Reversing Reciprocal Suppression in the Anterior Cingulate Cortex:

A Hypothetical Model to Explain EMDR Effectiveness

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A theoretical model is proposed to explain desensitization during Eye Movement Desensitization and Reprocessing (EMDR) as resulting from the reversal of reciprocal suppression of cognitive processing in the anterior cingulate cortex (ACC). Dual-attention and error monitoring are known to activate dorsal regions of the ACC that mediate metacognitive processing. Neuroimaging research has produced evidence that cognitive areas in the upper ACC may reciprocally suppress affective processing in the lower areas and vice versa. It is therefore proposed that the original eye-to-finger tracking task of EMDR may achieve its therapeutic effect by using error monitoring to reverse suppression of the upper ACC by the lower ACC. Contributions to EMDR effectiveness from resource installation and novelty-driven orienting reflexes may also influence ACC functioning. A distraction effect is proposed to be a negative and potentially disruptive by-product of very interactive stimulation tasks. A semantic priming procedure is suggested to limit distraction effects during more interactive forms of stimulation.

Keywords: EMDR, reciprocal suppression, anterior cingulate, semantic priming

When Francine Shapiro initially published her EMDR protocol for treating Post-Traumatic Stress Disorder (PTSD) in 1989, eye movements were hypothesized to be the catalytic ingredient to stimulate accelerated information processing. Since that time, many EMDR trainers and consultants have used alternating bilateral stimulation (ABS) as a more liberal interpretation of the catalytic stimulus. The use of numerous forms of ABS (e.g. auditory tones, vibrations, hand taps, etc.) is now widely accepted by EMDR clinicians. It is assumed that they all are effective forms of sensory stimulation because they alternate bilaterally. What is lost in this evolution is that the EMDR eye movement procedure is a visual-tracking task in the context of a performance expectation. It demands effortful divided attention. The patient is required to synchronize his or her gaze on a moving target while concurrently thinking about the target memory. In addition, the therapist's obvious scrutiny of the patient's gaze and the therapist's periodic verbal encouragement "paint" the patient's efforts with a sense of importance. All of these factors have neurological effects. From the standpoint of psychophysiology, such a performance task is a very different phenomenon than the passive reception of non-task-related sensations. By emphasizing eye movements and bilateral stimulation, the proponents of EMDR have drawn attention away from the informational dimensions of the methods used. Task relevance, novelty, ambiguity, complexity of stimulus information, social context, public exposure, relevance to the targeted memory, and load demand on short-term memory are just a few of the informational dimensions that may make one method of stimulation functionally nonequivalent to another.

In their 1997 article, van der Kolk et al. summarized research implicating dysfunction of the hippocampus under extreme stress and the failure of the nervous system to synthesize sensations related to the traumatic memory into an integrated semantic memory. Van der Kolk et al. hypothesized that this disorganization interferes with the evaluation, classification, and contextualizing of the traumatic experience. The authors also reported on pilot imagery work on the aftereffects of successful EMDR treatment. After such treatment, van der Kolk et al. found increased activation of the ACC bilaterally. The authors hypothesized that improvement of PTSD symptoms may be mediated by increased activation in the ACC and other frontal areas that help the patient to better discriminate context. Consistent with this hypothesis Levin et al. (1999) found increased ACC and left frontal activation during traumatic memory recall when comparing post- versus pre-EMDR SPECT scans. Levin et al. suggest that the improvement of PTSD may be mediated by the increased activation of the ACC and the prefrontal cortex which may assign meaning to the emotions from traumatic memory. Another study by Lansing et al.

(2005) also found post-EMDR increased activation in the left prefrontal, Brodmann areas 8, 11, and 44, along with other right hemisphere decreases. Taken together, these studies suggest that the ACC and the left frontal regions may be crucial mediators of EMDR's therapeutic effects. If this is true, then utilizing strategic manipulations to activate these areas during EMDR may hold promise for improving EMDR's effectiveness. The proposed hypothesis may also help explain why the eye-finger-tracking ABS procedure facilitates processing of traumatic memory.

Fernandez-Duque et al. (2000) explain how the ACC and the dorsolateral prefrontal cortex (DLPC) are key components of an executive system that carries out metacognitive control of lower level cognitive processes. Other areas involved in this system are the orbitofrontal cortex, portions of the basal ganglia, and the thalamus. According to these authors, the function of this system is to add flexibility to cognitive processes and make them less dependent on external cues. Consistent with this idea, Luu and Pederson (2004) summarize research showing the ACC to mediate at least three processes in action regulation: (1) Monitoring expectancy (context) violations, (2) Monitoring of response relative to context, and (3) Evaluating the affective consequence of any expectancy violations. According to Luu and Pederson, the ACC adapts behavior to context in a circuit also including the amygdala and other components.

