and human affect within a therapeutic context.

Contents

1. Introduction

As already indicated, this is the first of two linked papers on Affective Neuroscience. Part I is a general introduction, which attempts to place Affective Neuroscience in the context of historically held assumptions regarding consciousness, affect, and the neocortex; this forms an essential backdrop to Part II, which reviews the specific Emotional Operating Neuro Circuits (Systems – EONS) described by Panksepp (Panksepp 1998). A proper understanding of therapies for human distress, including Autogenic Training, can only be realised if we have a good grasp of the brain origins of affect (Panksepp & Biven 2012 e.g. pp ix – xxiii).

In a 2010 interview with Jaak Panksepp, Ginger Campbell's conclusions included the following:

> Dr Panksepp's main message is quite straightforward. Based on his decades of work with a wide variety of animals, he has isolated at least seven sub-cortical circuits that are the origin of affective experience. This means that emotional experience originates in the sub-cortical parts of the brain that evolved before humans, and even before primates. Other animals may not be able to analyse their emotions the way we do, but there is no doubt that they have feelings.
>
> Campbell 2010 p 33
> (Summary after Panksepp / Campbell interview)

We can see affect and emotion in terms of the organism's need to learn and adapt to the environment.

> Every emotional system down in the sub-cortical area is a special-purpose learning system. The SEEKING System is simply the broadest. It's for all resources, including safety……
>
> Panksepp 2010 p 27
> (being interviewed by Campbell 2010)

2. Affective Neuroscience in an historical context

Jaak Panksepp has been one of the main pioneers in the development and research of Affective Neuroscience. He grew up in the era of behaviourist psychologists such as B.F. Skinner; at that time emotions were regarded as merely subjective experiences and not worthy of scientific study. Panksepp disagreed fundamentally with this behaviourist perspective.

Attention then shifted towards Cognitive Neuroscience and the subsequent development of Cognitive Behaviour Therapy (CBT); this accepted that emotions and feelings were of importance, yet assumed that emotions were unique to humans and were a purely neo-cortical phenomenon. A reminder of the place of the neo-cortex in a basic model of the brain may be helpful.

The Neo-cortex

Paul McLean's model of the tri-une (three in one) brain embraces:

i. Reptilian Brain (including the basal ganglia), and the brain stem – which is crucial for basic life functions such as cardiac / respiratory regulation and digestion.
ii. Old Mammalian Brain – including the limbic system, and structures such as: septum, amygdala, hypothalamus, hippocampal complex, and cingulate cortex. This includes our basic Emotional Operating Neural Circuits.
iii. The Neo-cortex (Latin for 'new-bark'); this is the outer mantle of the cortex / cerebral hemispheres consisting of just six layers. In humans "it is involved in higher functions such as sensory perception, generation of motor commands, spatial reasoning, conscious thought, and language" (Wikipedia 2012a): in addition to "abstraction, planning, and perception" (Wikipedia 2012b). In particular, the Pre Frontal Cortex in humans allows us to Affect Regulate effectively – if we have been blessed with nurturing and caring parents (Sunderland 2007).

Our overall Well Being is largely determined by the state of our Affects and Emotional Operating Neuro Circuits deep within the older parts of the brain. Mental Training such as Meditation and Autogenic Training is thought to change the dynamics of the Pre Frontal Cortex – and so has the potential to reduce distressing affective circuits in the deep-seated parts of the brain, while at the same time facilitating positive affect (Davidson 2003A; 2003 B p 194; 335; 338-340: Goleman 2003 p 12: Ross 2010 pp 147-149: see also B5[1] in this series).

3. What is Affect?

Affect embraces more than emotion, and we can simplify it to three main areas or levels (Panksepp 2011 6.00 min), which are:

i. Sensory Affects: in the sense of pain / taste etc.
ii. Bodily Affects: feelings relating to, for example, hunger and thirst[2].
iii. Within the brain Affects: emotions.

Where do primary emotions originate?

Several decades ago, electrodes were placed in the brains (the neo-cortex) of various mammals. It was found that by stimulating the motor cortex, movement could be elicited in the animal – e.g. the movement of a leg. In humans, if the sensory cortex was stimulated, then that could give rise to a sensation – for example, of the left little toe being touched.

Research over the years has failed to show any evidence of emotional systems within the neo-cortex – i.e. there was nowhere in the cortex where an electrode was found to stimulate an affect.

> *Historical note on Walter Hess*
>
> Walter Hess, during the 1930s, placed electrodes in the hypothalamus of a cat's brain, and found that in a certain area this produced behaviour that a lay observer would regard as rage. Hess, in his published papers, called this 'sham rage', going along with the existing paradigm that animals do not experience feelings. According to Panksepp (Panksepp 2011 at 16.10 mins), Hess – after he had retired – admitted that he had never felt that the cat was exhibiting sham rage: rather, that this was real rage[3].

Panksepp, however, following in the steps of Hess,[4] found that deep down in the brain specific emotions could be elicited by such electrical stimulation. This implies that there are within mammals discreet Emotional Operating Neuro Circuits / Systems (EONS) that can be activated by energising (with the electrode) specific brain areas – for example, in the amygdala, hypothalamus and peri aqueduct grey. Panksepp has now described / discovered seven discreet systems: RAGE, FEAR, SEEKING (e.g. seeking food, water, shelter, companionship), LUST (relating to sexual circuits), CARE, Separation Anxiety (manifesting as

[1] B5 summarises, with diagrams, the findings of Davidson, and Davidson & Goleman, that show EEG activity in the Pre Frontal Cortex (PFC) in relation to affect; however, it is the changed PFC dynamics / neuro-physiology that then modulates Affect in the deep brain structures (i.e. the modulation does not occur within the PFC per se).

[2] This includes Feelings as described by Damasio. Damasio contrasts emotions (the unconscious emotional processes that have their origins in the Reptilian and Old Mammalian Brain), and Feelings, which are the subjective awareness and experience of emotions; while these neuro-circuits reside in the older parts of the brain (including the subjective awareness / experience of the feeling), they communicate with neo-cortical circuits. [Damasio 1994, 1999 (e.g. pp 284-287), 2003].

