THENEUROPSYCHOTHERAPIST

INSIDE EMDR

A NEUROLOGICAL PERSPECTIVE

Dr. James Alexander

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While there is still some scepticism raised about the efficacy of Eye Movement Desensitization & Reprocessing (EMDR) within psychology (e.g., Lilienfield & Arkowitz, 2008), it is clear that this therapeutic approach has more than adequately fulfilled the requirements of an evidence based therapy. Most psychological and psychiatric associations around the world endorse EMDR as an evidence based approach to the treatment of psychological trauma and PTSD. This status was recently acknowledged by the World Health Organisation, which recommended this therapy as a first line treatment option for psychological trauma based on the evidence which has amassed testifying to its efficacy.

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Despite the advances in neuroscience which fMRI research has afforded in the last decade or so, little remains known of the neurological mechanisms of change associated with any psychotherapeutic approach. EMDR is no different, in that the precise mechanisms of change can only be speculated. Harvard neuroscientist Robert Stickgold (2002) provides a comprehensive example of these speculations: He suggests that EMDR achieves its results by way of replicating the naturally occurring dream-based consolidation process via the eye movements which are common to both REM sleep and EMDR. However, little comment is currently available about EMDR in relation to recent findings concerning memory reconsolidation.

In a recent Shrink Rap Radio interview, neuroscientist and psychologist Dr Jaak Panksepp (2012) proposed a potential neurological mechanism which could explain the oftentimes remarkable results of EMDR. At the same time, any understanding of EMDR will have to incorporate what has recently been revealed about the neurological reconsolidation process, as this phenomenon appears to be central to 'transformative' psychotherapeutic encounters like EMDR (Ecker, Ticic, Hulley 2012). This paper will expand on Panksepp's cursory speculations on a potential neurological explanation regarding EMDR, and locate this possibility within the broader memory reconsolidation process.

While the limbic system, and the amygdala within it, are certainly very important brain areas when it comes to our experience of emotions, neuroscientific research makes it clear that our emotionality is not restricted to these areas alone. Richard Davidson's research has demonstrated that the right frontal lobe of the brain is highly involved in distressed emotion (Davidson & Begley 2012), and evidence provided by Panksepp and Biven (2012) makes it clear that areas of the brainstem are also highly important. In fact, Panksepp states that, "we know from neuroanatomy that the most important area for emotions is not the amygdala, as some people have marketed, but it is in the mid-brain, at the very core of the brain area called periaqueductal gray, because that's where we get emotional behaviors at the lowest amount of electricity for deep brain stimulation." (2012). Panksepp and Biven (2012) discuss the neurological fear circuit, which includes the periaqueductal gray, in addition to the amygdala, as well as the frontal lobes. The mid-brain is a part of the brainstem (the region where the cerebrum connects with the spinal cord), along with the neighbouring pons, and the medulla oblongata.

The brainstem is involved in several important functions of the body, including:

- Alertness
- Arousal
- Breathing
- Blood Pressure
- Digestion
- Heart Rate
- Other Autonomic Functions
- The relay of information between the peripheral nerves and spinal cord to the upper parts of the brain.

Among these functions, the scanning of the environment for potential dangers is an important job of the brainstem. This is done in a largely unconscious manner, and will be active, for example, when a person is walking in countryside where dangers such as snakes are present. The brainstem is governing the constant scanning of the ground ahead, highly sensitive to potentially dangerous objects that are moving. This powerful function of the brainstem can be seen even when a person is "brain dead" (all parts of the brain other than the brainstem, which is keeping the heart pumping and respiration happening, are no longer functioning). Such a person has no conscious awareness at all, and if their eyes remain open, will stare blankly ahead of them. However, if a person enters their hospital room from a door at the side, the brain-dead patient's eyes will move and follow the person across the room—all with no conscious awareness (Carter 2010). The brainstem is able to still undertake this scanning-for-danger function even though the rest of the brain is essentially 'dead'.

