

# Memory reconsolidation, emotional arousal, and the process of change in psychotherapy: New insights from brain science

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**Abstract:** Since Freud, clinicians have understood that disturbing memories contribute to psychopathology and that new emotional experiences contribute to therapeutic change. Yet, controversy remains about what is truly essential to bring about psychotherapeutic change. Mounting evidence from empirical studies suggests that emotional arousal is a key ingredient in therapeutic change in many modalities. In addition, memory seems to play an important role but there is a lack of consensus on the role of understanding what happened in the past in bringing about therapeutic change. The core idea of this paper is that therapeutic change in a variety of modalities, including behavioral therapy, cognitive-behavioral therapy, emotion-focused therapy, and psychodynamic psychotherapy, results from the updating of prior emotional memories through a process of reconsolidation that incorporates new emotional experiences. We present an integrated memory model with three interactive components—autobiographical (event) memories, semantic structures, and emotional responses—supported by emerging evidence from cognitive neuroscience on implicit and explicit emotion, implicit and explicit memory, emotion-memory interactions, memory reconsolidation, and the relationship between autobiographical and semantic memory. We propose that the essential ingredients of therapeutic change include: (1) reactivating old memories; (2) engaging in new emotional experiences that are incorporated into these reactivated memories via the process of reconsolidation; and (3) reinforcing the integrated memory structure by practicing a new way of behaving and experiencing the world in a variety of contexts. The implications of this new, neurobiologically grounded synthesis for research, clinical practice, and teaching are discussed.

**Keywords:** change processes; emotion; implicit processes; memory; neuroscience; psychotherapy; reconsolidation

## 1. Introduction

The modern era of psychotherapy arguably began with Breuer and Freud's (1895/1955) *Studies on Hysteria*. In that seminal work, Breuer and Freud hypothesized that the inability to express emotion at the time of trauma was the cause of hysteria (now called conversion disorder). They proposed that the key to treatment was emotional abreaction, or catharsis. Once the feelings that had not been expressed were brought to conscious awareness and relieved, the symptoms, Breuer and Freud proposed, would disappear.

Within the psychoanalytic tradition, Freud increasingly emphasized the importance of remembering and

understanding the past, whereas Ferenczi deviated from Freud by emphasizing the importance of emotional arousal in psychotherapy (Rachman 2007). Ferenczi's approach became the basis for the humanistic tradition launched by Carl Rogers and Fredrick Perls (Kramer 1995). Within psychoanalysis, however, the therapeutic importance of emotion was further refined by Alexander and French (1946), who proposed that the "corrective emotional experience" was the fundamental therapeutic principle of all "etiological psychotherapy." In their definition it meant "to re-expose the patient, under more favorable circumstances, to emotional situations which he could not handle in the past. The patient, in order to be helped,

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must undergo a corrective emotional experience suitable to repair the traumatic influence of previous experiences” (Alexander & French 1946). They also pointed out that “intellectual insight alone is not sufficient.”

The integrity and reliability of the evidence for Freud’s theories continue to be a topic of heated debate (Erdelyi 2006; Esterson 2002; Cleaves & Hernandez 1999; McNally 2005). Research shows that emotional catharsis alone (e.g., beating a pillow) does not attenuate or dissipate affect but rather leads to a heightening of it (Bushman 2002). Nevertheless, the importance of inducing emotional arousal as an ingredient in bringing about therapeutic change has stood the test of time. In his seminal overview of psychotherapy practices, Jerome Frank (1974a) stated that emotional arousal was a key ingredient in the success of psychotherapy. Modern psychoanalysts hold that re-experiencing and resolving core emotional conflicts in the transference relationship has a reality and authenticity that cannot be surpassed by other means (Luborsky 1984), and evidence for the effectiveness of psychodynamic psychotherapy is emerging (Leichsenring & Rabung 2008; Shedler 2010).

In behavior therapy (BT), cognitive-behavioral therapy (CBT), and emotion-focused therapy (EFT), emotion plays a central role in change. In behavioral therapy (BT) for anxiety disorders, activation of affect in the therapy session is a critical component and predictor of therapy success (Foa & Kozak 1986). CBT assumes that emotional distress is the consequence of maladaptive thoughts. Thus, the goal of these clinical interventions is to examine and challenge maladaptive thoughts, to establish more adaptive thought patterns, and to provide coping skills for dealing more effectively with stressful situations (Dobson 2009). Eliciting emotional responses through role-playing, imagination, and homework exercises is key to the identification and reformulation of these maladaptive thoughts. Recovery is facilitated by activities that encourage engagement of relevant pathological cognitive structures in a context that also provides information at odds with existing beliefs. In the humanistic tradition, research on EFT has also demonstrated that the intensity of emotional arousal is a predictor of therapeutic success (Missirlian et al. 2005). One must conclude that there is something about the combination of arousing emotion and processing that emotion in some way that contributes to therapeutic change, but the specifics of what it is about emotion that actually brings about change are not clear.

