

References supporting the Positive Mental Training animation.

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Firstly, athletes are well documented to be optimistic and have high levels of positive emotions, they are highly resilient and tend to see a failure as a learning situation see the positives in their performance (reappraisal). They also display a leftward cerebral dominance (as per left insula in the animation)¹ Our programme is based on an Olympic Sports mindset. For memory and mood see Emily Holmes' work a good review of the field.²

The Firewall. This is based on the self-memory system as proposed by Conway & Pleydell-Pierce in 2000³ and still regarded as the most comprehensive model for explaining many phenomena of memory. This model divides memories into 3 categories. There is lifetime memory, general memory, and Event Specific Knowledge (ESK). In the animation situation, for instance, the first and second categories would be 'when I worked in the office for Mrs Black' and 'it was stressful working with her' and the 3rd ESK memory 'one day I'd just started a coffee break when she started shouting at me for no reason'. These memories are not automatically linked and for trauma memory the ESK memory is often excluded – firewalled – so the person is unaware of the damage it has caused and the negative effect it continues to exercise. This model is generally accepted as a useful working model of memory, accounting for memory defences as a mechanism for exclusion of very intense emotions so that their thinking processes remain intact. So, someone might remember that their parents argued when they were small but will not recall specific arguments and the powerful distress they felt at the time, feeling helpless and frightened. They might think they are over it all, but certain ways their current partner or a work colleague has of speaking/behaving may act as an unconscious cue, making them feel helpless and angry without knowing why.

'A fundamental premise of our approach is that autobiographical memories are transitory dynamic mental constructions generated from an underlying knowledge base. This knowledge base, or regions of it, is minutely sensitive to cues, and patterns of activation constantly arise and dissipate over the indexes of autobiographical memory knowledge structures. Such endogenous patterns of activation may not coalesce into "memories," nor do they necessarily or even usually enter into consciousness Conway & Pleydell-Pierce (2000) page 261.

Adverse Childhood Experiences (ACEs) are recognised now as having a major impact on our wellbeing, and of being a major factor in depression and probably most mental and many physical health disorders. Recalling a feeling of helplessness and incompetence and lack of relatedness is guaranteed to lower our self-esteem long term. We need a mechanism to deal with it.

These findings are reflected in the experiences in our collaborating researchers in Canada, Led by Fred Philippe, who have formulated a theory of memory networks, linked thematic memories that may support or thwart our ability to cope in certain situations and looked at the influence these networks have on key negative memories.^{4 5}

They found that people do not recognise the effect of negative memories (doubtless because they do not come into consciousness):

'...people may not be aware of the actual effect that their episodic memories may have on their well-being. Indeed people appear to falsely believe that need-satisfying memories exert the most influence on their well-being, but not need-thwarting memories..... it would appear that people are not aware of the actual effect of their memories on their well-being.' P 509 -510⁶

Here also a personal communication from Fred Philippe Oct 2017

'obviously memories are not always activated implicitly (although it is probably the most frequent case scenario), but they can also be activated explicitly, either deliberately or involuntary (as when a memory pops in people's mind without a previous deliberate intent to retrieve it).' My italics.

Philippe's group looked at freely associated memories that are linked to peoples' stressful memories or events and found that the first 3 memories in the memory network, recalled in free association, were the most important in terms of the positive or negative effect on coping and situational and long-term wellbeing. Our own work with Philippe, verified his model of coping, resilience and memory networks and in our joint study we found that we could change one of the 3 core memories from negative to positive⁷. This flipped the students into a 'coping' state with feelings of autonomy, competence and relatedness (self-determination) they were able to visualise a good future outcome in which they are coping and competent, and this would then be triggered in the relevant situation. This fits well with our previous research which showed a significant increase in quality of life and decrease in depression.⁸