[3] We all tend to be caught up in the existing paradigms / assumptions / prejudices of our age. Hess – just as many scientists still are – was working within the Cartesian paradigm of a split mind and body. Descartes would have said, vis-à-vis the cat experiment: "That does not matter; it (i.e. the cat) is just a puppet" (Panksepp 2011 at 15.55 mins). Darwin would have regarded Hess's results as indicating that animals share basic emotions with humans (Darwin 1872 /1998).

[4] Panksepp, in his initial research, used rats rather than cats (Panksepp / Campbell 2010 p 9).

PANIC / GRIEF and sadness), and PLAY. It may seem odd that PLAY has discreet Emotional Operating Neuro Circuits just as the other EONS; yet this has been the finding of Panksepp's research (see for example Panksepp 1998 pp 280-299; also Panksepp & Biven 2007 p xi).

The inference of this work is that our basic emotions originate in ancient structure of the brain – that is, deep down and near the mid-line, and mainly within the old mammalian brain (including the limbic system). The EONS do not therefore rely on the neocortex or thinking. These dynamics are summarised in Figure 1:

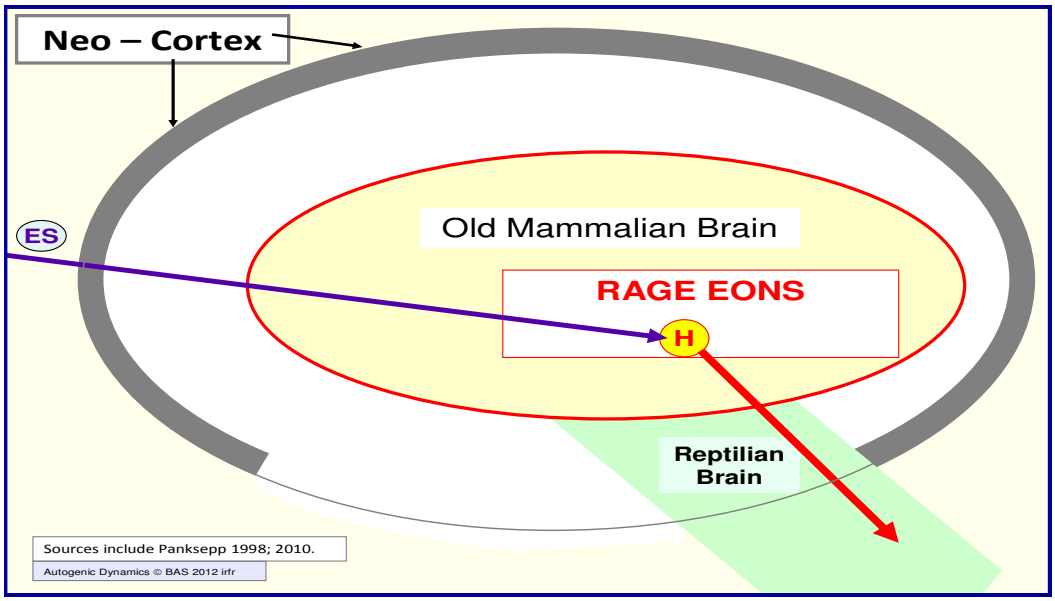

Figure 1
Schematic illustration of the original research by Hess (on cat) and Panksepp (on rat)

Comments on Figure 1

- Electrical Stimulation (ES) of the hypothalamus (H) depicted by the purple arrow coming in from the left.
- This elicits aggressive / anger / RAGE behaviour depicted by the red arrow output from the RAGE system.
- Such aggressive behaviour occurs if the electrode is put in anywhere along the RAGE neural circuits.
- Stimulation of the neo-cortex does not produce aggression / anger.
- Similar findings occur with all seven EONS described by Panksepp (1998).
- This suggests that these EONS are deep seated structures that developed prior to the development of the neo-cortex, in evolutionary terms.

4. Can we tell if animals like or dislike basic emotions?

Some EONS produce distress, others a desire for more (of that EONS).

As mentioned in the comments of Figure 1, Panksepp found seven discreet EONS by this method. He then wondered if the animals liked the particular EONS or found them distressing. So he set up tests in which the animal was able to switch on the electrode already sited in the brain (called self stimulation). He reasoned that if the animal kept switching on the electrode, this indicated the response was positive / pleasant; whereas if it was switched off that would indicate the EONS in question caused distress. FEAR,

RAGE[5], and PANIC circuits were disliked, whereas others, such as CARE, PLAY and SEEKING resulted in on-going self-stimulation.

The SEEKING system is involved in basic survival such as SEEKING food, water, and shelter. It is also closely related to the EONS that are, or are potentially, associated with positive affect, such as the PLAY, CARE, LUST / SEXUAL and PLAY circuits. Panksepp argues that the so called Reward System is a misnomer[6] – and is actually a subset of the SEEKING system. It is the positive affect induced by the SEEKING that is, in effect, the 'reward' (see also Section 5 below).

5. The 'Reward system'; SEEKING circuits and Well Being.

We normally think of a reward as getting something pleasant for some work / endeavour we have carried out: here the reward is external[7]. The Behaviourists used to talk about a 'Reward System' in some of their early research – when, for example, an animal would get a reward (e.g. food) when pressing an appropriate lever. The term is still widely used by psychologists / behaviourists.

Panksepp sees the term 'Reward System' as somewhat misleading. In terms of the self-stimulation described in Section 4 above, the reward can be seen in terms of an internal feeling where the EONS gives a positive valency: where the valency is negative, the animal will not self stimulate.

If we are hungry and are seeking food, the SEEKING circuits will be active; when food is found, the SEEKING circuit (of this particular domain – i.e. hunger) becomes inactive. The 'Reward System' described by the Behaviourist involves the SEEKING circuits; but in the latter it is the process (i.e. the seeking) that is important and gives drive and meaning. Once the SEEKING has been fulfilled, the neural (SEEKING) arousal for that particular modality is inhibited (Panksepp 1998 p147) – and will then switch to some other area of curiosity / interest.