Insight-oriented psychotherapy places heavy emphasis on the recollection of past experiences. It is typically thought that understanding these past experiences in a new way contributes to psychotherapeutic change (Brenner 1973). There is disagreement, however, across therapeutic modalities about the importance of understanding what happened in the past. An alternative view is that the past is clearly exerting an important influence on the interpretation of present circumstances, but what is important is to change current construals so they more accurately fit present rather than past circumstances (Lambert et al. 2004). For example, Ellis’ (1962) rational emotive behavior therapy emphasizes that distress symptoms arise from irrational belief systems developed from previous experiences and events that elicited strong negative emotions. For Ellis and others in the BT (Eysenck 1960; Foa & Kozak 1986), CBT (Beck 1979; Rachman

1997; 1980), and EFT traditions (Greenberg 2010), actual understanding what developmental experiences contributed to the current way of understanding the world may therefore not be necessary to bring about change.

This latter view becomes especially salient when considering that memories of the past are not likely veridical accounts of the original event (Heider 1988) but undergo revision with repeated recollections and the passage of time (Neisser 1981; Neisser & Harsch 1992; Talarico & Rubin 2003), especially for the autobiographical components of those memories (Bergman & Roediger 1999; Coluccia et al. 2006; Nadel et al. 2007; Ost et al. 2002). Instead of remaining faithful records of past events, memories are updated and re-encoded through a process referred to as “memory reconsolidation” (see Hardt et al. 2010 for a recent review). As such, there is a need to more precisely define in what way memory processes contribute to therapeutic change and to better define how these memory processes interact with emotional processes.

In this paper, we propose that change occurs by activating old memories and their associated emotions, and introducing new emotional experiences in therapy enabling new emotional elements to be incorporated into that memory trace via reconsolidation. Moreover, change will be enduring to the extent that this reconsolidation process occurs in a wide variety of environmental settings and contexts. This proposed mechanism may be timely. Kazdin, for example, stated, “After decades of psychotherapy research, we cannot provide an evidence-based explanation for how or why even our most well studied interventions produce change, that is, the mechanism(s) through which treatments operate” (Kazdin 2006, p. 1).

We propose an integrated memory model with three associative components – autobiographical (event) memories, semantic structures, and emotional responses – that are inextricably linked and that, combined, lead to maladaptive behaviors. This memory structure is similar to previous formulations of the “fear structure” by Foa and colleagues (Foa et al. 1989), but applied more broadly and, importantly, is predicated on recent neurobiological evidence that provides a basis for understanding how the memory structure is changed through psychotherapy. Briefly, we will argue that, broadly speaking, clinical change occurs through the process of memory reconsolidation. During therapy, patients are commonly asked to experience strong emotions, elicited by the recollection of a past event or other precipitating cue. By activating old memories and their associated emotional responses in therapy, new emotional elements can be incorporated into the memory trace. The corrective experience occurs within a new context, the context of therapy itself, which can also be incorporated into the old memory via the processes of reactivation, re-encoding, and reconsolidation. Additionally, recent evidence suggests that event memories and semantic structures are interactive (for review, see Ryan et al. 2008b). By updating prior event memories through new experiences, the knowledge and rules derived from prior experiences will also change. Thus, new semantic structures, or rules and schemas, will be developed that lead to more adaptive ways of interpreting events, and, in turn, more appropriate emotional responses. Change will be enduring to the extent that this reconsolidation process occurs in a wide variety of contexts, allowing

generalizability of the newly formed memory/semantic structure to novel situations and environments.

Importantly, we will argue that change in psychotherapy is not simply a result of a new memory trace being formed or new semantic structures being developed. Instead, reconsolidation leads to the transformation of all the components of the memory structure, including the original event memory. By this view, psychotherapy is a process that not only provides new experiences and ways to evaluate new experiences, but also changes rules and schemas derived from past experiences in fundamental ways through the reconsolidation of memory and its related cognitive structures. A number of therapeutic approaches are adopting this as an explanatory construct (Ecker et al. 2012; Greenberg 2010; Welling 2012).

In the sections that follow, we review implicit cognition and implicit emotion (sect. 2), the role of implicit processes in psychotherapy (sect. 3), and the evidence that emotional arousal is a key ingredient in the success of psychotherapy (sect. 4). We then focus on several key areas of research relevant to the integrated memory model, including interactions between memory, emotion, and stress (sect. 5), the inherently dynamic nature of memory (sect. 6), the phenomenon of memory reconsolidation (sect. 7), and the relationship between autobiographic (personal experience) memory and semantic (generalizable knowledge) memory (sect. 8). We conclude with a discussion of the implications of this new, neurobiologically grounded integrated memory model for clinical practice, future research, and education (sect. 9).

