Emotions, Frontal Lobe Dynamics, and Autogenic Training

in the context of autonomic afferent lateralisation

Contents

Thanks to Annie Sturgeon for her helpful suggestions and proof reading.

Preamble to updated version / Abstract

I came across the remarkable book "Destructive Emotions – *and how we can overcome them*" [by the Dalai Lama and Goleman] during 2003[1] when I was very fortunate to have a year's study leave from General Practice. During that year, I developed an interest in neuro-science and our emotions. The first version of this paper to appear on the web was based on a short section of a talk given to the British Autogenic Society in 2005 [Ross 2005X].

Part I of this updated paper remains more or less in its original 2005 format; it is brief and based on three Figures. Part II is new.

The original research on emotions and frontal lobe dynamics simply explained the findings, but not the underlying neuro-physiology of the findings. During the last decade, neuro-physiology and affective neuro-science have developed rapidly, and this present paper is an attempt to reflect some of this new knowledge. It now appears that our emotional state is intimately linked to our Autonomic Nervous System. Emotions that are associated with danger and withdrawal[2] [as opposed to approach and Social Engagement] are related to Sympathetic Nervous System [SNS] afferent activity; whereas emotions associated with approach and affiliative type behaviours[3] – and Social Engagement [Porges 2005; 2011] – are associated with PSNS [Para-Sympathetic Nervous System] afferent activity [Craig 2008 pp 272-281].

Furthermore, SNS afferents [nerve fibre transmitting information from the body to the brain] from both the left and right side of the body terminate in the *Right* Insula, whereas PSNS afferents for both the right and the left side of the body terminate in the Left Insula. It is suggested that this autonomic afferent anatomical lateralisation is associated with the underlying neuro-physiology for the frontal lobe dynamics of emotions discussed in Part I.

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[1] Thanks to Tamara Callea, at that time a member of Education and Training Team of the British Autogenic Society.

[2] Sometimes called negative emotions; yet they are vital for survival.

[3] Sometimes called positive emotions – e.g. nurturing and CARE [Panksepp 1998].

Note: The terms positive and negative emotions can be problematic, in that, for example, FEAR (which could be classified as a "negative" emotion), can protect us by motivating us to get out of danger. It may be more helpful to regard some emotions as toxic: for example, hatred and ill-will towards others can be seen as destructive and not helpful to the individual or society [Ekman et al 2005].

Part I: Emotions, Frontal Lobe Dynamics, and Autogenic Training

Our mental state at any one time is echoed by the EEG activity of our frontal lobes [Davidson 2003A; 2003B]:

i. Research over the last decade or so has shown that certain negative and "toxic" emotions (such as rage and anger) are associated with EEG activation of the Right Frontal Lobe of the brain – see Figure 1.
ii. Certain positive emotions such a Nurturing and Care are associated with EEG activation of the Left Frontal Lobes – Figure 2.
iii. Meditative (and thus Autogenic States) are also associated with EEG activation of the Left Frontal Lobes – Figure 3.

These dynamics are shown schematically in Figure 1 and Figure 2 below:

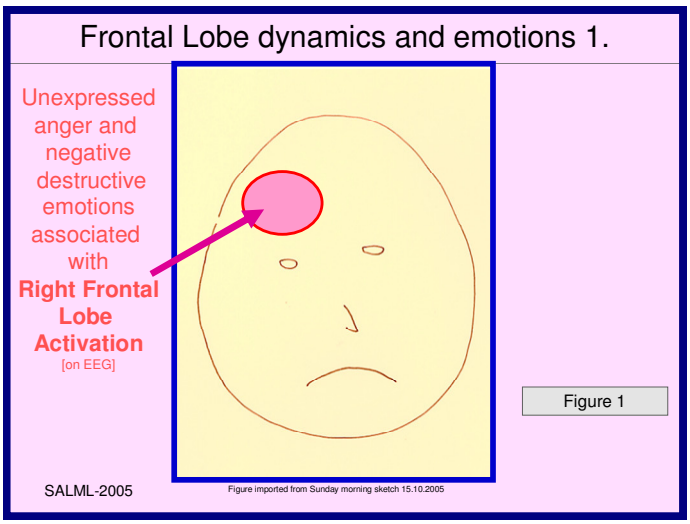

Figure 1
EEG activity associated with toxic / destructive emotions

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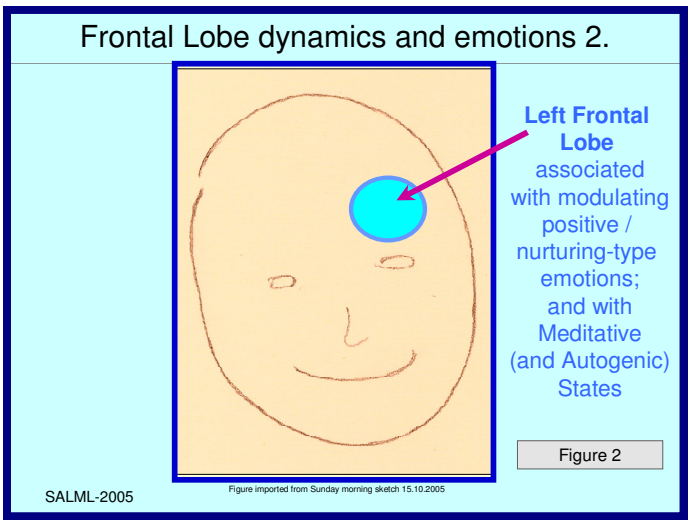
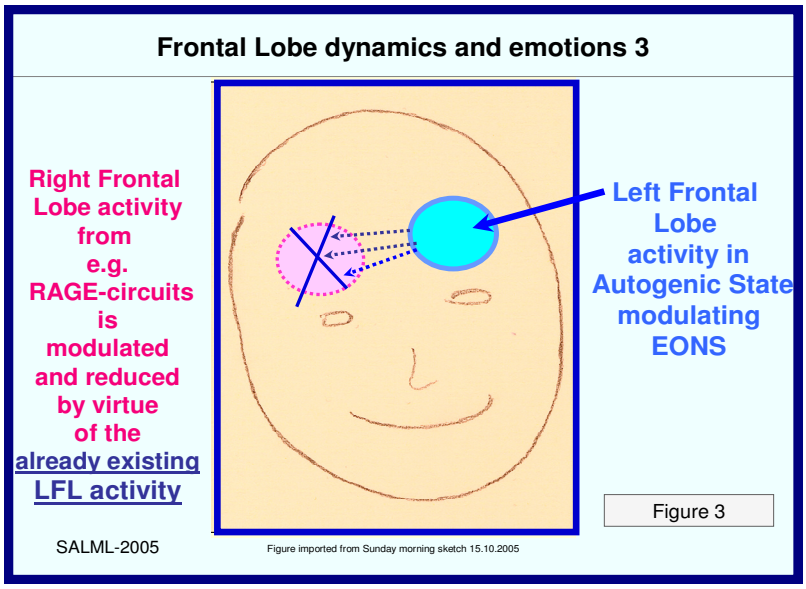


Figure 2
EEG activity associated with Positive / Nurturing type emotions

Furthermore /

Furthermore, activation of the Left Frontal Lobes has been shown to act as an antidote, per se, to negative and destructive emotions – and their associated Emotional Operating Neural Systems (EONS) [Panksepp 1998]. This is illustrated in Figure3:

Suggested model based on research: Autogenic State increases Left Frontal Lobe Activity, and this then acts as an antidote to the Toxic states (e.g. RAGE-, anger; FEAR-) associated with Right Frontal Lobe activity.



Note that the research by Davidson 2005 suggests that Meditation also improves immune function.