The SEEKING system described by Panksepp can best be seen in terms of a general "foraging / exploration / investigation / curiosity / interest / expectancy / SEEKING- system" (Panksepp 1998; p 145). This means it is non specific: for example, the positive EONS (i.e. CARE, PLAY, LUST / Sexual drive) are intimately linked with the SEEKING system. If our SEEKING system is destroyed or is suboptimal (e.g. in depression), our CARE, PLAY and SEXUAL circuits will be compromised: this can profoundly damage our Well Being (see A3 of this series). In the case of babies / children, their curiosity and energy for life (i.e. their SEEKING system) can be severely impaired by inappropriate parenting – for example, if parents are (over-) critical of (the child's) "noise, mess, and lots of running about", and where the main recreation for their children is watching television (see Sunderland 2007 pp 101- 102).

In general terms, we can say that curiosity, interest, investigating phenomena[8] and exploration (all aspects of the SEEKING system), are fundamental to our Well Being.

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[5] RAGE circuits are actually more complex than the above summary implies as there is more than one type. Anger / RAGE caused by, for example, us or our children feeling threatened was not liked. On the other hand, in the context of predatory aggression / RAGE, the animal would self-stimulate these particular circuits (Panksepp 2010 p 9). In the human context, this means that anger is normally a distressing experience – but in certain predatory pursuits such as foxhunting and in war scenarios, activation of these 'predatory' RAGE circuits may result in what we could term an aggressive / predatory buzz.

[6] Once the SEEKING – for example for food – is satisfied, there is a reduction in brain arousal; we do not (normally) just go on and on eating (see Panksepp 1998 p 147). We have to be careful not to make false conclusions from the research in the artificial self-stimulation of various brain areas by animals in the laboratory.

[7] Such external rewards can, of course, motivate us (as a sort of external locus of control motivator).

[8] This is one of the Seven Factors of Awakening in Buddhist psychology – see Hanh 1998 p 216)

6. Levels of emotional processing and consciousness

Consciousness seems to be an attribute not only of humans but also, for example, mammals. It is not primarily a neo-cortical phenomenon. Panksepp regards fundamental consciousness[9] as intimately linked with ancient brain structures and the EONS (Panksepp 1998; 2005); he calls this the primary process level (Panksepp / Campbell 2010 p 10; Panksepp & Biven 2012 p xi). In this context, we can distinguish three levels of processing / research.

Primary Process level:

This embraces the (seven) basic EONS described by Panksepp that are located in deep structures of the ancient brain (old mammalian brain / limbic system). A summary of some of the basic features of this primary level are shown in Figure 2 below.

Primary Process Level	Comments
EONS embracing basic consciousness and affect	These are sited in deep mid-line structure of the limbic system / old mammalian brain. • EONS "….. seem to be built as instinctual systems in the brain, so once you activate them the animal acts out an ancient scenario of behaviour" (Panksepp 2010 p 16). This is the "unconditional response" of the behaviourist (op cit). • EONS are linked in with deep seated levels of consciousness. • EONS do not in themselves involve neo-cortical processing. • EONS have a basic conscious-affective tone. • The Pre-Frontal Cortex (part of the neo-cortex) can have a modulating effect on EONS; mental training can facilitate such modulation in a positive direction (see page 10; and also B2 and B5 of this series)

Figure 2
BrainMind[10] : Primary Process Level.

Secondary Process levels are illustrated in the work of LeDoux, and embrace Pavlovian type learning:

Secondary Process Level	Comments
"Inbuilt emotional learning mechanisms" (Panksepp & Biven 2012 p xi) An example of this level is learning in Pavlovian sense. LeDoux's work is in this area (e.g. LeDoux 1998; 1999 pp 165-168).	Pavlov's classic work with dogs can be summarised thus: food produces salivation, the "unconditional response"; so the food here is the unconditional stimulus (see also Ross 2010 pp 208-209). • If the food is paired with a bell for a few days, and then the bell sounded without the food, the dog salivates. • This salivation is a Conditional Response to the bell (the Conditional Stimulus). • In humans, FEAR circuits can be activated by both Unconditional Stimuli (e.g. an angry person threatening us) and by a Conditional Stimulus (tall men, if in childhood our father was tall and frequently aggressive). These responses are occurring at an unconscious level. (See Ross op cit; and also p 293). • So Pavlovian learning, which involves these basic EONS, is an unconscious process.

Figure 3
Secondary Process Level – for example Pavlovian type learning.

[9] As does Damasio – 1999 & 2010
[10] The brain – or better, the BrainMind* – is an evolutionary layered organ with consciousness originating at a deep level (Panksepp 2010 p 10). * Panksepp feels it is inappropriate to separate brain and mind, hence his notation 'BrainMind' – e.g. Panksepp & Biven 2012 p xi).

Tertiary Process levels

In evolutionary terms this is the highest level and involves complex abilities such as "thoughts, planning, intuition (and) creativity" that can only be properly studied in humans (Panksepp 2010 p 10). This is exemplified in the work of Antonio Damasio, a neuroscientist and clinician. This tertiary level is summarised in Figure 4.

Tertiary Process Level	Comments
Embraces all brain levels including the neo-cortex and has been particularly developed in humans. "Emotional thoughts and deliberations that are so evident in human experience." (Panksepp & Biven 2012 p xi)	The catastrophic injury that Phineas Gage suffered (in 1848) caused disruption in the pathways between the limbic system and the Pre-Frontal Cortex (Damasio 1994 pp 3-51). This did not result in any impairment in neo-cortical processes involving the intellect such as making arithmetical calculations, yet it destroyed his sense of social convention and ethical code (Damasio 1994 p 11; Ross 2010 p 143). • This implies that we need more than just our neo-cortex. • The injury had severed parts of the SEEKING system (Turnbull 2003 pp 135-162). • Subsequent research on patients with ventro-medial frontal lobe damage (similar to Phineas Gage) suggests that without gut feelings, we make bad decisions[11]. This reflects an aspect of the 'Somatic Marker Hypothesis' of Damasio (e.g. Damasio 1994 pp 205-222; see also Dobbin & S.Ross 2012 for a lucid overview of the Somatic Marker Hypothesis; see also footnote 12).