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The scanning-for-danger function of the brainstem is seen in the orienting response, whereby the brain notices stimuli in the sensory field, be it visual, auditory or tactile. If it is a long slithery thing moving on the ground, or a hairy eight legged object in the peripheral vision, our brain responds with an orientating response, whereby we pay attention to the stimuli which may prove to be dangerous—our eyes will move towards it in order that we orientate to potential risk. Where risk is detected, the familiar flight/fight/freeze response may occur, in which case we are physiologically prepared to take evasive or defensive action (or overwhelmed into a collapse state, such as fainting). As such, the brainstem works in conjunction with the limbic system in order to respond to danger. And the frontal lobes also play a role in dampening down the alarm response in light of new information—the loud bang you hear while waiting in the bank que is a child exploding a paper bag rather than a gun discharging. Following the initial alarm response, the frontal lobes will dampen down the response with information as to the source of the bang.

Entailing the systematic use of visual, auditory or tactile stimuli which is presented to the client in an alternating left-right-left manner, EMDR clearly engages the brainstem via the orienting response. This response is being constantly triggered as the therapist's hand moves back and forth across the visual field (or a sound is delivered to the ears in an alternating pattern, or taps are delivered to the left then right knees in the same alternating pattern—all forms of bilateral stimulation).

Looking further into what goes on in the brainstem, and in particular, the mid-brain, we see that the functions of this area include eye movements, responses to sight, hearing, attention, and body movements. Within the mid-brain, a module called the tectum controls auditory and visual responses. The tectum consists of the superior colliculi (visual receptors) and inferior colliculi (auditory receptors). The tectum is a multi-layered structure, with the superficial layers being sensory-related, receiving input from the eyes and other sensory systems. The deeper layers are motor-related, capable of activating eye movements, amongst other responses.

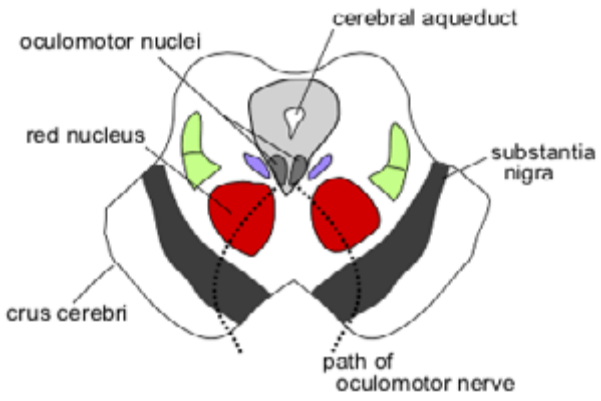
Visual input from the retina, or "command" input from the cerebral cortex, create a "bump" of activity in the tectal map, which, if strong enough, induces saccadic eye movements. The superficial layers receive input mainly from the retina, vision-related areas of the cerebral cortex, and two other tectal-related brain structures.

At the base of the mid-brain is another brainstem module called the tegmentum. This brain area includes the following structures: the cerebral aqueduct, periaqueductal gray (PAG), reticular formation, substantia nigra, and the red nucleus. Together, they are involved in the control of motor functions, regulating awareness and attention, and regulating some autonomic functions such as heart rate responses. These structures also relay nerve messages up to the cerebral cortex, and are involved in mood regulation and sleep.

The PAG is highly relevant to both the emotions and the experience of pain, including the dulling of pain. In fact, Panksepp (2012) states that the PAG is the most powerful source of emotionality in the brain, as it is where the emotions can be activated with the lowest grade of stimuli. Certain forms of stimulation of the PAG can result in an immobile, relaxed posture known as quiescence, and can reduce innate defensive behaviour associated with a perception of danger. It appears that, via its close connection with the movement detecting functions of the tectum, eye movements (as seen in EMDR, or the other forms of bi-lateral stimulation) are able to inhibit the distress generating functions and autonomic arousal generated by the PAG.