EONS: Emotional Operating Neuro-Circuits or Systems (Panksepp 1998)

Figure 3
Left Frontal Lobe EEG activity associated with Positive Emotions / Meditative-type states and down regulating RFL activity associated with toxic emotions

Whenever we carry out an Autogenic session, or meditate[4], we have the potential to both dissipate negative and destructive emotions, and at the same time enhance positive and nurturing-type emotions. Autogenic Training also helps us to be focused on the present moment, and so reduces the chances of us being distracted by "top down" presuppositions and negative thinking [see B6 in this series].

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Linked themes in this Autogenic Dynamics section

B6 Perceptions, flowers, and reality

Part II: /

[4] Autogenic Training can be seen as one form of mental training which overlaps with Meditative type practices and with Positive Mental Training. They all appear to have similar effects on frontal lobe dynamics (Benson 1975; Siegel 2007& 2010; Goleman 2003).

Part II: Internal Bodily States, Autonomic Nervous System Afferents, and Emotions

[after Craig 2005; 2008, Porges 2012[

Part I has briefly summarised the connection between our emotional state [whether positive or negative] in terms of the associated frontal lobe EEG activity. Do we have any idea as to what causes such lateralisation of this activity? We address this issue by initially looking at some background neuro-physiological matters in Sections 2.1 and 2.2; these two sections are best seen as a preamble to Sections 2.3 and 2.4, which attempt to answer the above question.

2.1 Background Feelings

All mammals share a fundamental set of primary process emotions that are located deep within our brains, below the neo-cortex. Core, deep seated consciousness, is located in these same deep mid-line structures in the old-mammalian brain [Panksepp 1998; Panksepp & Biven 2013 – e.g. p 13].

How we feel, moment by moment, very much depends on what is going on in our bodies, and the feed-back from the body to the brain that is transmitted through Autonomic Nervous System [ANS] afferents[5]. Such afferents are intimately linked with our "homeostatic emotions [Craig 2008 p 274] and "background feelings" [Damasio 1999]. So what exactly are background feelings? Damasio uses the term Feeling to denote the subjective awareness of emotions (Damasio 1994; 2003). He also uses the term background feeling to denote the minute by minute subjective feeling state that we are in at any one moment that may or may not be a classical emotion such as fear or joy. We could say that the inner state of the body is constantly being monitored (in the brain and periphery) and this gives rise to background feelings" [Ross 2010 p 271]. Damasio summarises background feelings thus:

> It is probably true to say that background feelings are a faithful index of momentary parameters of inner organism state. The core ingredients of that index are (1) the temporal and spatial shape of the operations of the smooth musculature in blood vessels and varied organs, and of the striated muscle of heart and chest; (2) the chemical profile of the milieu close to all those muscle fibres; and (3) the presence or absence of a chemical profile signifying either a threat to the integrity of living tissues or conditions of optimum homeostasis[6].
>
> Damasio1999, pp 286-287

We receive this "faithful index" of background feelings partly through the ANS afferents. These ANS afferents will also alert us to homeostatic emotions such as being too hot or thirsty [Craig 2008]; and also to our body not feeling right when we are anxious or angry.

Emotions and emotional brain activity can occur without conscious awareness – for example, our FEAR circuits can be activated before we become consciously aware of the fearful stimulus [see, for example, B10: Snakes, Conditional Stimuli, and Equanimity]. In this article we will be using the term feelings to express the subjective awareness of emotions and / or the feeling of how we are at any moment.

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[5] Afferent: affere: "to carry to"; i.e. carrying messages from the body, up the spinal cord, to the brain. [ex CED 2011]

[6] Craig's autonomic afferent list includes: "temperature, pain, itch, hunger, & thirst" and also "feelings from the body, such as ache, visceral urgency, and so-called 'air hunger' " [Craig 2008 p 273-274].