Figure 4
Tertiary Process Level embracing neo-cortical and lower mid-line structures

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Absence of neo-cortical involvement in the feeling of emotions (based on work by Damasio)

Much recent research has utilised fMRI – functional Magnetic Resonance Imaging; but this does not image feelings very well (i.e. subjective feelings), whereas Positron Emission Tomography (PET) does. Damasio (Damasio et al 2000) studied volunteers (using PET) who recreated the specific emotions of fear,

[11] In some sophisticated research into behaviour when gambling, Bechara, Damasio et al showed that those with Phineas Gage type lesions are very bad at gambling; the inference is that we need our gut feelings to make reliable decisions – whether in gambling or more normal walks of life. That is to say, we learn at an implicit bodily level that some actions lead to poor outcomes, and therefore do not take them: this is not at a conscious level. Ventro-Medial lesions deprive us of this (unconscious) ability (Bechara et al 1997; Damasio 1994 pp 212-222).

- More specifically, the gambling experiment was set up with four packs of cards the subjects had to choose from. Some packs had high rewards, but then very high / crippling losses. Other packs had lower rewards, but these were consistent and only associated with very small losses.

"Normal participants and patients with prefrontal damage and decision-making defects performed a gambling task in which behavioral, psycho-physiological, and self-account measures were obtained in parallel. Normals began to choose advantageously before they realized which strategy worked best, whereas prefrontal patients continued to choose disadvantageously even after they knew the correct strategy. Moreover, normals began to generate anticipatory skin conductance responses (SCRs) whenever they pondered a choice that turned out to be risky, before they knew explicitly that it was a risky choice, whereas patients never developed anticipatory SCRs, although some eventually realized which choices were risky. The results suggest that, in normal individuals, nonconscious biases* guide behavior before conscious knowledge does. Without the help of such biases, overt knowledge may be insufficient to ensure advantageous behavior"

Extract from Abstract: Bechara, Damasio et al 1997 p 1293

* The "non-conscious bias" is reflected in the SCR response – so these *physiological changes* warn the player at an unconscious level – IR.

sadness, anger, and happiness. The results showed that these states were associated with deep level brain activity – with little / no neo-cortical involvement.

> The most visually salient result in the whole-brain search was the finding of major negativities in neocortical areas in both hemispheres[12].
>
> Damasio et al 2000 p 1050

A schematic illustration of the findings is given in Figures 5 to 8. The colour key used in all the figures is as follows:

- Red areas: increased activity (following Damasio et al 2000).
- Yellow areas: reduced activity (Damasio's illustrations use purple for reduced activity – change made for the sake of visual clarity).

Note that in the case of the subjective feeling of fear, the left side of the brain is shown, whereas in the case of sadness, anger, and happiness the right side of the brain is illustrated. Note also that the increased and reduced activities of the two sides of the brain for each of these four emotions are not identical. This is no surprise as for many years it has been clear that the two hemispheres are not identical anatomically or functionally (see for example, McGilchrist 2009).

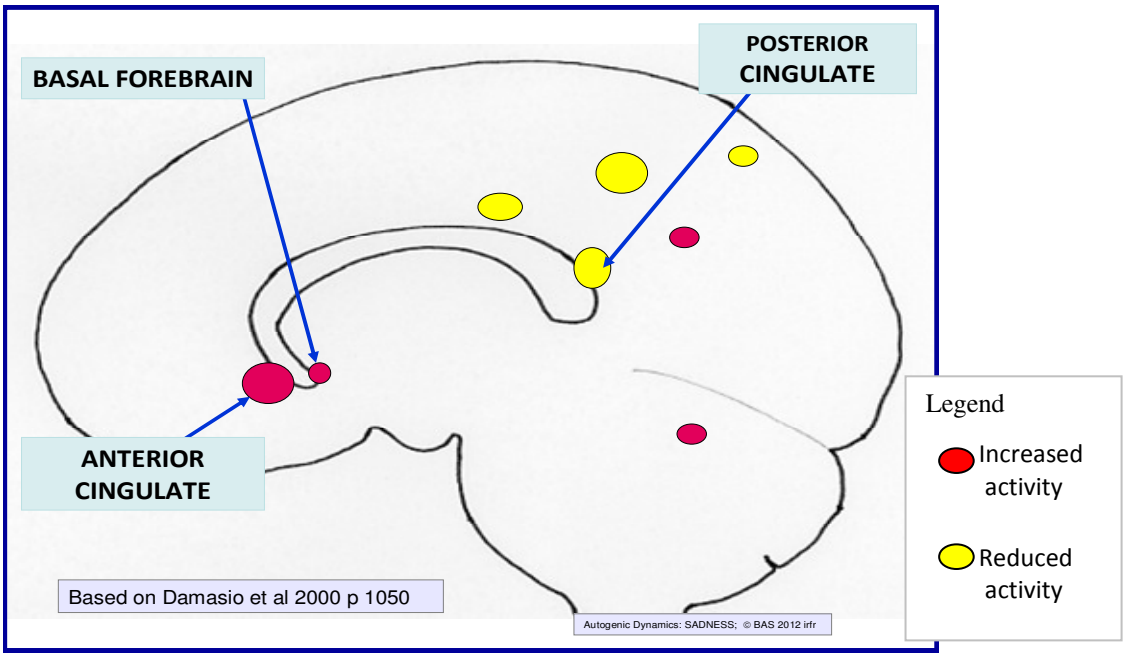

Figure 5
Neural Correlates of feeling Sadness (GRIEF circuits) using PET
Right side of brain – highly schematic
Based on Damasio et al 2000; Panksepp & Biven 2012 p 315
Colour representations changed for clarity

Comments on Figure 5

Notation: Red areas: increased activity
Yellow areas: reduced activity

Note:

- Neo-cortical areas are not correlated with the feeling of Sadness.
- Activity on the Left side of the brain is not a mirror image – but is similar in inference – i.e. that the neocortex in not directly involved in Sadness.
- This implies that when we are sad / suffering from loss / separation, this is actually an emerging feeling from neuro-circuits deep within the brain; subsequently, we may neo-cortically elaborate on these feelings (i.e. thinking).

