

Mental Imagery and Brain Regulation—New Links Between Psychotherapy and Neuroscience (2019)

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Abstract

Mental imagery is a promising tool and mechanism of psychological interventions, particularly for mood and anxiety disorders. [...] neuromodulation techniques have shown promise as add-on therapies in psychiatry [...] However, these techniques have not yet been combined [...] neurofeedback [...] entails the self-regulation of activation in specific brain areas or networks [...] by the patients themselves, through real-time feedback of brain activation [...] One of the key mechanisms [...] is mental imagery. [...] The overarching aim of this perspective paper will be to open a debate on new ways of developing neuropsychotherapies.

Article Quotes & Comments

"advances in the neuroscience of mental imagery and the increasing evidence for its utility particularly in affective and anxiety disorders now create a unique opportunity to exploit the enhancement of imagery approaches through neuromodulation (and vice versa) for the development of new integrated treatment tools, which may initially focus on depression, post-traumatic stress disorder, and specific phobias, but can, in principle, also be developed for a much wider range of psychological disorders."

"A crucial feature of mental images is their ability to induce emotional states [...] Repeated positive imagery has been shown to increase the tendency to interpret ambiguous situations as more positive and induce positive mood in healthy participants"

Cf. Kress & Aue's research on optimism bias (doi: 10.3389/fnhum.2019.00222): **"Directing attention to positive information does indeed enhance optimism bias** and can thereby provoke positive feedback effects on initial optimistic expectancies. Together, these findings argue for dynamic bidirectional optimism-attention interactions that maintain positivity and contribute to well-being and mental health."

"Switching valence is thereby usually achieved by either changing a mental image to an image with more positive features or wholly replacing it with another image"

"While rescripting aims to alter the content of mental images and, accordingly, also their emotional effect [...] strategies that focus on cognitive control instead aim at changing the interpretations of (mental) images, i.e., their cognitive context"

Two (related) therapies that do the same are Accelerated Resolution Therapy and EMDR. These elements, however, are also found in therapies like IFS (unburdening), schema therapy (limited reparenting), Dream Completion Technique (developing new ending), mindfulness techniques (safe place exercise), Somatic Experiencing (pendulation and titration) and so on. As you can see, many therapies have different ways (and techniques) to describe the same (or similar) thing.