2.2 Autonomic representations of body states [after Craig]

Analysis of autonomic neural circuits suggests that we can only understand the concept of emotions in terms of both the subjective feeling and the motivational neuro-circuits associated with those feelings. In this context, we may need to widen our understanding of what a feeling is in the emotional sense. If we feel cold, this will reflect our awareness – conscious or unconscious – of what is going on within the body [interoception] and this is processed in the anterior insular[7] cortex [via the posterior insular cortex]. From the point of view of survival and well being, the subjective experience of coldness is not sufficient; and nature has seen to this. Neural messages are relayed from the anterior insula to the anterior cingulate cortex[8], which is the autonomic action centre, as it were. Appropriate autonomic signals will then be sent to the body – for example, to shut down capillary blood flow in the skin to conserve heat.

This description may sound complex, yet it is analogous to the motor and sensory cortex areas of the neo-cortex – as indicated in Figure 4 below.

Neuro-circuits	Brain area	Comments / examples
Conscious Sensory[X]	Sensory Cortex [in neo-cortex]	e.g. aware of being touched on skin
Conscious Motor[X]	Motor Cortex [in neo-cortex]	i. action required when we decide to pick up a dish cloth. ii. physical activity when we consciously realises we are cold.
Autonomic Sensory • Unconscious	Anterior Insular Cortex [AIC]	"limbic sensory representation of subjective [bodily] feeling[9]" • Craig 2008 p 272
Autonomic Motor • unconscious	Anterior Cingulate Cortex [ACC]	"limbic motor representation of volitional agency" [i.e. unconscious] • Craig 2008 p 272

Figure 4
Analogous relationship between autonomic nervous system sensory and motor centres and motor and sensory cortex of our neo-cortex

[7] Insular: "a pyramid-shaped area in the brain within each hemisphere beneath parts of the frontal and temporal lobes" – CED 2011

[8] The **anterior cingulate cortex (ACC)** is the frontal part of the cingulate cortex, which resembles a "collar" surrounding the frontal part of the corpus callosum. [http://en.wikipedia.org/wiki/Anterior_cingulate_cortex …… [accessed 21-X-2013]. The **cingulate cortex** is a part of the brain situated in the medial aspect of the cerebral cortex. It includes the cortex of the cingulate gyrus, which lies immediately above the corpus callosum, and the continuation of this in the cingulate sulcus. The cingulate cortex is usually considered part of the limbic lobe. [i.e. limbic system – IR] [http://en.wikipedia.org/wiki/Cingulate_cortex] [Descriptions of names highlighted in blue can also be found by a direct link with the Wikipedia website cited.]

[X] Conscious in a manner of speaking: i.e. not always. For example, the response of taking our hand away from a very hot object will have started before we have consciously processed the information; in fact, this may be more mediated by the Autonomic Afferents.

[9] Some of the AIC activation from ANS afferents may become conscious; but note that while the AIC is "limbic sensory representation of subjective [bodily] feelings", this does not mean that this representation is per se conscious.

Craig interlinks these autonomic afferent systems with homeostasis – and the example above regarding the autonomic activity when we are cold is an example; in this situation, the sensory motor cortex of the neo-cortex will have also become activated, and if we are mindful this may result in us putting on a sweater; on the other hand, if we are immersed in mental activity such as writing this paper, we may consciously [or unconsciously] override the urge to put on the sweater, only to realise half an hour later that we have become very cold.

In the context of background feelings, emotions can now be seen in terms of "an on going continuous event", and not a periodic experience [Craig 2008 pp 272-273].

Our conscious and autonomic sensory states will result in different responses to the same external condition. For example, as Craig says: "…… the cool glass of water that feels wonderful if you are overheated feels gnawingly unpleasant if you are chilled" [Craig 2008 p 274]. So we could say that this implies that it is the internal state of our body that governs our activities and behaviour, and not the external conditions[10]. This implies that we need to become tuned in to what is going on within, and not ignore or over-ride it; this is an aspect of Mindfulness [see D1].