[12] This footnote by IR not Damasio: 'negativities' here refer to no activity on PET in the neo-cortical area.

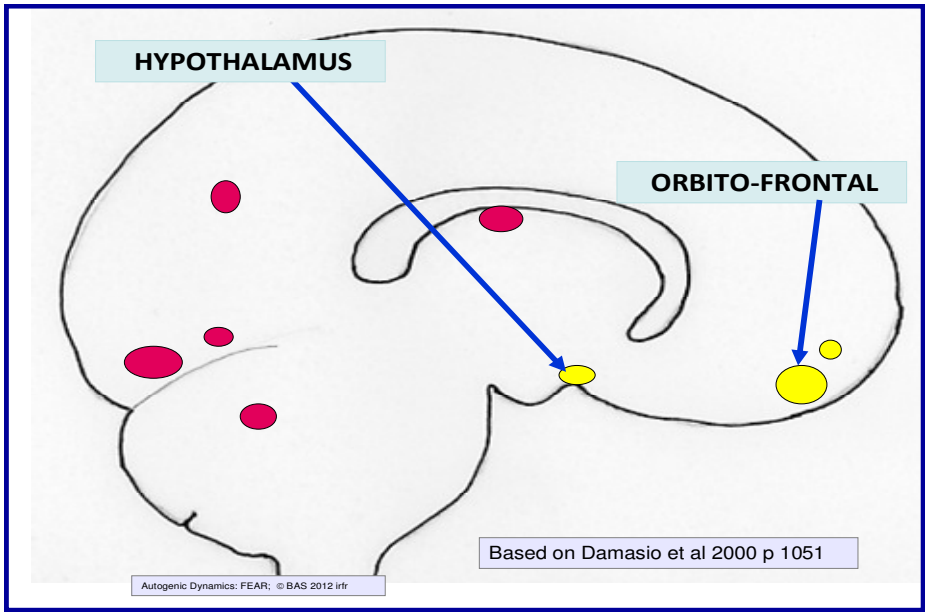

Figure 6
Neural Correlates of feeling Fear using PET

Left side of brain – highly schematic

Based on Damasio et al 2000; "Fear activates midbrain and deactivates left Secondary Somatosensory Cortex, hypothalamus, and orbit frontal cortex"
(see Figure 2, p 1051 for full details of precise brain areas implicated).

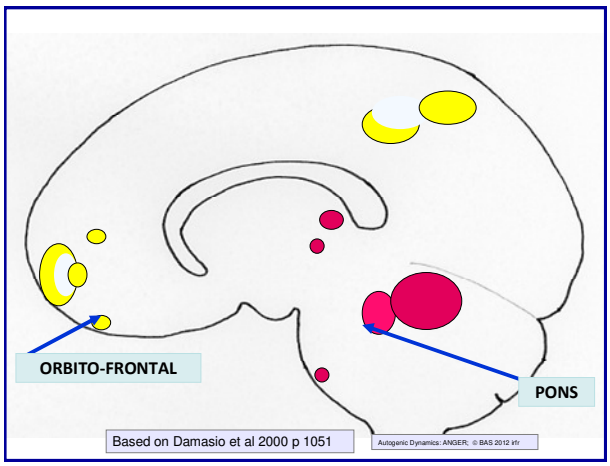

Figure 7
Neural Correlates of feeling Anger using PET
Right side of brain – highly schematic
Based on Damasio et al 2000
Colour representations as before

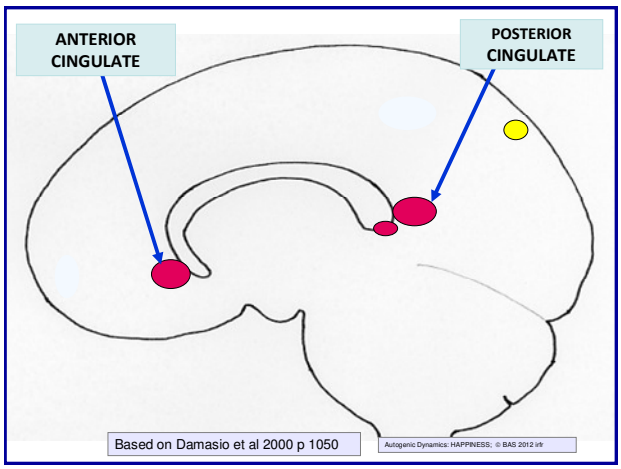

Figure 8
Neural Correlates of feeling Happiness
Right side of brain – highly schematic
Based on Damasio et al 2000
Colour representations as before

The implications of these findings overlap with Panksepp's perspective: the neo-cortex is not primarily involved in these feelings – and by inference, nor is basic consciousness – i.e. the subjective awareness of these feelings resides in interlinked sub-cortical circuits.

Note also that in many of the brain areas:

- Sadness / GRIEF had the highest activations (e.g.: Right & Left Insula, Left Anterior Cingulate, Left & Right Orbitofrontal, Left and Right Basal-forebrain (Damasio et al 2000 Table 1 p 1052; Panksepp & Biven 2012 p 314 "…the GRIEF system showed the clearest and most extensive arousal".)
- This suggests that distress associated with loss, separation, sadness, and grief are very deep seated; they reactivate our primordial childhood Separation Distress circuits – and so can be particularly difficult to recover from (see for example Bowlby 1969; Sunderland 2007 e.g. p 22).