With the various forms of bi-lateral stimulation, it appears that the tectum is being given a job to do with processing the stimulation which is being registered (i.e., a therapist's hand crossing the visual field from left to right), creating an ongoing series of orienting responses. This stimuli is able to induce a more relaxed state in the PAG by inhibiting its arousal, as seen in quiescence.

What is the relevance of an inhibited PAG for the psychological processing of distressed emotion related to trauma and PTSD? Psychologically traumatised people are able to reach a high level of affective and autonomic arousal when in touch with a distressing event, and the fight/flight/freeze response is regularly seen when they recount their experience. When this occurs to a significant degree, it is fair to say that the person is being re-traumatised by being brought in contact with the vivid experiential elements of the traumatic event. Sufferers are generally able to recount vivid details of the situation, and are likely to experience the affective, cognitive and physiological components of the memory in a powerful way. On such occasions, very little adaptive processing of the distress is possible, as it is merely an evocative replay of the initial trauma. This simply further entrenches the distressed affective state, as well as the underlying neural circuitry.



Section through superior colliculus showing path of oculomotor nerve. Periaqueductal gray is the gray area just peripheral to the cerebral aqueduct.(image: wikipedia.org)

The originator of EMDR, Dr Francine Shapiro (2001), proposes an Adaptive Information Processing model in order to explain both why traumatic memories can retain their emotional "sting", as well as why EMDR usually results in less distress. Shapiro suggests that the affective, cognitive and physiological components of a traumatic memory have been stored in a faulty manner, due to the emotional impact of the stressful event. The natural processing of psychological experience is presumed to be always heading towards greater adaptation, unless it is disrupted by traumatic experience. A consequence of this faulty storage is that the memory fails to undergo the normal adaptive information processing which is seen with non-traumatic experiences. With the latter, the affective, cognitive and physiological components of the memory "package" typically lose strength in an adaptive manner with time. It is presumed that this fails to occur with traumatic experiences, as evidenced by the high level of affective and autonomic arousal experienced by traumatised people when they recount their experience.

Stickgold (2002) suggests that much of the adaptive information processing occurs via the REM based memory consolidation process. It is noted that sufferers of PTSD have higher levels of stress hormones such as adrenaline and noradrenaline in their blood supply, both while awake and while sleeping (Carter, 2010). The autonomic arousal of the stress reaction is usually dampened whilst we are dreaming via the nocturnal suppression of these stress hormones. However, this is not the case while PTSD sufferers dream. As such, they remain vulnerable to high levels of autonomic arousal while sleeping, meaning that they are more likely to wake up in the middle of a disturbing dream as the stress hormones are not being regulated and suppressed. The consequence of this is that disturbing experiences are less likely to be adequately consolidated during REM sleep, and elements of the distressing memory package can remain unprocessed, or be processed in a maladaptive manner. This could account for the vivid recall and heightened emotionality which usually accompanies the traumatic memories of PTSD sufferers who remain in a state of autonomic arousal.

What would happen to the adaptive processing of this memory package were the emotional distress centres of the brain, such as the PAG, inhibited? Rather than enter a fight/flight/freeze state as the normal default experience, the mind/brain could be "freed-up" to process the experience in a different, perhaps more adaptive manner. Without the PAG being inhibited, it is common for the trauma sufferer to exit the affective "window of tolerance". With the PAG being inhibited by bilateral stimulation provided in EMDR, the brain becomes able to remain within the affective window of tolerance, and other neurological processes become possible—adaptive information processing can occur.

This is experienced by the EMDR client as becoming able to "connect" with the difficult memory, without defaulting to a high level of distress and autonomic arousal. Their experience of the process, rather than being an awareness of their PAG inhibition, is that they are required to get in touch with the distressing memory (an internally focused experience) while at the same time being in touch with an environmental stimuli in the form of bilateral stimulation (an external experience). As such, they are creating a dual focus of attention, which prevents their complete immersion in the traumatic memory (as usually occurs for PTSD sufferers). Maintaining the dual focus of attention prevents re-traumatisation, and allows the mind/brain to engage with the distressing material without being "hijacked" by it.