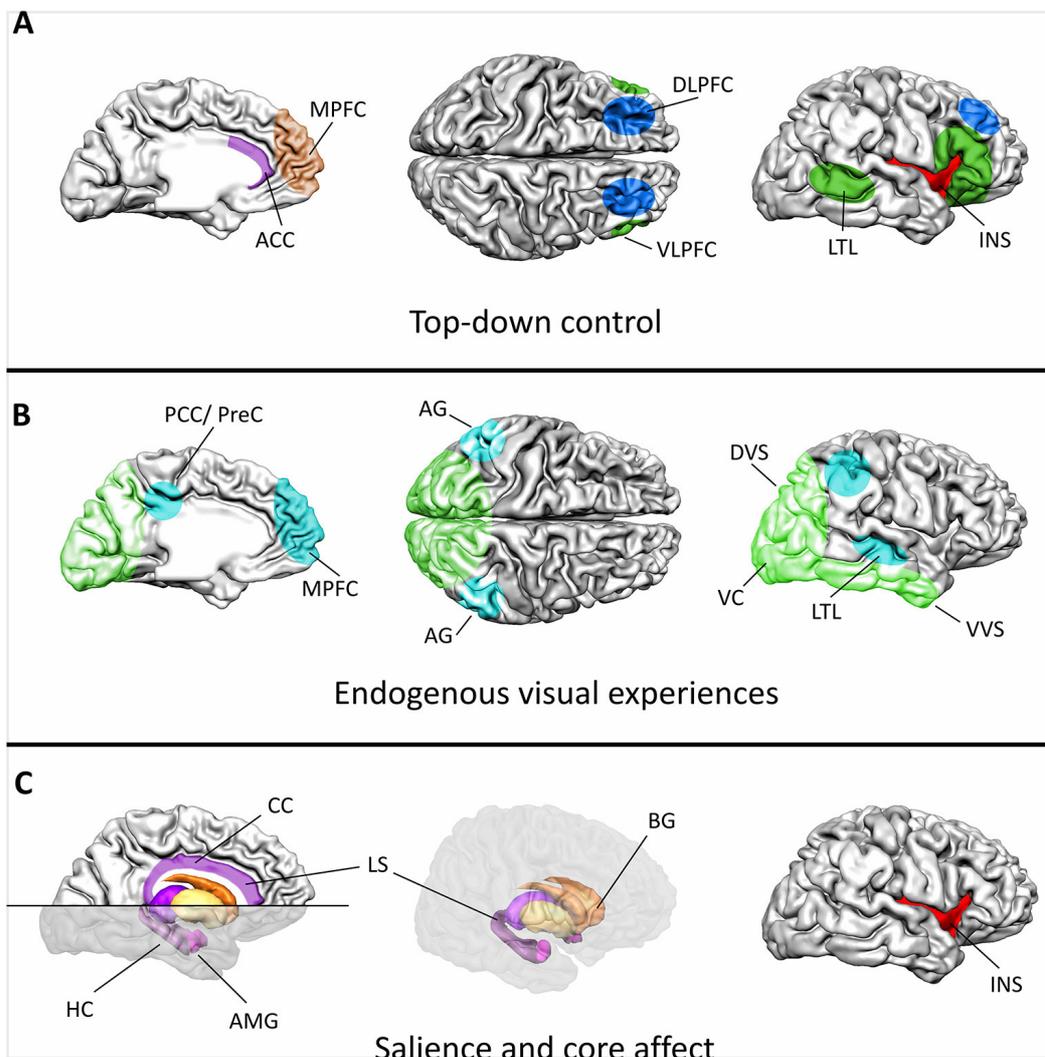


Figure 1 Major functional components and associated brain systems of mental imagery during emotion regulation.

(A) Cognitive control during mental imagery treatments relies on a distributed cortical network. The dorsolateral PFC and lateral parietal cortex (blue) control mental resources, while the semantic interpretation of the internal state is associated with activation in the ventrolateral PFC and the lateral temporal cortex (dark green). The anterior cingulate cortex (ACC, purple) and the medial PFC (brown) monitor the ongoing processes. The ACC together with the insula (red) thereby function as major connecting hubs between bottom-up saliency information and top-down attentional control.

(B) Visual experiences during mental imagery mimic actual perception of external stimuli in the visual system (light green). The sensory content of a mental image is thereby activated across different levels of the visual processing hierarchy, ranging from low level visual areas to associate cortices. Modulations in the default-mode-network (turquoise) indicate increased processing of the endogenously generated information.

(C) Particularly, the limbic system (purple), the basal ganglia (orange/yellow), and the insula (red) encode the hedonic value, arousal, and salience of the visual experience. This information can directly affect ongoing learning processes as particularly the hippocampus is crucially involved in encoding and

retrieving emotional memories. The insula, the anterior cingulate cortex, the amygdala, and the ventral basal ganglia form a network that encodes the salience of a generated experience. As a connecting hub between various systems the insula constitutes a key region for introspection during mental imagery. ACC, anterior cingulate cortex; AG, angular gyrus; AMG, amygdala; BG, basal ganglia; DLPFC, dorsolateral PFC; DVS, dorsal visual stream; HC, hippocampus; INS, insula; LS, limbic system; LTL, lateral temporal lobe; MPFC, medial PFC; PCC/PreC, posterior cingulate cortex/precuneus; VC, visual cortex; VLPFC, ventrolateral PFC; VVS, ventral visual stream; CC, cingulate cortex.

Simplified for us who aren't too clued-into tragical jargon:

(A) When people use imagination to regulate emotions, the brain relies on a network that helps with focus, meaning, and monitoring. Areas at the front and sides of the brain help control attention and decide what to imagine, while other parts help interpret what the imagined experience means. The anterior cingulate cortex and the insula act as key bridges, linking automatic emotional signals with conscious attention and control.