7. PLAY, the neo-cortex, undergraduate students and Panksepp /

7. PLAY, the neo-cortex, undergraduate students and Panksepp

PLAY in decorticate rats – an experiment

As already indicated, we tend to assume that Affect and emotions are very much a neo-cortical phenomenon; but we are wrong. A good demonstration of the actual brain locus of EONS – in this case PLAY – is given by Panksepp, when he did a lab experiment with students in the context of whether rats need the neocortex for PLAY (Panksepp 2011 at 48.00 mins).

> Once I had an undergraduate laboratory class on animal behaviour and the brain. I had sixteen students, and I said: "The last experiment you are going to do is I'm going to bring two animals into the lab; one of them is missing the whole neocortex – taken away at three days of life – the other animal will have gotten sham surgery. And the mother takes care of them, and they grow just like normal. Your job is to tell me who's who. You have spent a semester studying animal behaviour, and you make the choice in whatever way you wish."
>
> Panksepp / Campbell 2010 p 18

After the two hour lab experiment was finished, twelve (of the sixteen) students thought that the decorticate rats (i.e. the ones that had no neocortex) were the normal rats. In the subsequent debriefing, it became clear that these twelve students based their choice on the fact that the (decorticate) rats that they selected were more interesting – they were moving around more, looking around more, and generally showing more active engagement[13]. In contrast, the normal rats were somewhat inhibited, somewhat scared (i.e. from the laboratory experiment with the students). Such behaviour is typical of neo-cortical inhibition. The decorticate rats were in fact dis-inhibited.

Affect Regulation requires our Pre Frontal Cortex

In the context of human society, we do of course need our neo-cortex (specifically, the Pre Frontal Cortex) to appropriately modulate our emotions – and this can be developed with appropriate Mental Training[14] (see, for example: B5, B9; C7 & C10 in this series), which facilitates Mindfulness (e.g. Siegel 2007 pp 337-345). Some of these aspects are depicted in Figure 9.

[13] This particular piece of research on rats actually shows that the neuro circuits for both PLAY and SEEKING are sub-cortical.
[14] Such as Meditation / Autogenic Training.

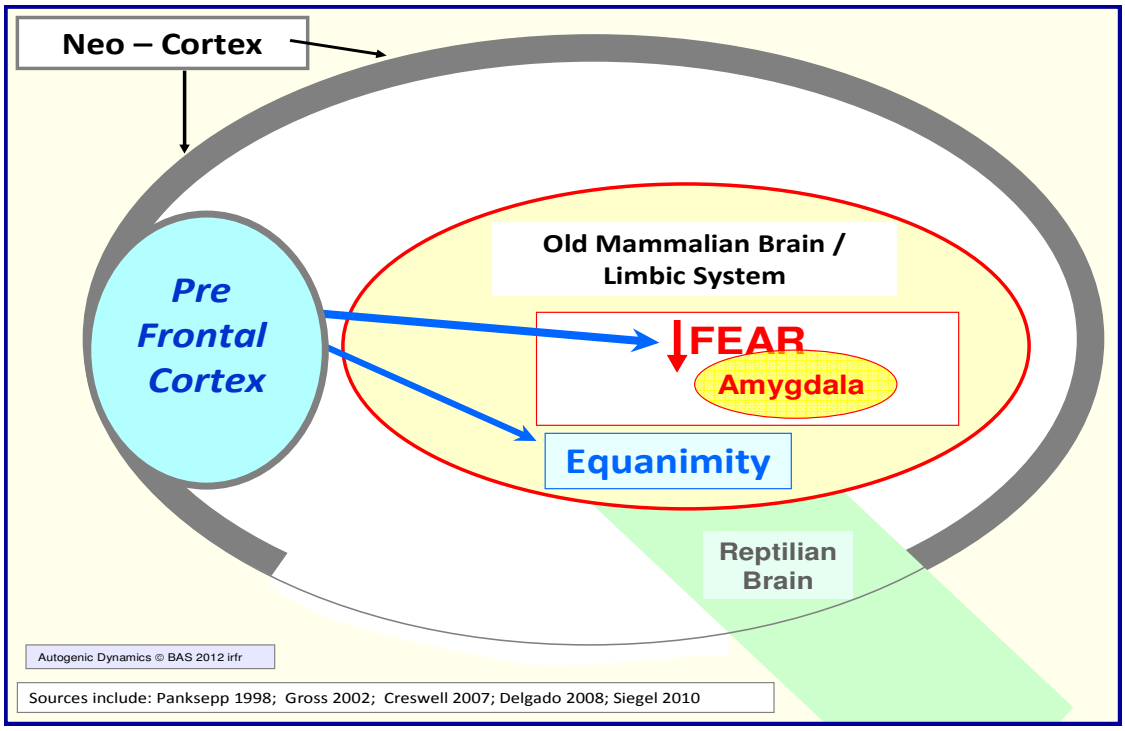

Figure 9
Modulation of Affect by the Pre Frontal Cortex

Comments on Figure 9

- The Pre Frontal Cortex (PFC) is part of the neo-cortex.
- Particularly important parts of the PFC, from the perspective of Affect Regulation, include Lateral PFC, Ventro-Medial PFC (Gross 2002; Cahn & Polich 2006; Delgado 2008); Medial PFC (Creswell 2007; Siegel 2010);
- In general terms, PFC activation reduces amygdala activity (Gross 2002; Delgado 2008), and in particular reduces negative affect such as FEAR (anxiety) and RAGE.
- Mental Training, via the PFC, facilitates in settling tensions within the body [which can be associated with a 'negative interpretation bias' secondary to hyper-vigilant states (see Dobbin & S. Ross 2012 and also webpages B10 & B11)] – and in bringing about a state of equanimity.
- In addition, the Medial PFC is associated with nine specific positive functions:

• Bodily Regulation	• Empathy
• Attuned Communication	• Insight
• Fear Modulation	• Morality Modalities
• Response Flexibility	• Intuition
• Emotional Balance	

Based on Siegel 2007 pp 337-345
See Figures 1 & 2, pages 3 & 4 respectively, of C10 for further details

8. Consciousness, CARE, and Compassion

As already implied, consciousness is intimately linked with Affect and our EONS – for example, with PLAY, SEEKING, and CARE; basic consciousness is not a specific attribute of the neo-cortex – rather, consciousness has its origins in our old mammalian and reptilian brain (Panksepp 1998 – e.g. pp 309-313; and Panksepp 2005; Damasio 2010). The neo-cortex is not essential for the sensation of pain or for affiliative bonding.