Much imaging research with the ACC and prefrontal cortex has been performed using various conflict-inducing tasks such as the color-word Stroop where the subject must discriminate and selectively respond to the name of a color that is printed in an incongruent color (e.g. "green" typed in red letters). Another frequently used method is the flanker task in which the incongruent (conflict) stimulus is a target arrow pointing in one direction while flanking arrows point in the opposite direction. The creation of a go/no-go conflict requiring discrimination of context is yet another way of activating the ACC (Nieuwenhuis et al., 2003). The general picture that emerges from much of this response conflict research is that the ACC helps monitor conditions under which response conflict errors are likely to occur

(Carter et al., 1998). The role of the DLPC seems to be to hold in mind the relevant information for the particular task (Posner & Fan, 2003).

While response conflict has been a frequent research method for activating the ACC, other conditions have also been found to involve ACC activation. Intense negative emotional states have been found to involve activation of the pregenual portion of the ACC (Drevets & Raichle, 1998). Corbetta et al. (1991) found that both the ACC and the DLPC activate during divided attention, but not with focused selective attention. Perhaps this latter finding is relevant to the eye-finger-tracking procedure used in Shapiro's original EMDR protocol. Considering the research already discussed, at least two dimensions of the tracking can plausibly activate the ACC. First, the eye-finger-tracking task involves dividing attention between the processed topic and the tracking. Second, the tracking task may evoke some error monitoring. This latter process may be helped by the fact that the therapist usually reinforces this monitoring by offering verbal encouragement about performance.

Other findings about ACC activity can be summarized as follows:

1) Different conflict tasks have been shown to activate the ACC and the left DLPC but each task involves a somewhat different location on the ACC. This finding supports the idea that either there are distinct networks for each conflict task or a single network that monitors conflict with different sites used to resolve the conflict (Posner & Fan, 2003).
2) ACC activity can be stimulated by instructions long before a stimulus is presented (Bush et al., 2000). This finding is potentially very relevant to clinical practice. The implication is that manipulations to activate the ACC may have relatively enduring effects on subsequent cognitive processing. If ACC activation only occurs during stimulus presentation, then clinical applications would be impractical because the effects would be too transitory. A state of ACC activation needs to endure long enough between stimulus presentations so as to allow practical clinical work. The implications of the Bush et al. research are that ACC activation

can be maintained between manipulations merely by the anticipation and vigilance involved in response conflict.

3) ACC activity has been shown to decline with practice and automatization of task skills by the nervous system (Bush et al., 1998). In this study, relative difference in anterior cingulate activity between interference and neutral conditions on the Counting Stroop decreased as subjects learned the task.

4) Higher activity in the ACC during response conflict and error trials has been found to be associated with greater subsequent behavioral adjustment at later points in time (Kerns et al., 2004). In this study, the higher ACC activity was also predictive of later increased activity in the prefrontal cortex in subsequent trials. The central feature of this piece of research was the demonstration that increased ACC activity projected benefits of improved control across time.

5) Different regions of the ACC activate for emotional processing versus cognitive processing (Drevets & Raichle, 1998). Cognitive processing involves activation of the upper anterior region, whereas emotional processing involves activation of the lower anterior region. It should be noted that only negative (not positive) emotion was involved in all of these studies cited by Drevets & Raichle (1998).

6) There are important interactions between emotion and cognition involving the ACC and the dorsolateral prefrontal cortices. Drevets and Raichle (1998) summarize a number of these studies. The pattern is that some areas showing increased blood flow while performing attention-demanding cognitive tasks (upper ACC and dorsolateral prefrontal cortices) will also show <u>decreased</u> blood flow during experimentally induced and pathological negative emotional states. Conversely, attention-demanding tasks have been found to decrease activation in the same regions that typically activate during intense (negative) emotional processing (amygdala, posteromedial orbital cortex, and the ventral ACC). Based on these

> findings, Drevets and Raichle propose a reciprocal suppression model involving a neural substrate where competition between mental operations may occur. They also propose that this model may more specifically define the mechanisms by which extreme fear or severe depression may interfere with cognitive performance.

Mayberg et al. (1999) also demonstrated similar reciprocal effects to those summarized by Drevets and Raichle. In the Mayberg study, sadness was found to increase activation in the lower ACC and decrease activity in the right DLPC. These findings of reciprocal suppression between affect and cognition in the ACC are extremely important. They may offer the potential for evolving EMDR treatment by facilitating the development of new treatment techniques to manipulate the cognitive/emotional neurological interface.