Any attempt to explain EMDR from a neuroscience perspective must now take into account the role which memory reconsolidation plays. Memory consolidation is the process that the brain undertakes in order to convert short term "working" memories into long term memories. Carter (2010) states that the initial memory consolidation process can take as long as three years. This explains the gradual process of a memory coming in and out of our awareness, and over time losing some of its emotional charge. Where the experience is a highly emotionally stressful one (the type typically referred to as traumatic), this consolidation process can occur very quickly (Panksepp & Biven 2012). The brain is especially geared towards remembering events and information which are essential for survival, such that the details of a dangerous or traumatic situation are likely to be well consolidated in a rapid manner. The experiential components relating to a traumatic or dangerous event are important pieces of information which the brain will latch on to in order that the chances of surviving similar experiences in the future are enhanced. As such, traumatic memories can be stored in rich detail with the full emotional charge, as seen with PTSD.

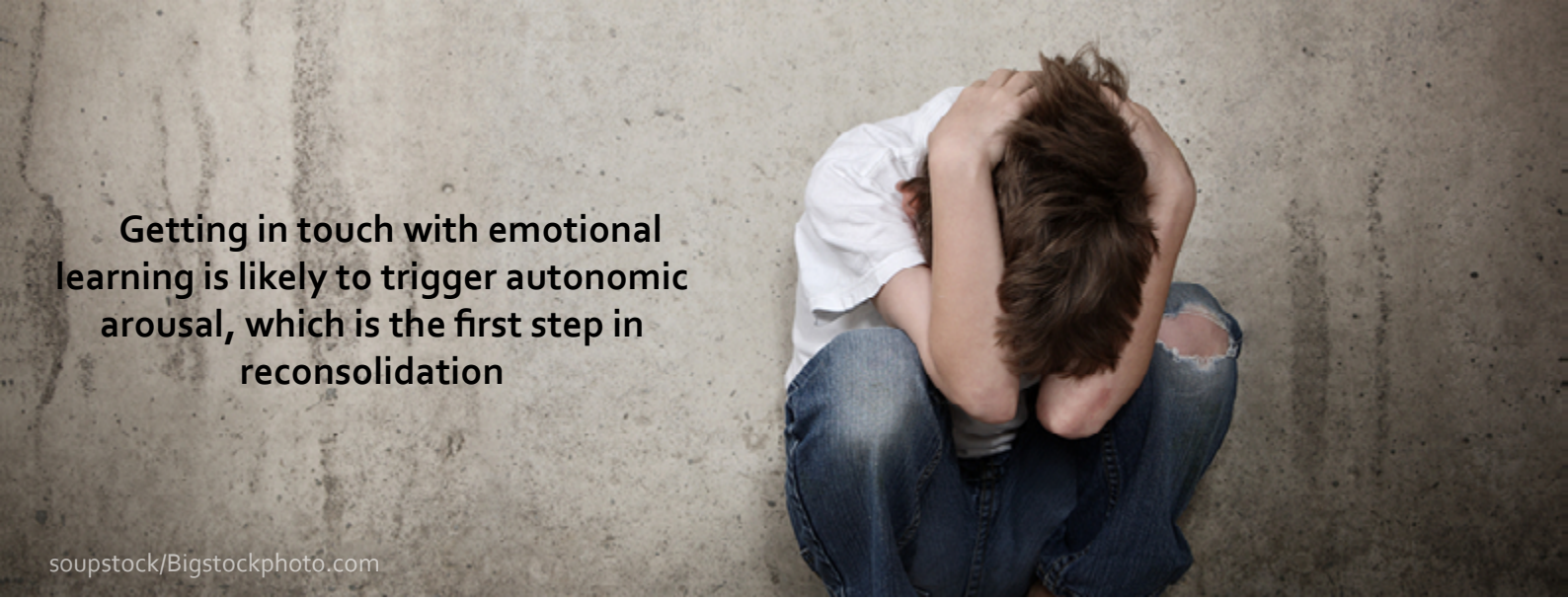
In contrast to traumatic experiences, the more gradual consolidation process with non-traumatic events occurs over time and involves our mind/brain sifting through experiences in order to work out what to do with the more short term working memory. Do the contents need to be discarded as unimportant, not serving our emotional needs, etc., or stored away as important information? The obvious comparison with the 'defragging' process of computers is often used to describe this aspect of consolidation.