The Body Switch. The concept of the parasympathetic 'relax and relate' system switching off the sympathetic 'fight or flight' system, a concept called **opponent inhibition**, is summarised by Arthur Craig. (Craig A (2015) 'How do you feel? An Interoceptive Moment with your Neurobiological Self' Princeton University Press 2015: Chapter 8 and Fig 21 plate 16). He has established over a lifetime of innovative research in neuroanatomy, that pathways from body to brain show that certain bodily sensations (affiliative touch, oxygen and nutrient levels, circulatory flow, pain and more) are in fact not sensations in the way we have been taught; they flow directly to the 2 **insulas**, left and right, which brain centres activate the parasympathetic and the sympathetic systems respectively, with, for instance, affiliative touch and signals of bodily health flowing to the left insula while pain and signals of inflammation and body *dis*-ease flow to the right insula. The left and right insulas are associated with emotional activity, they activate different behavioural strategies through robust connections to their respective anterior cingulates, and the whole emotional system, connected to the body by the spinothalamic tract and the vagus nerve, is very separate from the somatosensory cortex. As the sympathetic system is associated with withdrawal (fight or flight) behaviour and the parasympathetic system with approach (relax and relate) which promote diametrically opposed behavioural strategies, Craig suggests and demonstrates that there are brain pathways that switch the balance between one and the other, he suggests the pathway of inhibition is probably the anterior commissure (private communication) from rat experiments. To understand more about these ideas see Craig (2009)⁹ and a useful video¹⁰.

Stephen Porges came up with a theory of how the parasympathetic system changed our physiology and behaviour, affecting all the cranial nerves to make us more receptive to approach by others switching into an 'automatic' affiliation mode, linking us to a positive upward spiral of affiliation and good feelings¹¹ Porges early work established the effect of respiration on the parasympathetic nervous system and mental health (panic)¹² showing that changes in the homeostasis of gas and electrolyte control decreases parasympathetic activity and causes panic. Others have found that slow breathing increases the end tidal CO₂, and slowing the breathing is a recognised way of controlling panic and anxiety¹³. CO₂ is the key factor controlling arteriole dilatation and oxygen release from haemoglobin (Bohr Effect), increasing the oxygenation and nutrition of all body tissues, increasing autonomic feedback up the spinothalamic tract (the pathway identified by Bud Craig) increasing activity in the left insula while simultaneously diminishing activity in the right insula. This essentially means we can calm the mind with the body, as Craig says:

*'bodily awareness, or more accurately interoceptive awareness, has a crucial role in emotional awareness, in other words, the neural substrates responsible for subjective awareness of your emotional state are based on the neural representation of your body's physiological state.'*¹⁴ So slow deep breathing will calm the mind¹⁵ and isometric Jacobson relaxation also has an added positive effect, while focussing attention on the bodily sensations may cause thalamic blocking of attention to threat cues, reducing distressing and distracting sympathetic arousal from cues that may arise from firewalled memories. The result is an intense parasympathetic state from the physiological exercises which also switches off the sympathetic system by opponent inhibition. We regularly demonstrate this in our workshops (we have a video of this) measuring heart rate variability in real time combined with emotional observation of trauma memory and recovery. Additionally, an anatomical pathway of mammalian calming by slow breathing has been recently established, a link between a nucleus that controls breathing rate and the locus coeruleus, the centre that promotes mammalian arousal¹⁶. Although there is no doubt that the relationship between breathing science and emotional regulation is complex, there is no doubt that it has been known about since antiquity and now has a validated scientific basis for emotional and physiological control. The upshot is that as humans we are aware of our feelings and *we can choose how we want to feel*.

One other factor involved in the altered mental state engendered by paying attention to our breathing, is that it prevents us paying attention to negative information or indeed positive information. This a) removes the insidious effect of unconscious negative environmental cues, but b) also stops us rejecting positive information (i.e. that event was 'not your fault') that we might normally reject by paying attention¹⁷ which although it might raise our self-esteem would also challenge our social homeostasis which is risky. Just following a visualization of the past also changes our attentional focus, and has been likened to a state of mindfulness¹⁸, and this visualization has been shown to help us reappraise negative information puts us into an altered mental state; it also drives the process of attentional distraction and thalamic inhibition still deeper, and Positive Mental Training also drives:

'visualisations of situations displaying traits, mindsets, and actions characteristic of resilience, such as self-control, hardiness, taking on challenges, experiencing growth as result of difficulties, strong personality, high self-esteem, trust in abilities, being energetic, and positive meaning finding.' (Philippe et al 2017 p3)

Finally back to Olympic Sports: The students in our study listening to the resilience programme *all* had an average increase in needs satisfying coping memories by 1 out of 3, even the ones who had good psychological function (ie 2 needs satisfying memories) in their network to start with. This has the potential to turn a programme for mental health improvement into a programme for excellence, peak performance in the sports *and the social* arena (depression and anxiety are seen by many as a form of social defeat). This brings us back to the origin of Positive Mental Training, as an Olympic sports development programme, created from study of the mental and physiological skills and mindset of Gold Medal Winners.