Brain imaging can give us an idea of what is going on in the brain, yet it does not tell us why it is going on: it may be because of the inputs from the autonomic afferents. Furthermore, increased brain activity can be difficult to interpret, as it can signify increasing neuronal inhibition of certain areas – rather than stimulation (Panksepp & Biven 2012). Craig is concerned that such imaging studies, in lovely colours, can be misconstrued, and his work has focused on a bottom up [i.e. autonomic afferents], rather than a top down, perspective [Craig 2008 p 273; see also B6].

2.3 Brain lateralisation of Autonomic Afferents [after Craig]

Craig's extensive research has shown that SNS afferents [sensory] from both sides of the body [i.e. the left and the right side] are relayed to the Right Anterior Insular, (the "limbic sensory representation of subjective feeling[11]" – Craig op cit); and from there on to the Right Anterior Cingulate Cortex (the "limbic motor representation of volitional agency" – Craig op cit). We can broadly distinguish two different causes for the activation of these SNS afferents:

i. SNS afferents that have been activated because of real external danger; this is associated with an increased state of vigilance in the body, and this is then relayed to the Right Anterior Insular. This state heightened vigilance in the body in this context is appropriate[12], and will result in activation of appropriate SNS efferents.
ii. However, the Stress Response can also be activated when there is no actual external threat – for example, when we imagine something bad and / or go into negative ruminations. In this situation, the SNS afferents will again be activated; yet this may now lead to an inappropriate hypervigilant state in both our minds and our bodies; the afferent messages are now telling us, in effect, that "all in the body is not well"; and so this has the potential to reactivate, for example, flight [FEAR] and / or fight [RAGE] circuits – using Panksepp's notation [Panksepp 1998].

[10] Clearly the internal state may accurately reflect the external situation, as is generally the case with (external) temperature and temperature regulation. However, if and when we mis-construe a remark, and or make assumptions about an event, then our internal state may become distressed, for example, when the actual external "reality" does not warrant this. [See for example Riu 1997; and handout DD-20: Reflections on the Four Agreements]

[11] Subjective feelings in terms of bodily awareness; i.e. what is going on within the body, not directly what is going on in the external environment.

[12] Activation of the right anterior insular and the right ACC will normally be associated with emotions associated with danger and withdrawal. (Of course, RAGE may result in attack and not withdrawal).

If we suffer from recurrent stress and / or persistent anxiety, our bodies will most of the time be in this hyper-vigilant state; and so all the time we will be receiving these messages from the body that "all is not well"; this may lead, for example, to SNS efferent inappropriately increasing our heart rate. These dynamics can, in turn, affect our behaviour and will tend to result in negative / distressing emotions and feelings.

On the other hand, Craig's research has shown that PSNS afferents [sensory] from both sides of the body are relayed to Left Anterior Insula; and from there on to the Left Anterior Cingulate Cortex. As already implied, activation of these PSNS afferents lets us know that "everything in the periphery is quiet" [Wallnöfer 2000]; this in turn will be associated with activation of myelinated vagal efferents, and the ability to positively Socially Engage with others [Porges 2011; 2005].

Figure 5 summarises some of the above lateralisation dynamics schematically.