<u>Loosening the Knot: Error Monitoring, Novelty, Dopamine, and the Anterior Cingulate</u>

While van der Kolk offers an elegant model for how post-traumatic memories originally become un-integrated, the pressing question for treatment is how to integrate. Van der Kolk's model of PTSD genesis does not necessarily show us the way. Why don't these shattered memories quickly meld together with contextual information when they are revisited in talk therapy? The current author proposes that the answer to this question may be severe reciprocal suppression involving the ACC. If the ventral ACC is sufficiently "hot" from negative affect, then cognitive processing in the dorsal ACC may be so strongly suppressed that new contextual information may not be allowed to enter the system. Strong associations would then be expected to perseverate. The appropriate metaphor is that of a self-tightening knot. While some researchers have sought mechanisms that account for hyper-association during EMDR, they may not be framing the task accurately. Instead, it may be more appropriate to search for ways to reduce under-association. In other words, we need to find ways to "loosen the knot." One logical method would be to utilize the reciprocal suppression effect in the ACC. By stimulating upper ACC activation with tasks that evoke error monitoring and/or divided attention, a “hot” lower ACC during traumatic memory recall might be cooled down. Theoretically, this reduced activation would allow new contextual information to enter the system as long as the tasks are not too distracting. This model does not assume that error monitoring and/or divided attention directly process new contextual information. Rather, it assumes an indirect “loop” effect: Error monitoring may reciprocally suppress the lower ACC that in turn reciprocally loosens its suppression of parallel processing of contextual information back in the upper ACC.

An important study was performed by Rainville et al. (1997) who demonstrated that the distress aspect of pain is encoded in the ACC and not the somatosensory cortex. Hypnotic suggestion was used to alter the unpleasantness of noxious stimuli without changing perceived stimulus intensity. PET (Positron Emission Tomography) scans revealed significant resulting changes only in the ACC. Furthermore, the resulting changes closely correlated with reduction in the perceived unpleasantness of the stimuli. The reason this study is so important is that it shows that affective distress can be dissociated from a previously associated network and it strongly suggests that the ACC may be a critical mediator of this effect. There is also another possible implication from the study: If affective distress can be dissociated from painful sensation, then perhaps it can also be dissociated from painful memory. If this can happen then cognitive processing might be opened up on the traumatic material by reversing reciprocal suppression. This possible effect would assume that the traumatic memory is not completely deactivated as affective distress goes down. Early Soviet research on dominant foci (areas of brain activation) is consistent with this assumption. There is appreciable momentum for a dominant focus to endure until it is inhibited by a new competing focus of activation (Ukhtomski, 1926; Rusinov, 1973; Anokhin, 1974). Even after losing its primacy of dominance, a focus of activation may remain as a “latent dominant.” To the extent that affective distress can be dissociated from a traumatic memory in the ACC, then the momentum of the traumatic memory's dominant focus might allow remaining time to cognitively reprocess its context.