## 2. Implicit emotion and emotional trauma

Breuer and Freud (1895/1955) believed that the critical pathogenic element in hysteria was strangulated affect. Consistent with Janet’s concept in the late nineteenth century (Van der Kolk & Van der Hart 1989), trauma was conceptualized as an experience that was psychologically overwhelming because of the intensity of the affect that was activated, not because it was an event that was inherently life-threatening (as is specified in current Diagnostic and Statistical Manual [DSM-V] criteria for Post-Traumatic Stress Disorder [PTSD]) (American Psychiatric Association 2013). They believed that there was a lack of affective expression at the time of a trauma that kept the memory of the traumatic event alive for years. Once this emotion was experienced, expressed and put into words in the therapeutic context it would be curative. This conceptualization was consistent with the Freudian concept of unconscious mental representation, which was that mental contents including emotions were fully formed in the unconscious, were revealed in conscious awareness only when defenses were removed or overcome (Schimek 1975), and that the goal of therapy was to “make the unconscious conscious” (Breuer & Freud 1895/1955; Freud 1923/1961).

A century of research has altered our understanding of unconscious mental representation. We now understand that memories and feelings do not reside in the unconscious fully formed waiting to be unveiled when the forces of repression are overcome (Lane & Weihs 2010; Levine 2012). In contrast to a model of the unconscious as a cauldron of forbidden impulses and wishes, the “adaptive unconscious” (Gazzaniga 1998) is conceptualized as an

extensive set of processing resources that execute complex computations, evaluations, and responses without requiring intention or effort. Much of this processing may be unavailable to conscious awareness, or at least, awareness is unnecessary for such processing to occur. More commonly, cognitive psychology refers to implicit processes to differentiate them from explicit processes that are engaged during intentionally driven and goal-directed tasks. The distinction between implicit and explicit processing has been applied in some form to virtually all areas of cognition, including perception, problem solving, memory and, as we will discuss, emotion, leading Gazzaniga (1998) to suggest that 99% of cognition is implicit. Importantly, some psychoanalysts believe that this new way of understanding the unconscious as fundamentally adaptive calls for a revision of classic psychoanalytic models of the unconscious mind (Modell 2010).

In the memory domain, *implicit memory* refers to the impact of prior experience on subsequent behavior in the absence of explicit recall or awareness of that prior experience (for review, see Schacter et al. 1993). In the laboratory a brief exposure to a specific word, for example, increases the likelihood that a person will respond with that particular word during various language-based tasks such as completing a three-letter word stem (Graf & Schacter 1985; Schacter & Graf 1989) or producing exemplars belonging to a semantic category (Ryan et al. 2008a). A different form of implicit learning is the acquisition of complex sets of rules that govern predictions (Reber 1989), allow categorization of novel objects and concepts (Seger & Miller 2010), and guide social interactions (Frith & Frith 2012). Importantly, this learning occurs regardless of whether the individual is explicitly aware of the rules that have been acquired or that learning has even taken place. In the social domain, this learning consists of the semantic rules, expectations, and scripts for behavior that provide the basis for the self-concept (Markus & Wurf 1987).

The distinction between implicit and explicit processes, a cornerstone of modern cognitive neuroscience, has also been applied to emotion (Kihlstrom et al. 2000; Lane 2000). Emotions are automatic, evolutionarily older responses to certain familiar situations (Darwin 1872). Emotion can be understood as an organism's or person's mechanism for evaluating the degree to which needs, values, or goals are being met or not met in interaction with the environment and responding to the situation with an orchestrated set of changes in the visceral, somatomotor, cognitive, and experiential domains that enable the person to adapt to those changing circumstances (Levenson 1994). Implicit processes apply to emotion in two important senses. First, the evaluation of the person's transaction with the environment often happens automatically, without conscious awareness, and is thus implicit. Importantly for this discussion, this implicit evaluation is based on an automatic construal of the meaning (implications for needs, values or goals) of the current situation to that person (Clore & Ortony 2000). Second, the emotional response itself can be divided into bodily responses (visceral, somatomotor) and mental reactions (thoughts, experiences). The latter include an awareness that an emotional response is occurring and an appreciation of what that response is. A foundational concept of this paper is that emotional responses can be implicit in the sense that the bodily response component of emotion can occur without concomitant feeling states or awareness of such feeling states.

There is now considerable evidence supporting an implicit view of emotion (Kihlstrom et al. 2000; Lambie & Marcel 2002; Lane 2008). Indeed, 25 years of research has demonstrated the occurrence of spontaneous affective reactions associated with changes in peripheral physiology and/or behavior that are not associated with conscious emotional experiences (Ledoux 1996; Quirin et al. 2012; Winkielman & Berridge 2004; Zajonc 2000). For example, one can activate emotions with subliminal stimuli and demonstrate that the emotional content of the stimuli influences subsequent behavior, such as consummatory behavior, without the person being aware of such influences on behavior (Winkielman & Berridge 2004).