Pain and the neocortex

Children with hydranencephaly, as their parents will know, experience pain. Yet as of 2007 this was not widely appreciated by the medical profession: "It is not uncommon for parents to encounter surprise on the part of medical professionals when requesting analgesia or anaesthesia for their crying children during invasive procedures….." (Merker 2007 p 80; see also Shewmon et al 1999). For the parents it is obvious that their child suffers pain. Incorrect ideas can be very strongly held, and can be very dangerous[15].

> In hydranencephaly the cerebral hemispheres are replaced by sacs filled with cerebrospinal fluid; in anencephaly there is a neural tube defect in which the neo-cortex / cerebral hemispheres basically do not develop. In both conditions, consciousness and affect awareness (including pain) can be present.

Affect in babies / children without a neocortex

Babies who are born without a neocortex (anencephalic / hydranencephalic) have potential consciousness and can develop positive affect. However, conventional medical wisdom has historically thought otherwise.

> Infants with anencephaly, lacking functioning cerebral cortex, are permanently unconscious…..the suffering associated with noxious stimuli (pain) is a cerebral interpretation of the stimuli; therefore, infants with anencephaly presumably cannot suffer.
>
> Medical Task Force on Anencephaly 1990; quoted by Shewmon et al 1999 p 364

As already discussed, such children do experience pain (Merker 2007). The assumption that the neocortex is essential for consciousness and the subjective experience of affects has led to the assumption that "any form of congenital decortication will equally yield a development vegetative state" (Shewmon et al 1999 p 364). Shewmon et al then go on to say a single "counter example" is sufficient to disprove a "universal truth". They then discuss four such examples.

Research suggests that the lack of apparent affect and consciousness in such children may simply reflect what happens when it is assumed that these children are essentially in a vegetative state – which is particularly the case when they are put into institutions.

> The relative rarity of manifest consciousness in congenitally decorticate children could be largely due to an inherent tendency of the label 'developmental vegetative state' to become a self fulfilling prophecy.
>
> Shewmon et al 1999 p 364

The research by both Shewmon and Merker suggests that such decorticate children have historically done best when their parents (or foster carers) disregard medical advice.

> What surely made all the difference was that their (i.e. the decorticate children's) parents ignored the prognosis and advice, and instead followed their instincts to shower the children with loving stimulation and affection. Such children and their families have much to teach about not only the neurophysiology of consciousness (sic).

[15] As Thich Nhat Hanh has said: "a man with a gun can kill a number of people, but a man with a fixed ideology can kill millions" (paraphrasing Hanh 1993 pp 37-39).

Shewmon et al 1999 p 373

Specific nurturing and caring by their mother (or foster mother) stimulates affect, affect responsiveness, and consciousness, indicating that such transformations may reflect " 'vertical' plasticity of the brainstem and diencephalic structures" (op cit; and see Shewmon et al 1999 for very moving examples).

Affect in a three year old anencephalic girl (cited by Merker 2007)

So the research in this area suggests that if children without a neocortex are assumed to be affectless, then this may be what is experienced by observers – especially in the context of institutions. If, on the other hand, they are nurtured and talked to and treated as sentient beings, especially when there are caring siblings, then they can develop in some remarkable ways – interacting with others in an effective and affective way (Shewmon et al 1999; Merker 2007; Panksepp 2011 at 50mins 40 secs; Panksepp & Biven 2012 pp 490-492).

Figures 10 to 13 illustrate the above schematically, starting with the underlying brain anatomy in Figures 10 and 11.

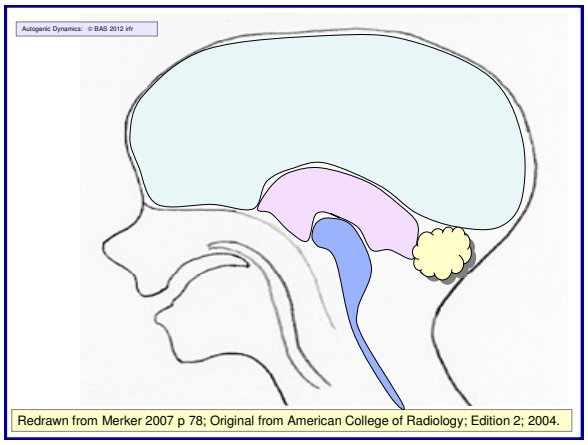

Figure 10
Normal Child – *Brain Configuration*
Highly schematic

The brain stem is represented in blue.
The limbic system / old mammalian brain in light mauve.
The neo-cortex in light blue.

Brain areas showing only relative positions, not exact sizes or shapes.

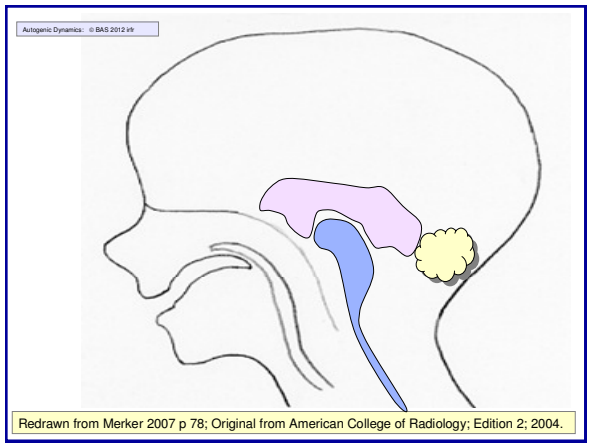

Figure 11
Anencephalic Child – *Brain Configuration*
Highly schematic

Brain areas as in Figure 10

- Note absence of neo-cortex.