In addition to the phenomenon of reciprocal suppression, there is yet another possible influence on the ACC that might facilitate traumatic memory processing. Dopamine release that accompanies positive affect may also play a role. In EMDR, positive resource consolidation is assumed to facilitate treatment effectiveness (Korn & Leeds, 2002). While the underlying mechanism for this phenomenon is not known, research on positive affect relative to cognitive flexibility may be relevant. Ashby et al. (1999) present a theory for how cognitive flexibility and the selection of perspective may be facilitated by dopamine in the ACC. These authors summarize a large number of experiments showing that randomly assigned positive affect enhances one's ability to see alternative cognitive perspectives. It is not their contention that positive affect actually causes cognitive flexibility. Instead, they propose that positive affect via dopamine release in the striatum and nucleus accumbens often accompanies activation of the ventral tegmental area's (VTA) dopamine projections to the ACC and the prefrontal cortex. It is known that these dopamine receptors are richly expressed in layer five of the cingulate (Posner & Fan, 2003). Ashby et al. cite other research suggesting that dopamine projections from the VTA into the ACC facilitate the cognitive selection process and that dopamine projections from the substantia nigra into the striatum facilitate the actual switching. Ashby et al. predict that any pathological condition that is associated with reductions in brain dopamine levels might be temporarily relieved by positive affect. Converging with this prediction, a collection of neuroimaging studies have associated increased dopamine release in the striatum with positive benefits from placebo treatments for Parkinson's disease (de la Fuente-Fernandez et al., 2001, 2002; de la Fuente-Fernandez & Stoessl, 2004). In a review article summarizing neuroimaging studies on the placebo effect, Lidstone and Stoessl (2007) conclude that the evidence suggests that expectations of symptom improvement are driven by frontal cortical areas, particularly the DLPC, orbitofrontal, and the ACC. These authors report that in the case of placebo analgesia, the midrostral dorsal anterior cingulate, the superior medial prefrontal cortex, and the dorsolateral, ventrolateral, and orbitofrontal cortices are consistently involved. Rainville et al. (1999) showed that the unpleasantness of pain involves activity in a more caudal region of the ACC whereas suggestion related modulation of pain distress involves more activity in the rostral ACC region. While the aforementioned studies focused on either placebo relief for Parkinsons's disease or placebo analgesia for pain, the question can be raised as to whether this research is relevant to emotional pain. Petrovic et al. (2005) showed its relevance in a study using Functional Magnetic Resonance Imaging (fMRI). They demonstrated that the same modulatory network including the rostral ACC and the lateral orbitofrontal cortex were involved for both emotional placebo and placebo analgesia. All this placebo research is especially relevant to the current discussion because it is consistent with Ashby's model for how cognitive flexibility may be enhanced via dopamine projections from the VTA to the ACC. The current author suggests that procedures that create the expectancy of symptom relief or that evoke positive affect such as "resource installation" may reverse suppression of the VTA dopaminergic projection system caused by traumatic memory. Because of this, it is proposed that a placebo may form a type of psychological "resource" and that "resource installation" may also act like a placebo.

There is evidence that the VTA dopamine system can be suppressed by a series of reactions initiated by serotonin-based projections from the raphe nuclei (Nieuwenhuys, 1985; Cloninger, 1991). In his article, Cloninger (1991) describes the latter serotonin-based system as a major personality mechanism for behavioral inhibition. He proposes that the serotonin-based inhibition system opposes the VTA dopamine-based activation system that drives pursuit of novelty and hedonic pleasure. In 2001, Suhara et al. provided strong evidence for the dopamine side of this theory. In a hypothesis-driven study, these researchers measured the dopamine-bonding factor in the right insular cortex and then correlated it with the novelty-seeking trait score on Cloninger's Temperament and Character Inventory (Cloninger, 1994). The resulting correlation ($r = -.67$) is very powerful evidence that the dopaminergic system is a central mediator of a broad array of novelty-seeking behaviors. In his article, Cloninger describes how repeated frustration and other events can result in inhibition of the VTA dopamine-based system. Cloninger's description of this process is strikingly similar to Nathanson's (1992) description for the generation of shame. The current author also proposes that traumatic installation of "learned helplessness" (Seligman, 1973, 1983) may involve the same system of behavioral inhibition. It is plausible that all of these phenomena are involved in the inherently shameful and disempowering characteristics of traumatic memory. If so, then VTA activating experiences may improve flexibility of cognitive switching via the ACC as proposed by Ashby et al. (1999). This is one plausible explanation for how resource installation facilitates EMDR.

If Ashby et al. (1999) are correct and cognitive flexibility can be improved through VTA activation of dopamine in the ACC, there may be yet another possible dopamine-activating variable besides resource installation. The current author proposes that novelty also qualifies. Horvitz (2000) summarizes research showing how "prediction error" from novelty activates dopaminergic VTA projections. The personality research by Cloninger (1991) and Suhara et al. (2001) have also shown these monoaminergic dopamine tracts to be closely correlated with the novelty-seeking personality trait. The current author suggests that novelty may neurologically contribute to ABS effectiveness during EMDR. Since ABS is a rare phenomenon in daily life, it should be a very novel manipulation when starting treatment. However, as treatment proceeds, stimulation novelty would be expected to gradually habituate and lose its contribution to the overall effect.

To summarize this part of the discussion, it is proposed that three variables contribute to EMDR effectiveness through the VTA dopaminergic projections: "resource installation," expectance/placebo effects and novelty. In the preceding discussion, novelty was addressed as being relevant to ABS and other stimulation methods. However, the current author proposes that novelty can also evoke an investigatory state during EMDR even without sensory stimulation. MacCulloch & Feldman (1996) hypothesize that the visceral components of an investigatory state may be activated by eye movement in EMDR. The current author agrees that an investigatory state can help facilitate processing. The VTA dopamine activation during such a state should logically contribute. However, the patient's own newly emerging material may have more to do with this investigatory state than the eye movements themselves. Previous research on the orienting reflex is relevant here.