Furthermore, many decades of research preceding the modern era of neuroimaging demonstrated the evocation of visceral and somatomotor expressions of emotion in brainstem stimulation studies of laboratory animals (Ledoux 1996). Although these phenomena cannot be linked to reportable experiences in animals without language, they nevertheless are the physical manifestation of emotion. We believe that implicit emotion, consisting of these visceromotor and somatomotor expressions of emotion, constitute the foundation upon which differentiated emotional experience is built. Moreover, subcortical structures including the thalamus, hypothalamus, amygdala, and periaqueductal grey likely contribute to the generation of these undifferentiated emotional responses that are not associated with specific emotional experiences (Lane 2008).

Lambie and Marcel (2002) distinguish among three different conditions: an emotional state with no phenomenal experience; the first-order phenomenal experience of emotion, which is expressible; and a second-order experience of emotion associated with awareness, which is reportable. Implicit emotion, or bodily felt sensations, can be transformed into discrete conscious experiences of specific emotions or feelings by putting the felt sensations into words (Barrett et al. 2007; Lane 2008). Through this process individuals can feel specific, differentiated emotions and “know” what it is that they are feeling. Thus, the term “explicit” is used to refer to states of awareness that are symbolized and known. In relation to emotion the term “implicit” refers to automatic bodily responses that are unconscious in the sense that they are not associated with awareness, are not consciously symbolized and are not known (but could include the unattended conscious or phenomenal experience of the bodily state). Note that the unconscious can further be differentiated into that which has never been mentally represented and needs to be formulated for the first time versus that which has previously been represented or known but is not consciously accessible at the moment (Levine 2012). “Emotion processing” refers to any change in either the implicit or explicit components of the emotional response. “Cognitive processing of emotion” includes attending to the experience, symbolizing it (e.g., in words or images) and reflecting upon what the experience means (e.g., determining what one needs), or some combination thereof.

Based on these conceptual distinctions, one can revisit the concept of trauma as described by Breuer and Freud (1895/1955). Trauma may consist of experiences that are emotionally overwhelming in the sense that the ability or resources needed to cognitively process the emotions (attend to, experience and know them) are exceeded.

Trauma may consist of a single event but more commonly consists of a repeated pattern of abuse or mistreatment that is emotionally painful to the victim. In the context of growing up as a child in a family in which abuse repeatedly occurs, one makes cognitive and emotional adaptations to keep the subjective distress to a minimum. This helps to keep attention and other conscious resources available for other tasks (see Friston 2010). The victim learns to accept certain kinds of mistreatments in order to continue in relationships, which appear to be (and often are) necessary for survival. The needed adjustments include tuning out awareness of one's own emotional responses or taking for granted certain things about the self (such as "you're no good and deserve to be punished"). Later in life, related situations are interpreted implicitly based on the implicit learning that occurred from these experiences (Edelman 1989). One might conjecture that the more intense the abuse the more implicit evaluations in distantly related contexts are influenced by the trauma.

All too commonly, perhaps as a result of direct physical threats, shame or lack of available confidants, these experiences are never discussed with anyone. When a parent is the instigator of abuse it is often a "double whammy," first because of the violation or harm and second because the parent is not available to assist the victim in dealing with it (Newman 2013). The lack of an available caregiver to provide comfort and support may be a critical ingredient in what makes the experience(s) overwhelming or traumatic. What this means emotionally is that the implicit emotional responses were never brought to the conscious level of discrete feeling through mental representation, as in language. As a result, the traumatized individual knew the circumstances of the trauma but did not know how it affected him emotionally. This lack of awareness contributes to the tendency to experience traumatic threats in an overly generalized manner that reflects the inability to distinguish circumstances that are safe from those that are not. It is often only in therapy when the experiences are put into words that the emotional responses are formulated for the first time (Lane & Garfield 2005; Stern 1983).

Although Breuer and Freud believed that expressing the emotion was critical, this alternative perspective highlights the importance of becoming aware of the emotional impact of the experience(s) through symbolization and contextualization (narrative formation) (Liberzon & Sripada 2008) and using this awareness in the promotion of more adaptive responses (that is, converting implicit emotional responses to explicit emotional responses). When the trauma is first recalled, the description of experience is likely to include strong emotions, such as fear, that were experienced at the time and contributed to strong encoding of the event. As the therapy process unfolds, the events are recalled in the context of a supportive therapist who also helps the client to attend to contextual information that may not have been available to the client at the time of the trauma (in part because of temporary hippocampal dysfunction [Nadel & Jacobs 1998]; see sect. 4). This new information in therapy contributes to a construction of the events in a new way that leads to emotions that had not been experienced before, for example, experiencing anger at abuse that could not be expressed or experienced at the time because the threat was so severe. The anger is a signal that one needs to be protected. In that sense, the emotional response is adaptive to the circumstances: It

probably was not permissible at the time of the trauma to experience or express it. Experiencing and describing anger in therapy helps create a coherent narrative account of what occurred. Doing so is not the same as Freudian catharsis (release of pent up energy) but rather the creation of a more complete picture of what happened, how one responded, what one experienced, and how it could have been different (Greenberg 2010).