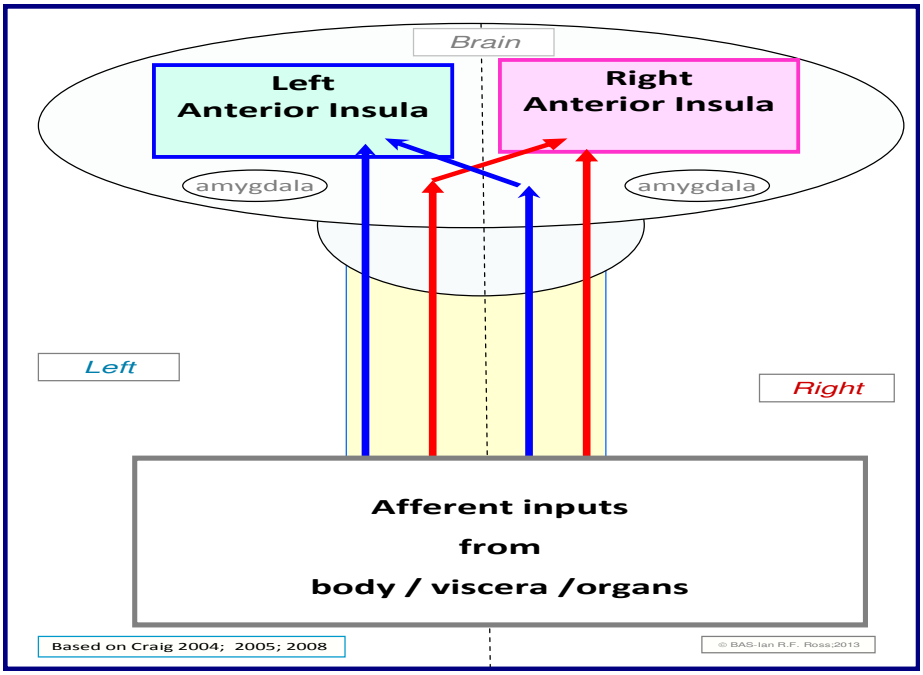

Figure 5
[from Figure 2 of C12 on this website]
Lateralisation of Autonomic Afferent Fibres from the body to the brain

Comments on Figure 5 [adapted from Figure 2 of C12 on website]

- This diagram is highly simplified for the sake of clarity.
- Red arrows represent SNS afferents.
- Blue arrows represent PSNS afferents.
- It will be noted that SNS afferents from the left side of the body cross over to the right insula [insular cortex]; those from the right side do not cross, and so also terminate in the right insula.
- In a mirror fashion, the PSNS afferents from the right side of the body cross over to the left insula, while those from the left side do not cross.

- This means that the right insula deals with only SNS afferents, while the left insular deals only with PSNS afferents.
- The amygdalae are shown. Increased SNS afferent activity will be associated with increased amygdala activity in terms of, for example, the flight and fight response [FEAR and RAGE circuits of our primary process emotions – Panksepp 1998].
- On the other hand, increased PSNS afferent inputs to the left insular cortex will be associated with changed dynamics in the pre-frontal cortex, with the ability to down regulate FEAR and RAGE circuits.
- In addition, increased PSNS afferents will be associated with Social Engagement [Porges 2012].

A more detailed account of these Autonomic Afferent pathways can be found, as mentioned above, in C12 on this website.

2.4 Autonomic Lateralisation and EEG affect lateralisation

The lateralisation of these afferent autonomic fibres may be associated with the observed lateralisation of EEG activity in the frontal lobes [Craig 2008 pp 284-285] discussed in Part I of this article.

When we are tense, fearful and / or in a hypervigilant state, the brain will be sending SNS efferent signals to the body, with resultant increased SNS activity in the body; this state will be picked up by the SNS afferents to the brain / right anterior insula, which will correctly interpret that everything in the periphery is not quiet: this will then be associated with "negative" type emotions such as FEAR and / or RAGE – and that this will be associated with the increased EEG activity illustrated in Figure 1.

On the other hand, if we are feeling settled / relaxed, there will be increased PSNS efferent and afferent activity; and this is just the situation that Wallnöfer described in the context of Autogenic Training as "all in the periphery is quiet" [Wallnöfer, Heinrich. 2000]. The associated PSNS afferent activity, lateralised to the left anterior insula, will be associated with increased EEG activity – illustrated in Figure 2.

Linked themes in this Autogenic Dynamics Section:

B4	Emotional Triggers and the Refractory period
B6	Perceptions, flowers, and reality
B10	Snakes, Conditional Stimuli, and Equanimity – *Approaches to treating mind-body disturbances*
B12	Affect Labelling, Autogenic Training and Reducing Emotional Distress
C12	Presence in Mind – *Autonomic Afferents and Well-Being*
D1	Reflections on foundations for mindful living (after Kabat-Zinn)
D2	Dana Paramita

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