By the late 1970s, most researchers had come to the conclusion that the orienting reflex construct was not unitary but covered a class of related and not identical phenomena. Emotional significance, task relevance, signal value, and other attributes of a stimulus will not necessarily evoke the same physiological responses as will novelty. They may evoke sympathetic arousal but affective tone and other visceral components can be quite divergent (Barry, 1990). Novelty-generated OR's originate via novelty detectors in the hippocampus relatively early in the detection process (Sokolov, 1990). Vinogradova (1975) discovered novelty-activated neurons and sameness-activated neurons in the hippocampus that service the activation and inhibitory functions respectively. The novelty neurons were found to stimulate the reticular activating system whereas sameness neurons feed into the synchronizing system that takes part in the induction of sleep. The novelty neuron system works rather quickly (approximately 80 to 100 ms). Sokolov explains that significance requires longer to process in the cortex before it makes its contribution to sympathetic arousal (at around 300 ms). In addition to these psychophysiological differences, novelty and significance can evoke very different affects. For example, the anxiety about performing poorly on a visual-motor task would be much less positive than the arousal of considering surprisingly novel questions. For these considerations, our present discussion of orienting responses will only pertain to novelty-generated orienting.

Major points from the previous discussion can be summarized as follows:

1) Several neuroimaging studies have found increased activation in the ACC and left frontal areas following successful EMDR treatment of PTSD. Neuroimaging research has

strongly implicated the ACC and prefrontal cortices as mediating the override of previously conditioned responses.

2) Traumatic memory is difficult to change with normal recall and reflection. Neuroimaging research strongly supports the concept of reciprocal suppression whereby sufficiently strong affective processing in the lower ACC can suppress cognitive processing in the upper ACC.

3) EMDR traditionally uses a dual-attention task in its ABS eye-to-finger tracking procedure. Dual-attention has been shown to activate the dorsal ACC along with the prefrontal cortices where cognitive processing is mediated.

4) In EMDR, its dual-attention tracking task can mitigate some of the distress from traumatic memory recall. Dual-attention tasks have been shown to activate the cognitive processing areas in the ACC and deactivate the affective processing areas.

5) Affective distress can be dissociated from physical pain via hypnosis. ACC affective processing areas deactivate during this phenomenon while still leaving somatosensory areas active in the brain.

6) There is research to support that positive affect facilitates cognitive flexibility. There is also research to support that the VTA dopaminergic projection system is associated with this phenomenon. The ACC is a major dopaminergic recipient for projections from the VTA. EMDR is facilitated by the use of positive “resources” associated with positive affect.

7) A very strong correlation has been found between novelty seeking in personality and post-synaptic sensitivity in the dopaminergic projection system. Therefore, it is hypothesized that novelty may be a stimulus dimension for activating dopamine release in the ACC for eliciting cognitive flexibility.

A Two-Stage Model

Various researchers have proposed models to account for the therapeutic effect of eye movements during EMDR. Denny (1995) proposes an external inhibition model whereby an orienting reflex suppresses the pain and distress of traumatic memory. Armstrong & Vaughan (1996) propose a fairly straightforward extinction model whereby an orienting reflex catalyzes a new appraisal and changes in the neuronal model of the un-conditioned stimulus (UCS). Andrade et al. (1997) propose a model whereby eye movements interfere with the vividness of traumatic material in the visual-spatial sketchpad of working memory. MacCulloch and Feldman (1996) propose that eye movements in EMDR evoke a "reassurance reflex" via positive visceral components of an investigatory OR response. Consistent with this concept, Barrowcliff et al. (2003) demonstrated psychophysiological de-arousal effects of eye movement following arousing stimulation. Barrowcliff et al. (2004) also demonstrated reductions on measures of vividness and emotional valence of emotional memories during eye movements as compared to an eyes-stationary condition. The authors interpret these results as supportive of the MacCulloch and Feldman (1996) reassurance reflex model. Corrigan (2002) proposes that EMDR relies on bilateral activation to reinstate the reciprocal relationship between subdivisions of the ACC that has probably been disrupted by trauma. Corrigan's model is congruent with an earlier model for explaining PTSD by Hamner et al. (1999) who propose that PTSD may dampen the emotional gating function of the ACC due to overly active efferent noradrenergic projections from the local corruleus to the ACC. Bergmann (1998) and Stickgold (2002) suggest that the orienting of eye movements may activate REM sleep like neurological mechanisms that involve ponto-geniculo-occipital (PGO) waves as well as hyper-association. Bergmann (2000) goes on to propose the possible additional influence of the lateral cerebellum during EMDR. He hypothesizes that the cerebellum may project its influence through the thalamus to promote the ACC's filtering function, thereby allowing the dorsolateral cortex to integrate semantic and other neocortical information into the traumatic memory. Rasolkhani-Kalhorn and Harper (2006) similarly propose that the ACC plays a central role in EMDR effectiveness. These authors speculate that low frequency bilateral stimulation during EMDR may produce the same effect as tetanic stimulation of lab animal synapses. The latter has been shown to depotentiate memory traces in synapses and Rasolkhani-Kalhorn and Harper speculate that fear memories are similarly depotentiated during EMDR. Without overwhelming input from the amygdala, the authors suggest that the more logical response to the hippocampally mediated memory can be selected by the ACC.