Having another person such as a therapist participate in and facilitate this mentalization process in adulthood may be essential (Allen 2013). The capacity for self-observation is limited, and more so if empathic and responsive parenting was limited during development (Paivio & Laurent 2001). Just as having a teacher/coach/observer is helpful in the development and refinement of any athletic, intellectual, or musical skill, in the case of psychotherapy the therapist is potentially able to view a given situation from a different, if not a broader, perspective, making it possible to construe the situation, and the client's emotional response to it, differently. This relates to the "coaching" aspect of helping someone to get in touch with feelings of which they were previously unaware (Greenberg 2002).

The guiding thesis of this article is that the therapy experience provides new information and that the old memory (or memories) is reconsolidated with this new information. Different therapy modalities focus on different kinds of information that are inherent in the therapy experience (see sects. 3 and 9). The discussion above focused on new information consisting of expansion of the client's understanding of what they experienced emotionally. The new information consists, in part, of both the conscious experience of emotions not previously experienced originally or during prior retellings of the event, and an understanding of what these experiences are and what they mean. Another source of new information, which is a common denominator across modalities, is the therapeutic alliance with the therapist (Horvath & Luborsky 1993). Experiencing the safety, support, caring, and compassion of the therapist in the context of recalling adverse experiences permits incorporation of this interpersonal experience, a type of information, into the traumatic memories, which often involve being alone and unprotected. The experience of comfort and support may be sensed and responded to implicitly without being brought to explicit awareness through attention, reflection, and verbal description.

Therapy modalities differ in the emphasis placed on self-exploration and the importance of the interpersonal connection with the therapist. A person's ability to be aware of and process her own emotions, and to engage with a therapist, may be a function of the degree to which caregivers succeeded in providing this function during childhood in a way that matched the needs of the child in question (Steklis & Lane 2013). In the case of emotion as a subjective experience, there is no information in the external environment that corresponds to the child's internal experience except that which is provided by an attuned other. For example, one cannot typically see one's own facial expressions and in infancy such expressions may not be recognized as one's own even if looking in the mirror. This may be contrasted with the example of self-initiated movement (Keysers & Gazzola 2006). The basic coordination of intention with actual motor movement can occur without help from other people because one can see what happens when one intentionally moves one's arm.

This visual input goes beyond the feedback provided by proprioceptive sensation. Thus, in early development the ability to link subjective experience of emotion with an understanding of its behavioral manifestations in the real world requires input from others (Gergely & Watson 1996).

For example, a very young child may recoil and appear frightened when a puppy approaches. A parent may say, “Don’t worry. There’s nothing to be afraid of (parent pets the puppy). See how friendly he is.” A somewhat older child may manifest avoidance behavior in anticipation of an upcoming event at school. Recognition by a parent that the avoidance behavior may be an expression of fear, labeling it as such, discussing with the child what he perceives as threatening and discussing ways to deal with it all contribute to the child’s ability to experience fear and use it as a cue for adaptive responding in similar situations in the future. If input such as this from significant others is missing during development the capacity to know what one is feeling will be impaired in childhood and persist into later life, creating a predominance of implicit emotional responses relative to explicit emotional experiences and a greater propensity for being overwhelmed (traumatized) or unable to cognitively process one’s own emotions later in life.

The expansion of awareness in therapy is not unlike that induced by a physical therapist who helps extend the range of motion of a joint by facilitating movements that are associated with tolerable but not excessive levels of pain and discomfort. It is difficult to extend oneself in these ways on one’s own on account of self-protective mechanisms (the same ones that led to avoidance of emotional pain through regulatory actions). Parenthetically, the origin of restricted movement in a joint typically arises from inflammatory mechanisms designed to respond to and repair the original injury, just as psychological adjustments are made to limit access to “the part that hurts.” In psychotherapy, according to our formulation, expanding awareness involves experiencing, labeling, reflecting upon and using emotions that were originally associated with the trauma, but which by definition originally exceeded the person’s capacities for assimilation and coping. Thus, new information brought in or facilitated by the therapist, available for reconsolidation, includes new ways of construing and responding to the client as a person, a new perspective on the originally traumatic events, and the facilitation of new emotional experiences.