(B) When someone imagines a visual scene, *the brain activates many of the same visual areas that are used when actually seeing the world.* At the same time, brain networks linked to inner thought become more active, showing that the brain is processing information that is created internally rather than coming from the outside.

(C) Emotional meaning is added to mental images by brain systems involved in feelings, motivation, and memory. These areas determine whether an image feels pleasant, intense, or important. Memory-related regions help store and recall emotional experiences, allowing imagined scenes to influence learning and future reactions. The insula plays a central role by helping people notice, feel, and reflect on what is happening inside them during imagination.

"Although such findings show that activation in certain brain areas can reflect subjective psychological experiences of emotions, they do not imply that activation in these brain structures is necessarily specific to a particular emotional state."

This is a very important point. For example, in Nestor's book *Breath* he says: "It turns out that **the amygdalae**, those gooey nodes on the sides of our head that help govern perceptions of fear and emotions, also **control aspects of our breathing**. Patients with epilepsy who have had these

brain areas stimulated with electrodes immediately cease breathing. The patients were totally unaware of it and didn't seem to feel their carbon dioxide levels rising long after their breathing ceased. **Communication between the chemoreceptors and amygdalae works both ways: these structures are constantly exchanging information and adjusting breathing every second of every minute of the day. If communication breaks down, havoc ensues.** Feinstein believes that people with anxiety likely suffer from connection problems between these areas and could unwittingly be holding their breath throughout the day. **Only when the body becomes overwhelmed by carbon dioxide would their chemoreceptors kick in and trigger an emergency signal to the brain to immediately get another breath. The patients would reflexively start fighting to breathe. They'd panic. Eventually their bodies adapt to avoid such unexpected attacks by staying in a state of alert, by constantly overbreathing in an effort to keep their carbon dioxide as low as possible."**

And, here, in Barrett's *How Emotions Are Made* (a lengthy quote): "The search for fear in the brain is an instructive example because for many years, scientists have considered it a textbook case of localizing emotion to a single brain area – namely, the amygdala, a group of nuclei found deep in the brain's temporal lobe. **The amygdala was first linked to fear in the 1930s** when two scientists, Heinrich Klüver and Paul C. Bucy, removed the temporal lobes of rhesus monkeys. Lacking an amygdala, these monkeys approached objects and animals that would normally frighten them, like snakes, unfamiliar monkeys, or others that they'd avoided before the surgery, without hesitation. Klüver and Bucy attributed these deficits to an "absence of fear." Not long afterward, other scientists began studying humans with amygdala damage to see if those patients continued to experience and perceive fear. The most intensively studied case is a woman known as "SM," afflicted with a genetic disease that gradually obliterates the amygdala during childhood and adolescence, called Urbach-Wiethe disease. Overall, SM was (and still is) mentally healthy and of normal intelligence, but her relationship to fear seemed quite unusual in laboratory tests. Scientists showed her horror movies like *The Shining* and *The Silence of the Lambs*, exposed her to live snakes and spiders, and even took her through a haunted house, but she reported no strong feelings of fear. When SM was shown wide-eyed facial configurations from the basic emotion method's set of photos, she had difficulty

identifying them as fearful. SM experienced and perceived other emotions normally. Scientists tried unsuccessfully to teach SM to feel fear, using a procedure commonly called fear learning. They showed her a picture and then immediately blasted a boat horn at one hundred decibels to startle her. This sound was meant to trigger SM's fear response if she had one. At the same time, they measured SM's skin conductance, which many scientists believe to be a measure of fear and is related to amygdala activity. After many repetitions of the picture followed by the horn blast, they showed SM the picture alone and measured her response. People with intact amygdalae would have learned to associate the picture with the startling sound, so if just shown the picture, their brain would predict the horn blast and their skin conductance would jump. But no matter how many times scientists paired the picture and the loud sound, SM's skin conductance didn't increase when viewing the picture alone. The experimenters concluded that SM could not learn to fear new objects. Overall, SM seemed fearless, and her damaged amygdalae seemed to be the reason. From this and other similar evidence, scientists concluded that a properly functioning amygdala was the brain center for fear. But then, a funny thing happened. Scientists found that SM could see fear in body postures and hear fear in voices. They even found a way to make SM feel terror, by asking her to breathe air that was loaded with extra carbon dioxide. Lacking the normal degree of oxygen, SM panicked. (Don't worry, she was not in danger.) So SM could clearly feel and perceive fear under some circumstances, even without her amygdalae."