Several of the preceding models converge in proposing that the ACC obtains a restorative benefit from EMDR that allows more adaptive information to integrate from the neocortex or the hippocampus. What varies significantly is the mechanism each model proposes to explain how EMDR alters ACC functioning. The currently proposed two-stage model similarly assumes that EMDR influences the ACC to allow integration of neocortical information. However, the current model assumes that during EMDR there are two routes of influence that stimulate the ACC to reverse the direction of its reciprocal suppression of cognitive and semantic processing. The first route is error monitoring from the eye-finger-tracking task. Resulting activation of the upper ACC may reciprocally suppress the affective processing in the lower ACC and thereby "loosen the knot" to improve parallel processing of perspectives back in the upper ACC. The second route of influence may be dopaminergic VTA projections to the ACC that are activated by resource installation, placebo, and novelty effects. These two routes of influence are theorized to comprise the first stage of the proposed two-stage model.

The current author agrees with MacCulloch and Feldman that the investigatory reflex is probably involved during EMDR. However, instead of attributing the investigatory OR to eye movements themselves, the current author proposes that novelty-driven OR's may be more prevalent during a second stage. This second stage in the model involves novelty-evoked investigatory OR's from the patient's own newly emerging contextual information. This two-stage model is consistent with MacCulloch and Feldman's model but without the assumption that eye movements actually stimulate the investigatory reflex. The error monitoring in the eye-finger-tracking task may merely allow it. When the therapist engages the patient with an interweave framed as a question then an investigatory OR is likely to be more directly stimulated. However, it would be a mistake to assume that investigatory OR's necessarily depend on the therapist's intervention. The present author has observed real-time GSR during EMDR over a period of several years. Novelty-driven OR's were observed to be frequently occurring to patients' own material as indicated by the phasic nature of the responses as well as patient verbalizations. These observations were consistent with the description of novelty-driven phasic OR's (short-term orienting reflexes) previously described by Maltzman, Sokolov, and others (Maltzman, 1971, 1979; Maltzman & Mandell, 1968; Maltzman et al., 1970; Sokolov, 1963, 1975). These phasic OR's to emerging material are important because once an investigatory OR is underway, then multiple layers of processing are accelerated as indicated by classical OR research (Sokolov, 1963, 2002). In addition, some positive affect from the investigatory reflex may accompany dopaminergic activation in the ACC thereby further increasing cognitive flexibility (Ashby et al., 1999).

While the proposed model has some interesting implications, a point of caution should be raised. It is tempting to assume that any manipulation that evokes reciprocal suppression in the ACC will enhance desensitization effects. However, this is not always the case due to the importance of other moderator variables such as distraction It is assumed by some that distraction is a beneficial force when explaining EMDR effectiveness. In contrast, the currently proposed model assumes distraction to be a detracting by-product. It is proposed that reduced processing of negative affect in the lower ACC is the primary therapeutic factor. It is also proposed that a pure distraction effect can result in poor desensitization if it decommissions the target material in working memory through "coordinative inhibition" (Anokhin, 1974). This is a term referring to the cross inhibition that takes place when a new motivational system or “dominant focus” competes with and gradually eliminates a previous motivational system. The current author has found evidence for this latter effect when piloting intensively interactive ABS tasks for EMDR. For example, a drumming task was developed whereby the patient pursued a tone that alternated between left and right speakers in the room. Very poor desensitization was observed until a coinciding semantic priming task, derived from the patient’s own material, was added to keep the target material active in working memory.