The assumption in neuroscience (until around 2004) was that such emotional memories, particularly of distressing event, are indelible—that is, that they can't be erased. Research evidence, from studies with both animals and humans, now makes it clear that these powerfully learnt emotional responses can indeed be erased, via processes which are referred to as reconsolidation (Ecker et al 2012). What is being erased is not the auto-biographical memory, in that people still remember what they have experienced when the emotional component of the memory has been targeted for change. However, when reconsolidation has occurred, the emotional charge of the upsetting memory has been erased.

Neuroscientists have established the necessary conditions for reconsolidation to occur—these can be, and often are replicated, in particular types of psychotherapy. Ecker et al (2012) state that psychotherapies can be roughly divided between those that are counteractive and those that are transformative. Counteractive therapies attempt to control and counteract the symptoms with a range of strategies. These are reliant upon the neocortex attempting to control the lower-down emotional centres of the brain, such as the limbic system and the midbrain PAG. The classic example of counteractive therapies is CBT, but there are many others, such as mindfulness and related approaches like Acceptance & Commitment Therapy. If people stick to only counteractive psychological approaches, the best they can hope for is to have the limbic and PAG arousal (emotional distress) contained. Such approaches can provide the person with a new emotional learning, which then competes with the existing neurological pathway of established distress. There is no guarantee that the new emotional learning will succeed in over-powering the traumatic learning, and the latter can often be easily triggered by environmental or cognitive cues.

Transformative psychotherapies, on the other hand, work in reverse, i.e., creating changes in the deeper emotional centres of the brain, which then flow changes on to the higher thinking centres. It is likely that there have always been psychotherapeutic processes which harnessed this capacity for reconsolidation, long before neuroscientists were aware of either the term or the process. In fact, the most effective psychotherapies have managed to launch reconsolidation processes without any awareness that this is what happens. And some distinctly non-reconsolidation therapies have also occasionally achieved this outcome by accident. Examples of transformative therapies given by Ecker et al (2012) are their own approach, Coherence Therapy, as well as EMDR, Gestalt therapy, Hakomi and other body therapies such as NLP, Emotion Focused Therapy, Accelerated Experiential Dynamic Therapy, Interpersonal Neurobiology, Focusing, inner child work, Jungian active imagination, guided imagery, and Emotional Freedom Techniques (not an exhaustive list). It is apparent that reconsolidation can also occur spontaneously in a non-therapy context when the right conditions happen to be in place. Accounts of people experiencing a sudden and powerful shift from a distressed to non-distressed state are examples of this phenomenon. The common feature of reconsolidation experiences, achieved either through transformative or counteractive therapies, or through spontaneous non-therapy experiences is that once the shift has occurred, there is no further need to be working against the distress. It simply ceases to exist.