From this perspective, what constitutes traumatic stress varies from person to person. This also helps to explain why trauma early in life predisposes to trauma later in life. As we’ll see in section 3, the role of implicit memory in the construal of current situations based on past experience provides another perspective on how we might currently interpret what Breuer and Freud meant when they said that the lack of affective expression at the time of the trauma kept the memory of the traumatic experience alive.

### 3. Role of implicit emotion in different therapeutic modalities

Based on the considerations above, implicit emotion plays a critical role in a variety of psychotherapy modalities. In this section we will briefly discuss how implicit processes are relevant to behavioral (sect. 3.1), cognitive-behavioral

(sect. 3.2), experiential (sect. 3.3), and psychodynamic psychotherapies (sect. 3.4).

#### 3.1. Behavioral perspective

Numerous therapies based on exposure have been shown to be effective for treating trauma and anxiety-related disorders including PTSD, and their effectiveness appears to be based on emotional processing (Foa et al. 2003). Effective therapy requires the activation of a fear structure that includes an associative network of prior distressing memories, the representations of fear and/or trauma-related stimuli, and emotional responses to those stimuli (Foa et al. 1989). Components of the fear structure can be implicit, in that the individual may be unaware of the circumstances leading to the development of the fear structure, or even the stimuli that activate the fear response. The fear structure becomes pathological when the individual persistently avoids engaging emotionally and experiencing the emotion associated with the fear-inducing memories leading to behavioral avoidance of fear-related stimuli and exceptionally strong emotional responses when those stimuli are encountered (Foa et al. 1995). According to Rachman (1980), if a fear probe elicits a strong emotional reaction during therapy, it signals that adequate emotional processing has not taken place. Emotional processing is defined by Foa and Kozak (1986) as the modification of memory structures that underlie emotional responding. Change occurs when the fear structure is modulated, that is, when the bonds between specific eliciting stimuli and a strong (and often maladaptive) emotional response are broken.

These modifications often occur through implicit learning, because the changing emotional and physiological responses to particular stimuli during treatment may be unavailable to the conscious awareness of the individual, as in the case of habituation or extinction (Foa & Kozak 1986). Thus, exposure training can be conceptualized as both intervention and change at the level of implicit emotion. Through exposure training the somatomotor (behavioral) response is modified from avoidance to either non-avoidance, approach, or other behavioral options, and the initially strong visceromotor (e.g., autonomic and neuroendocrine) response is attenuated.

#### 3.2. Cognitive-behavioral perspective

Cognitive behavioral therapy (CBT) emphasizes the importance of identifying the underlying semantic structures that have been built through prior experience and now lead, often without the clear awareness of the individual, to inappropriate evaluation of new situations and the elicitation of negative emotional responses (Beck 1979; Foa 2009; Hofmann et al. 2013). Although the learning of the rules, schemas, and scripts that make up the semantic structure came about because of prior experiences, CBT does not focus on understanding these experiences, because a significant portion of semantic knowledge as it applies to social interaction is obtained implicitly. As such, CBT holds that there is no particular benefit to an exploration of the learning sources. Instead, it focuses directly, and presumably more efficiently, on identifying and making explicit these rules as they are applied inappropriately to recent and novel situations, leading to emotional distress and maladaptive responses. Making these implicit rule systems, or what

Reber (1996) refers to as the “cognitive unconscious,” explicit is a key ingredient to therapeutic success. The client is then led, through in-session exercises and homework, to experience novel situations and how these rules apply, and to consider evidence that undermines these rules. In summary, the implicit thoughts that are the basis for automatic emotional responses are brought to explicit awareness and modified. Because the evaluation is thought to be the trigger of the emotional response, a change in the evaluation leads to a change in the emotional response.