The virtue of the original eye-to-finger tracking task of EMDR is that it is a task that lightly evokes error monitoring in executive functioning while decommissioning very little of the target material in working memory. If the currently proposed two-stage model is correct, then other tasks may also desensitize as long as the distraction trade-off can be minimized. For example, the current author has used the semantic priming strategy to maintain working memory material for patients while also performing a highly interactive type of cognitive motor interweave. This intense interweave is designed to evoke metacognitive error monitoring by creating a conflict between competing execution versus inhibition response tendencies. Nieuwenhuis et al. (2003) have shown that such a go/no-go task is a powerful stimulus for ACC activation. In the currently described interactive cognitive motor (ICM) interweave, a hand-touching task is employed whereby the patient must rapidly touch one finger but not two when the therapist’s hand is placed in different locations on either side of the patient. Each time the interweave is used, the polarity of touching is reversed (i.e., Touch one and not two in the first interweave episode, touch two and not one in the next episode). This reversal of polarity prevents the patient from losing ACC activation due to gradual performance learning. Because this task is so demanding of attention, the current model predicts that the resulting distraction effect would ordinarily limit desensitization benefits. However, because semantic priming is used from the patient’s own verbalized target material, distraction effects are theoretically minimized in the ICM interweave and processing breakthroughs have been observed frequently.

The semantic priming procedure deserves attention because it can be a very useful tool to limit the distraction trade-off for other highly interactive stimulation methods. The procedure is outlined as follows: At the end of each association channel and before returning to the target memory, the patient is asked the following question: “Since you last visualized the disturbing experience and for these past (xx) minutes that you’ve been talking, what’s the most important personal meaning of everything you’ve said? I’m going to ask you to take that meaning and put it into one sentence. What would that sentence be?” Once a sentence has been offered by the patient the therapist then asks: “Would you now take that sentence and condense it down to a symbolic phrase of only two or three words?” Once these words are obtained, the therapist writes them down on a sheet of similarly derived phrases. The therapist then asks the patient to revisit the target memory as usual. Whenever the therapist decides to use the ICM or another highly interactive interweave method, the therapist can then use these phrases by asking the patient to repeat a series of questions spoken to them while they are performing the interactive task. These questions are composed from the patient’s own phrases which the therapist can glance at from the recorded list. The therapist takes at least one and ideally two of the phrases at a time and uses them to compose unusual questions for the patient to repeat out loud. The procedure for deriving these cues is illustrated in Figure 1.

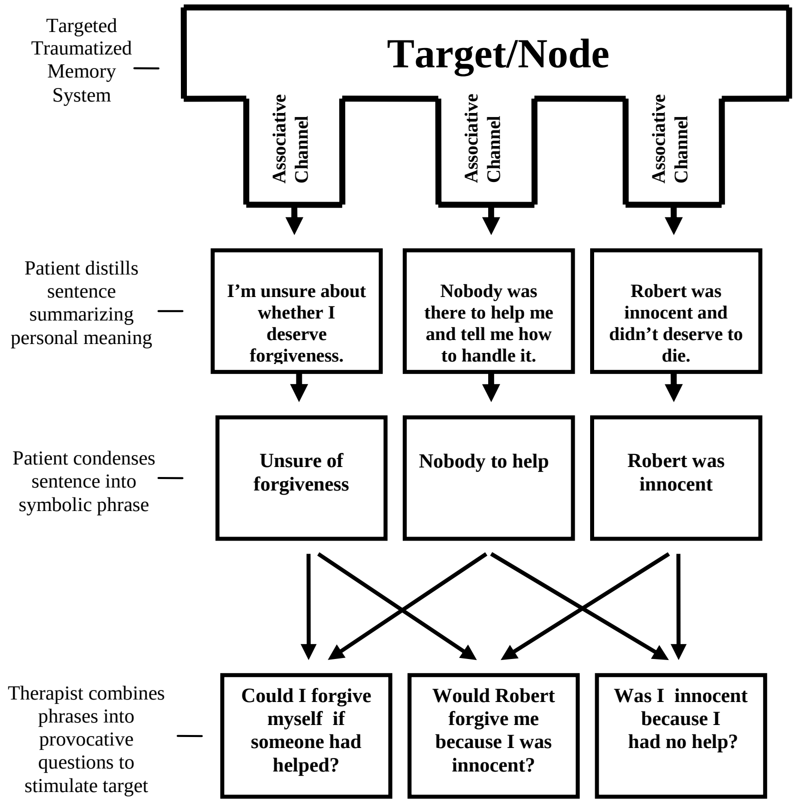

FIGURE 1. Illustrated process for deriving semantic cues.