Transformative psychotherapeutic approaches are the most likely ones to achieve this outcome. When they have been effective, there is no need to counteract the distressing emotions or material, as this has been erased via changes in neural pathways at the synaptic level (Ecker et al 2012). The neural pathways associated with the old emotional learning, e.g., fear of loud bangs, have been altered in terms of synapses disconnecting from the established fear pathway. The affective experience of fear has been transformed by a reconsolidation process so that there is simply no more distress there that needs to be controlled or managed, thought away or ignored. This sounds fantastic, but Ecker et al (2012) have detailed how transformative psychotherapies actually replicate the same reconsolidation conditions in the therapy which neuroscientists have elucidated in the laboratory. When this reconsolidation occurs, the seemingly intractable emotional distress from past experiences ceases to exist. The neural pathway itself has been altered, rather than being in competition with a new pathway. People still have the episode in their biographical memory, but it no longer elicits distress. This type of outcome is regularly seen with the use of EMDR. A memory which 30 minutes earlier could cause a panic attack, after effective EMDR, is experienced as merely another episode in one's life, without the autonomic arousal or negative views of the self.



The conditions required for such transformative memory reconsolidation, both in the laboratory as well as in therapy, entail firstly the reactivation of the distressing emotions associated with the target memory. In a therapeutic context, this involves the trauma sufferer being brought in contact with the experience in an emotionally evocative and vivid manner. Ecker et al (2012) describe how traumatic events result in "emotional learnings", or cognitive schemas, which entail notions of causality and responsibility, expectations of future events, as well as associated physiological sensations. As an example, a child who experiences violence from a parent may "learn" from the situation that they are unlovable, that other people are unpredictable, and that the world is essentially a dangerous place. Getting in touch with this emotional learning is likely to trigger autonomic arousal, which is the first step in reconsolidation.

Ecker et al (2012) have provided a thorough examination of an EMDR case, analysed from a reconsolidation perspective. It is clear from their analysis that EMDR sessions operate in a non-linear manner, with the different steps involved in reconsolidation being used back and forth throughout the session. With that reality in mind, the bilateral stimulation phase of the EMDR process is preceded by having the client get in touch with the experience through imagination. As part of the preparation phase, the client will be asked a range of questions which are designed to vividly reactivate the affective experience. Specifically, they are asked to create a visual picture of the distressing event; what negative thoughts or beliefs about themselves arise when in touch with that image (e.g., themes of responsibility, personal failing, and/or lack of safety or control); what emotions are triggered when in touch with the image and the negative cognition; the strength of these emotions on a SUDS measure; and where they feel this distress in their body. As such, the person is brought in contact with the visual, affective, cognitive, and physiological components of the distressing event. Typically, this involves a reactivation of the distress associated with the event.

The second requirement of the reconsolidation process is the activation of an experience or information which disconfirms the phenomenological experience of the original distressing event via a "mismatch". The new perception or experience needs to differ from the target memory in terms of its salient novelty or simple contradiction, as it is the violation of expectations from prior learning which launches the reconsolidation process. Such a mismatch, or violation of expectations can be in terms of qualitative differences, whereby the presumed outcome does not occur at all, or it can be in terms of quantitative differences, whereby the outcome is of a different magnitude to what is predicted.

During the bilateral stimulation phase, around fifty percent of clients of EMDR clients will experience a spontaneous "arising" of cognitive/emotive material, and/or mental imagery and associated physiological changes, which are discordant with the original target memory. As an example, the person who was subjected to violence as a child may spontaneously experience imagery of themselves as a powerful adult, now able to defend themselves. The cognition, "It's over and I can defend myself now," may present in their awareness. Other clients may experience the spontaneous arising of imagery which appears completely unrelated to the theme of the target memory. For example, they may experience imagery (and associated cognitions, feelings and bodily sensations) of being on a beautiful beach enjoying the sunshine. Or an image of their

favourite tree to climb as a child may arise, along with the associated positive feelings of being safe. Ecker et al (2012 p.145) state, "Phenomenologically it is as though the individual's inner being possesses a hidden store of intuitive knowledge that has been precisely tapped for a needed unit of illumination. Whatever its actual source, the newly emergent contradictory knowledge had the specificity and compelling realness required for successfully disconfirming and dissolving the target construct ".