### 3.3. Experiential perspective

In emotion-focused therapy (EFT), a neo-humanistic integration of gestalt and person-centered therapy, emotion is seen as core to the construction of the self and a key determinant of self-organization (Greenberg 2010). In EFT a core assumption is that change comes about both through more complete processing and awareness of emotion and through the transformation of emotion schemes. Emotion schemes, in line with Piaget’s notion of schemes, are seen as action and experience producing implicit structures as opposed to the semantic cognitive schemas of cognitive therapy. This focus is consistent with the integrated memory model (described briefly above in sect. 1 and expanded on in sect. 9) in that personal experience (autobiographical memories), generalized knowledge (semantic structures), and emotional responses (including action tendencies and emotional experiences) are co-activated and mutually interactive. In this approach, the client is helped to experience and become more consciously aware of his or her emotions by focusing attention on bodily sensations, action tendencies, thoughts, and feelings, putting emotional experiences into words and examining what the emotional experiences mean. Bodily sensations and action tendencies are implicit emotional processes that may go unnoticed in problematic situations but through therapy are transformed into explicit representations through language and other representation modes (e.g., pictorial) and are re-experienced in an intense and vivid fashion. A major therapeutic goal is to “change emotion with emotion.” This is done by activating core maladaptive emotion schemes, based on implicit emotion memories of past, often traumatic, experience of painful abandonment or invalidation. The empirically validated theory of change (Greenberg 2010; Pascual-Leone & Greenberg 2007) shows that accessing the unmet need associated with maladaptive emotions, and promoting a sense of rightfully deserving to have the unmet childhood need met, creates a sense of agency. The withdrawal emotions of fear and shame were found to be the predominant maladaptive emotions and were transformed by approach emotions such as empowered anger, the sadness of grief and compassion (see Greenberg 2002, pp. 171–91, for a more detailed discussion of maladaptive emotions). This new, more agentic self-organization helps generate new, adaptive, emotional responses to the old situation. Thus, one might feel assertive anger at having been invalidated, which undoes the prior feeling of shame. The method does not focus on transference or a developmental perspective but rather the experience of new emotional responses during therapy in the “here and now,” with the goal of generating new responses to change old responses and consolidating this with a new narrative that includes alternative ways that one could respond to similar situations in the future.

### 3.4. Psychodynamic perspective

Patients who seek psychodynamic therapy or psychoanalysis typically have long-standing maladaptive patterns of behavior that they want or need to change (Luborsky 1984). These repetitive patterns are related to the Freudian concept of repetition compulsion (Freud 1913/1958). Not uncommonly, these involve ways of relating and responding to people and situations of which they are not consciously aware. A core component of psychodynamic treatment is the transference, which is the sum of the feelings of the patient for the therapist. Transference may be conceptualized as an emotional procedure (an implicit way of relating to others) (Clyman 1991) that is applied or “transferred” to the treatment relationship and is explicitly discussed and understood relative to what “actually” transpired in the treatment relationship, as constructed by both the therapist and patient. A second core component of psychodynamic therapy is a developmental perspective, which involves an explicit, co-created historical reconstruction of how the problems, which are the focus of treatment, got established earlier in life and how they are manifested in current relationships outside the treatment and in the transference relationship with the therapist. Changing the problematic implicit emotional procedures through insight involves interrupting the automatic behavioral enactment, consciously experiencing the associated “underlying” emotions (or implicit emotional processes), consciously extracting the information inherent in the emotional response, reappraising the situation and pattern, altering behavior, and establishing new procedures until they become automatic (i.e., working through) (Lane & Garfield 2005). A guiding assumption, which differentiates it from the three other modalities listed above, is that change is facilitated by understanding the origin of the patterns and how they recur due to motivations and behaviors that are out of awareness. The corrective emotional experience in this modality involves experiencing the on-line feelings that occur in interaction with the therapist that are contrary to expectation, for example, experiencing acceptance and support when criticism is anticipated.

From the brief discussion above, several commonalities emerge. The maladaptive behavior patterns that bring people to psychotherapy often include several implicit components. First, people may not be aware of how these patterns of behavior were acquired, increasing the likelihood that they will be over-applied in new situations that share characteristics with earlier threatening or distressing events (Lane & Garfield 2005). Second, the elicitors of the behavior patterns are often themselves implicit. Emotional responses are elicited by semantic structures (rules and schemas) or contexts that derive from each individual’s past experiences. At some level the configuration may be sensed by the individual (e.g., the demanding authoritarian boss “reminds” one of a demanding parent), but the underlying cognitive structures leading to emotional responding may not be well articulated, or even noticed. Third, these repetitive behavior patterns often include expressions of implicit emotion. Implicit emotions lead to action tendencies (Frijda 1986), such as withdrawal and avoidance, that may be inappropriate or maladaptive. Fourth, emotional responses, with their associated memories, semantic structures, and action patterns, can be revised, and thus the tendency for repetitive

maladaptive behaviors can also be revised. Fifth, the presence and support of an engaged therapist changes the interpersonal and emotional context in which the problematic patterns are activated. Finally, a common precursor to change is the elicitation of strong emotional responding in the therapy situation. In the next section we review evidence that this is so in preparation for a discussion of how this interacts with memory structures that themselves can change.

#### 4. Evidence that emotional arousal is critical to psychotherapeutic success

As noted in the introduction, there is good evidence that emotional arousal appears to be important for the success of many different forms of psychotherapy. Although this appears to be the case for BT, CBT, EFT, and psychodynamic psychotherapy, there are important caveats to consider.