Figure adapted from original radiographs illustrated in Merker 2007 p 78 and Panksepp & Biven 2012 p 491 Figure 13.2

Figure 12 and 13 (on the next page) illustrates (symbolically) the effects on a three year old anencephalic child – whose younger brother has just been placed in her arms by her parents (Figure 12). In Figure 13, taken a short time later, her affect has changed in the on-going presence of her sibling and her parents.

This series of Figures (10-13) may well induce feelings of compassion in us for the family and child. Compassion itself has its own neural correlates; this includes compassion for another's physical pain and psychological / social pain – though the neural circuits are subtly different. It seems that compassion for another's physical pain may "co-opt neural mechanisms for personally experienced pain most efficiently and directly…" – and more so than compassion for another's psychological pain (Immordino-Yang et al 2009). They go on to say:

> If replicated, these findings could have important implications for the role of culture and education in the development and operation of social and moral systems; in order for emotions about the psychological situations of others to be induced and experienced, additional time may be needed for the introspective processing of culturally shaped social knowledge. The rapidity and parallel processing of attention-requiring information, which is the hallmark of the digital age, might reduce the frequency of full experience of such emotions, with potentially negative consequences.
>
> Immordino-Yang, McColl, Damasio & Damasio 2009 p 8024

Such educational and cultural approaches would embrace all three process levels (primary, secondary, and tertiary).

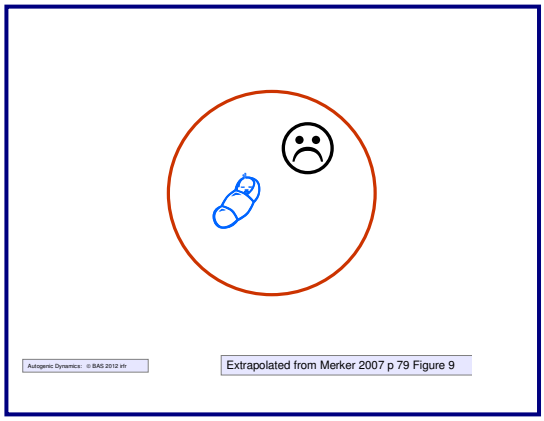

Figure 12

Symbolic representation of three year old girl who is anencephalic whose younger brother has just been put into her arms by her parents

Note the negative affect of the girl at this moment in time (which may have already been negative before her sibling was placed in her arms).

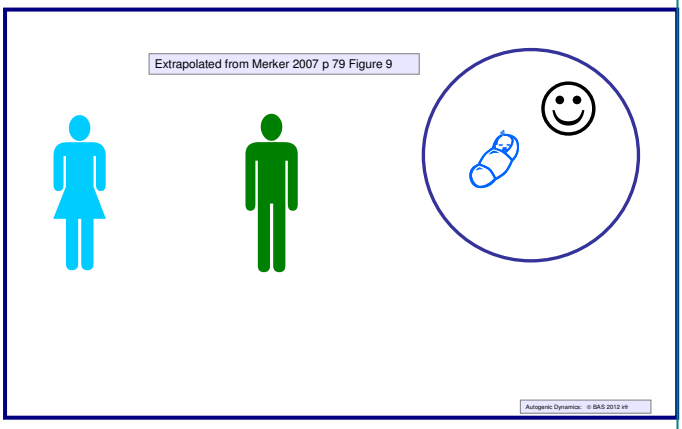

Figure 13

Symbolic representation of the three year old girl who is now settling with her younger baby sibling in her arms; both parents remain Present.

Note transformed affect in the three year old who has no neo-cortex.

Source of Figure 12 and 13: Merker 2007 p 79 Figure 9 photographs. Please see originals available on line (see references).

Similar principles apply for those (adults) suffering from brain diseases such as dementia / Alzheimer's disease, and their carers'.

9. Some concluding reflections on Affect Regulation

Consciousness and affect have their origins in deep seated midline brain structures; for this, the neo-cortex, contrary to conventional wisdom, is not required.

Affect Regulation is facilitated by the neocortex (embracing tertiary process levels), and in particular the Pre Frontal Cortex (PFC); however, in children the PFC is immature and cannot regulate disturbed affect, for which we need nurturing and caring (parental) support (Sunderland 2007). Hence a healthy / "good enough" mother-infant dyad is crucial for the appropriate maturation of these PFC and limbic system neuro circuits. Even with such positive parenting, most of us will still, of course, be affected by the ups and downs of life and sometimes suffer from distress.

Significant Affect Dysregulation tends to come about in childhood[16] when there is inappropriate parenting / education which alters the fundamental affect circuits deep in the brain (primary and secondary process levels).

Whatever our origins, research suggests that Mental Training such as Meditation and Autogenic Training alters the dynamics of the Pre Frontal Cortex in a positive way, as a result of which deep seated affect circuits are changed - and this can bring about appropriate Affect Regulation and well being. In order to properly understand the dynamics and transformative powers of Meditation and psychotherapies, some knowledge and grasp of both the primary process level of EONS, and the secondary level which embraces conditional stimuli and conditional responses, is essential. In B3, Part ll, we look at the specific infra-cortical EONS as described by Panksepp.

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[16] For the avoidance of doubt, here we are now referring to children with normal brains at birth.

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A3	Towards a concept of happiness and well-being
A7	Porges and the Polyvagal Theory – reflections on clinical and therapeutic significance
A8	The Polyvagal Theory and a more sympathetic awareness of the ANS
B2	Reframing, Reappraisal, and Well Being
B3	Part ll: Emotional Operating Neuro Circuits – *a brief introduction to the work of Panksepp*
B5	Emotions, Frontal Lobe Dynamics, and Meditation
B9	Mental Training, the Pre Frontal Cortex, Resilience and Equanimity
B10	Snakes, Conditional Stimuli, and Equanimity – *Approaches to treating mind-body disturbances*
B11	Transforming Distressing Mind-Body-States – *from Negative Ruminations towards Well-Being*
C7	Being in touch with Feelings – *Hemispheric Integration*
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