Another common observation is that with continued bilateral stimulation, clients will often experience a relatively sudden or more gradual reduction of emotional and physical tension associated with the troubling memory. As stated above, in the EMDR process, following the reactivation of the target memory, the alarm generating actions of the PAG are inhibited with the application of bilateral stimulation. To be in a more relaxed state while still being in touch with the traumatic memory is an experience which also disconfirms the normal experience of autonomic arousal associated with the memory—a violation of expectations is experienced. These alternative experiences, possibly resulting from the PAG being inhibited, are experienced as a different felt reality in that moment. All of these possible reactions create an emotional mismatch with the distress that usually goes along with the incident. Such spontaneous experiences stand in juxtaposition to the distress associated with the target memory, and can be seen to conform to the necessary requirements of memory reconsolidation.

Where such experiences do not spontaneously arise, the EMDR therapist is able to guide the client with a wide range of "cognitive interweaves". These are designed to assist in the movement towards psychological material which stands in contradiction to the reactivated distress, and can take a variety of forms, from simple but evocative questions to guided imagery processes. The client abused as a child may be asked to see themselves as they adult they currently are attending to the emotional needs of the child they were many years earlier. Typically, they will develop imagery of holding or hugging the child, and speaking to them in a soothing tone, emphasising their worthiness and lack of blame for the negative situation. As such, most EMDR sessions will result in a phenomenological experience which stands in stark contrast to the target memory, whether it spontaneously arise or be initiated by the therapist. It is essential that these mismatching experiences be felt, rather than merely thought about or intellectually discussed.

In the final step of the reconsolidation process, new learnings are required in order to erase the old learnings associated with the distressing memory. These new learnings may simply be the new psychological material which either arose spontaneously during the bilateral stimulation, or that which was suggested by the therapist. It is during the 5-6 hours following the reconsolidation experience that the target neural pathways are labile and the old emotional learning can be erased. The EMDR process entails repeatedly moving between the initial distressing target memory and the incompatible new experience (steps 2 and 3 in the reconsolidation process).

Ecker et al (2012) state that the concurrent holding of two mutually exclusive emotional experiences in the same field of consciousness will result in the

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They may experience imagery, and associated cognitions, feelings and bodily sensations, of being on a beautiful beach enjoying the sunshine.**

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eradication of the distressed affect associated with one of those experiences—in particular, those associated with the target memory. When this has occurred, reconsolidation has been 'launched' and is likely to result in the person losing the emotional distress associated with the traumatic event as a result of the new emotional learning. Neuroscience research indicates that the synapses, forming the neural pathways which contain the distressed emotions, become disconnected for a period of up to 5-6 hours following reconsolidation. New learnings are able to "un-wire" the neural connections of the old emotional learnings, revising and rewriting these pathways. When successful, the client is left with only the autobiographical memory, minus the emotional sting which used to accompany it. Where the clients has suffered from a one-off trauma in their adulthood, it is likely that very few bilateral stimulation sessions will be required to assist them in overcoming the distressed emotions. Where the client has suffered from developmental traumas associated with repeated upsetting events over their childhood, it is likely that considerably more bilateral sessions will be needed to overcome many of the associated aspects of their trauma.

Obviously, all parts of the brain work in conjunction with other parts to create any particular experience. This discussion has presented the role of the brainstem PAG in creating the types of responses usually seen with EMDR. It helps us to make sense of the impact of bilateral stimulation in preventing the cascade of autonomic arousal when threatening memories and images have been activated, and how this may then allows the rest of the brain to have an involvement in the processing and resolution of associated emotional distress via memory reconsolidation. Keeping the PAG inhibited by responding to bilateral stimulation appears to allow this resolution to occur, rather than just have the memory trigger the normal autonomic cascade into distress which, in a sense, can "hijack" the brain. A non-hijacked mind/brain is able to do remarkable things with distressing memories and old hurts, as is regularly seen in transformative psychotherapies such as EMDR and Coherence Therapy.

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