"Such findings support contemporary constructivist approaches, which constitute that emotional experiences do not emerge from increased activation of single brain structures, but rather from pattern of activation distributed across brain regions that subservise more general functions"

"Most neuroimaging work converges to suggest that **cognitive reappraisal** [e.g. changing meanings associated with emotion] **is associated with downregulation of the amygdala** [...] thereby potentially decreasing the salience of the emotional event."

"The clinical development of fMRI-neurofeedback (fMRI-NF) started in 2005 with the publication of a study in patients with fibromyalgia [...] relatively little work has followed up on this."

"**Mental imagery is one of the most common strategies reported by participants training to control the neurofeedback signal** and often explicitly suggested as a potential strategy by the investigators. For this

reason, the same general networks related to self-regulation, emotion, and visual imagery are modulated during these neurofeedback interventions as discussed for the psychotherapeutic applications of mental imagery”

“While neurofeedback provides information on whether a mental strategy is effective in modulating the neural basis of an emotional state, it has also been shown that neurofeedback at the same time stimulates the reward system”

In a neurofeedback session, you’ll typically sit comfortably while small sensors are placed on your scalp to read your brain’s electrical activity (EEG); these sensors don’t send anything into your brain—they measure. On a screen, you might watch a simple game, animation, or video whose movement, brightness, or sound changes in real time based on your brain activity, subtly rewarding certain patterns associated with focus, calm, or regulation. The clinician may explain what they’re tracking and check in about how you’re feeling, but much of the process is quiet and experiential, with you simply observing the feedback and letting your brain respond naturally. Sessions often feel relaxed or mildly absorbing, and over time the brain learns to shift toward more stable and adaptive patterns. (Source: ChatGPT explanation of what happens in a neurofeedback session)

“many protocols involve instructions or explicit mood induction strategies, for example, to engage with positive autobiographical memories [...] or offer patients the opportunity to use cognitive strategies learnt in the course of other treatment programmes to try and aid the self-regulation of disease-relevant circuits. In these approaches, mental imagery is commonly an integral part of the intervention. Participants gain control over the neurofeedback signal by identifying the mental content which most strongly affects the neural processes that is regulated.”

“In conclusion, **mental imagery is a core process of many psychological interventions, particularly in affective and anxiety disorders.** It has also been a core topic of investigation of cognitive neuroscience, and the neural and psychological mechanisms of mental imagery and its impact on emotional experience have been extensively studied. Based on this knowledge of processes, we can now exploit synergies between imagery and neuroscientific techniques, in order to use the latter to boost the former, or use the former to facilitate the latter.”

Final reflections: I’ve used imagery-based techniques in many of the therapeutic approaches I’ve used over the years. It appears that the neural correlates are there ... and the implications vast. Think about techniques that help you

(clinician) take the client out of a memory by transporting them to another safer place. And then helping them imagine overcoming the main stress, visually. These techniques occur in many therapies from Somatic Experiencing to IFS to the Dream Completion Technique to Schema therapy ... and beyond! As a clinician, this kind of research gives me further confidence to apply techniques that are grounded in theory and demonstrated in practice, logged later for research purposes. Having a why behind the what that we do in the room is extraordinarily helpful. This is another why.

These notes were collected by psychotherapist and author Emil Barna in January 2026 in his efforts to assist with professional development and further education for himself and those who read them. But remember, they are but a glimpse of what the article is actually about—for more context, read it at length and make up your own mind. You can find out more about Emil by visiting www.barnacc.com

"A text without a context is a pretext to a proof text."

—Dr. Don Carson