In the currently described ICM interweave, the patient is asked to repeat approximately 8 questions in the space of about 45 seconds while performing the finger-touching task. This does not allow sufficient time for the patient to bring any single question to closure but rather leaves them with a mix of novel and curious possible relationships among the tagged meanings of their material. It should be acknowledged that these are not simple semantic cues but rather a combination of semantic and novelty cues together. In addition to probably provoking more memory search to reduce the induced ambiguity, it is proposed that this cuing procedure may result in powerful dopamine activation in the VTA due to novelty-driven OR's about the patient's own material. Some patients report feeling "protected" by the procedure but this may be due to the interactive motor component of the interweave as well. Other patients showed large GSR responses as well as increased blood flow through the superficial temporal artery and vasoconstriction in their toes as measured by plethysmograph. This response pattern is consistent with a strong OR response according to classical OR theory. Of course, well controlled research on this procedure is needed before any claim can be made regarding its overall effectiveness.

Suggestions for Future Research

If the current author's two-stage model is correct, then several lines of research may prove productive:

Future imaging research on post-EMDR effects should examine deactivation in addition to activation of different regions. Also, more specificity of location is needed since there is evidence of reciprocal suppression functions between the upper and lower ACC areas.

Research is suggested for correlating the rate of EMDR desensitization with frequency of novelty-driven OR's stimulated by the patient's own material. This author predicts a positive relationship based upon his pilot observations of real-time GSR responding. Such findings would be consistent with Maltzman's previous research on OR's being predictive of learning and conditioning. They would also be consistent with Rossi's (2002) description of a naturally occurring four-stage creative psychobiological cycle.

Research is suggested for examining individual differences in both novelty-OR responding and rates of desensitization. If VTA dopaminergic activation of the ACC plays an important part during desensitization, then individual differences should be salient. Post-synaptic sensitivity of the VTA dopamine projection system can be correlated to personality as demonstrated by the Suhara et al. (2001) study. Therefore, it is predicted that patients scoring high on Novelty Seeking measured by Cloninger's TCI inventory (Cloninger, 1994) will generally desensitize faster than those scoring lower. It is also predicted that individuals holding the 7-repeat allele version of the DRD4 gene will generally desensitize faster than those holding the 4-repeat version. The DRD4 gene effects dopamine sensitivity and the 7-repeat version of the gene has been found to correlate with greater novelty seeking (Cloninger, 2004).

Further research is also needed to adequately establish that passive ABS methods produce beneficial desensitization effects separate from error monitoring and in addition to any placebo and novelty effects. Most studies of ABS in EMDR do not adequately control for novelty. For example, Servan-Schreiber et al. (2006) compared SUD changes resulting from different ABS modalities along with a dual-hemispheric stimulation modality of pulsing tones and vibration. Unfortunately, the question still remains as to how the ABS conditions would compare to a truly comparable novel stimulation that does not alternate between the hemispheres. If such a stimulation involves vibrations that alternate between the right hand and right foot, will those results be inferior to those from vibrations alternating between left and right hands? It is suggested that future research on stimulation modalities should incorporate three characteristics: First, the dependent variable should be the desensitization effect measured at a later follow-up. In-session SUD changes are subject to temporary distraction effects and one stimulation method may be inherently more distracting than another. The first SUD measure on a target during a follow-up session can give a better measure for comparing real consolidated change. Second, a similarly novel stimulation should be used for any non-ABS modality that will be compared with ABS. Otherwise, confounding of the novelty variable will limit conclusions about the alternating hemispheric characteristics. Third, it is best if stimulation modalities can be compared after a previous session of practice has sufficiently habituated any novelty effects. These aspects of research design will probably be necessary to control for novelty and distraction to see if alternating bilateral stimulation provides additional therapeutic benefit as suggested by Bergmann (1998, 2000), Stickgold (2002), and Rasolkhani-Kalhorn and Harper (2006).

Conclusion

Based on neuroimaging and earlier research on cognitive and emotional processing, a two-stage model for EMDR desensitization is proposed. The first stage involves error monitoring that may reverse reciprocal suppression of executive processing in the upper ACC. It also involves novelty, expectation/placebo effects, and resource effects that may stimulate VTA dopaminergic projections to influence the ACC. The second stage involves an additional catalytic effect from investigatory OR reflexes. This model considers trade-offs that need to be balanced between gains in desired reflex phenomena versus distraction in working memory and inhibition of implicit memory.

To use a metaphor, we are no longer working with a black box. However, the box is still appreciably grey. The proposed model represents a more psychophysiological approach than labeling the EMDR tracking task as “eye movements” or “alternating bilateral stimulation.” These externalizing labels ignore the contextual meaning of the sensory stimulation and ignore that the sensory information is utilized to perform a specific task. The historical result is that passive ABS techniques have been equated with the original eye-finger-tracking task. We may have consequently labeled oranges as apples in the EMDR orchard.

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