¹ Hecht, D. (2013) The Neural Basis of Optimism and Pessimism *Exp Neurobiol.* 22(3):173-199 see page 183.

² Holmes, E. A., Blackwell, S. E., Burnett Heyes, S., Renner, F., & Raes, F. (2016). Mental imagery in depression: phenomenology, potential mechanisms, and treatment implications. *Annual Review of Clinical Psychology*, 12, 249-280

³ Conway, M., & Pleydell-Pearce, C. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review*, 107, 261–288. doi:10.1037//0033-295X.107.2.261

⁴ Philippe, F. L., Koestner, R., Beaulieu-Pelletier, G., Lecours, S., & Lekes, N. (2012). The role of episodic memories in current and future well-being. *Personality and Social Psychology Bulletin*, 38, 505–519. doi:10.1177/0146167211429805

⁵ Houle, I., & Philippe, F. L. (2017). Need satisfaction in episodic memories impacts mood at retrieval and well-being over time, *Personality and individual differences* 105, 194–199. doi: 10.1016/j.paid.2016.09.059

⁶ Philippe, F. L., Koestner, R., Beaulieu-Pelletier, G., Lecours, S., & Lekes, N. (2012). The role of episodic memories in current and future well-being. *Personality and Social Psychology Bulletin*, 38, 505–519. doi:10.1177/0146167211429805

⁷ Philippe F, Dobbin AE, Ross S, Houle I. Resilience facilitates positive emotionality and integration of negative memories in need satisfying memory networks: an experimental study. *J Pos Psychol* 2017; DOI: 10.1080/17439760.2017.1365158.

⁸ Koeser L, Dobbin A, Ross S, McCrone P (2013) Economic evaluation of audio based resilience training for depression in primary care. *J Affect Disord* 149(1–3):307–312, doi:10.1016/j.jad.2013.01.044

⁹ Nat Rev Neurosci. 2009 Jan;10(1):59-70. doi: 10.1038/nrn2555. How do you feel--now? The anterior insula and human awareness. Craig AD(1). Author information: (1)Atkinson Research Laboratory, Barrow Neurological Institute, Phoenix, Arizona 85013, USA. bcraig@chw.edu.

¹⁰ Video of Arthur Craig from Lindsjoping University <https://vimeo.com/8170544>

¹¹ Porges, S. (2000) The polyvagal theory: phylogenetic substrates of a social nervous system *International Journal of Psychophysiology* 42 2001 123-146

¹² George, D., Nutt, D., Walker, W., Porges, S., Adinoff, B., Linnoila, M. (1989) Lactate and Hyperventilation Substantially Attenuate Vagal Tone in Normal Volunteers A Possible Mechanism of Panic Provocation? *Arch Gen Psychiatry* 1989:46:153-156)

¹³ Gilbert, C. (2005) Better Chemistry Through Breathing: The Story of Carbon Dioxide and How it Can Go Wrong *Biofeedback* Fall 2005 Volume 33 - Number 3

¹⁴ Craig, A. (2018) Handbook of Emotions 4th Edition Chapter 16 Interoception and Emotion Guildford Press

¹⁵ Zautra, A., Fasman, R., Davis, M., Craig, A. (2010) *Pain* 149 (2010) 12–18

¹⁶ Yackle, K. et al (2017) Breathing control center neurons that promote arousal in mice 355, Issue 6332, pp. 1411-1415 DOI: 10.1126/science.aai7984 see related [video here](#)

¹⁷ Kaiser J, Barker R, Haenschel C, Baldeweg T, Gruzelier JH. (1997) Hypnosis and event-related potential correlates of error processing in a stroop-type paradigm: a test of the frontal hypothesis. *International Journal of Psychophysiology : Official Journal of the International Organization of Psychophysiology.* 27: 215-22. PMID 9451580 DOI: 10.1016/S0167-8760(97)00055-X (particularly see fig 3 p 220 showing loss of error evaluation signal from ERP)

¹⁸ Aliza Werner-Seidler, A & Moulds, M. (2012) Mood Repair and Processing Mode in Depression *Emotion* 12:3:470–478