Numerous behavior therapies based on exposure have been shown to be effective for treating trauma and anxiety-related disorders. A meta-analytic review of the literature found that exposure therapy is the most effective treatment for PTSD, and that its effectiveness is based on emotional processing (Foa et al. 2003). Patients with anxiety disorders who are best able to experience anxiety during the therapy session are most likely to benefit from therapy, including those with phobias (Borkovec & Sides 1979), agoraphobia (Watson & Marks 1971), obsessive-compulsive disorder (Kozak et al. 1988), and PTSD (Foa et al. 1995). In a series of studies on behavioral exposure (Foa et al. 1995; Jaycox et al. 1998), positive outcome for PTSD from rape was predicted by the arousal of fear and its expression while narrating memories of the trauma during the first exposure session and by reduction of distress over the course of treatment. Findings like this show that emotional arousal while engaging in imaginal exposure is an aspect of the mechanism of change. In studies of recovery patterns in sexual and nonsexual assault victims, long-term recovery in general was found to be impeded if the indispensable emotional engagement with traumatic material in therapy was delayed (Gilboa-Schechtman & Foa 2001). As Greenberg & Pascual-Leone (2006) note, research on behavioral exposure (e.g., Jaycox et al. 1998) has shown that only some individuals actually engaged in the exposure task and therefore only some were able to benefit from the treatment.

Jones and Pulos (1993) found that the strategies of evocation of affect, and the bringing of troublesome feelings into awareness, were correlated positively with outcome in both cognitive-behavioral and dynamic therapies. Another study (Coombs et al. 2002) by this group examining the therapists' stance in CBT and interpersonal therapy of depression showed the importance of focusing on emotion regardless of orientation. Reviews of process-outcome studies in psychotherapy show a strong relationship between in-session emotional experiencing, as measured by the Experiencing Scale (Klein et al. 1986), and therapeutic gain in dynamic, cognitive, and experiential therapies (Castonguay et al. 1996; Goldman et al. 2005; Orlinsky & Howard 1986; Silberschatz et al. 1986).

A survey (Pifero 2004) investigated clients' experience of the process of affect-focused psychotherapies. The clients

had participated in one of three emotion-focused therapies: Accelerated Experiential Dynamic therapy (Fosha 2000), Intensive Short Term Dynamic therapy (Abbass 2002), and Emotion-Focused Therapy (Greenberg 2002). Clients' experiences were assessed retrospectively. Client reports of having experienced deep affect in therapy were clearly related to both satisfaction with therapy and feeling that change had occurred. There was a significant relationship between clients' recognition of their therapist's affect-eliciting techniques and feelings of satisfaction and change. Pifero (2004) concluded that emotional experiencing may be the final common pathway to therapeutic change.

In studies of EFT for depression higher mid-therapy emotional arousal was found to significantly predict outcome, whereas a client's ability to use internal experience to make meaning and solve problems added to the outcome variance over and above middle phase emotional arousal (Missirlian et al. 2005). In addition, in a study of emotion-focused therapy of depression a curvilinear relation between emotional arousal and outcome was found showing that too much or too little arousal when emotion was being processed was not as predictive of outcome as was arousal 25% of the time (Carryer & Greenberg 2010). Thus, it appears that a combination of emotional arousal and reflecting on the emotion is a better predictor of outcome than either alone. In addition, productivity of aroused emotional expression as measured by the ability to mentalize and work with the aroused emotion was found to be an excellent predictor of outcome (Auszra et al. 2013; Greenberg 2010).

In studies of EFT for trauma good client process early in trauma therapy has been found to be particularly important because it sets the course for therapy and allows maximum time to explore and process emotion related to traumatic memories (Paivio et al. 2001). One practical implication of this research is the importance, early in therapy, of facilitating clients' emotional engagement with painful memories. Being able to symbolize and explain traumatic emotional memories in words helps promote their assimilation into one's ongoing self-narrative (van der Kolk 1995). This form of putting emotion into words allows previously unsymbolized experience in emotional memory to be assimilated into peoples' conscious, conceptual understandings of self and world, where it can be organized into a coherent story. Timing is also important, as there is strong evidence that debriefing immediately after a trauma has occurred is harmful in that such debriefing increases rather than decreases the likelihood that PTSD will develop (McNally et al. 2003). The activation of emotion in therapy for trauma appears useful only after PTSD has set in.

Regarding psychodynamic psychotherapy, emotional arousal is part of clinical lore. Vividly re-experiencing emotions in the transference is thought to contribute to therapeutic change (Luborsky 1984; Spezzano 1993), but objective evidence that this is an essential ingredient to psychodynamic therapeutic success may not be available. Monsen et al. (1995) conducted a five-year follow-up study on personality-disordered patients who had been treated using a psychodynamic psychotherapy that had a particular focus on patient's consciousness of affect. Both during treatment and five years post treatment, researchers found significant and substantial changes in the degree to which patients were aware of affect, characterological

defenses, and symptoms. Moreover, at the end of treatment, nearly three-quarters of the patients who met DSM-III criteria for both Axis I and Axis II diagnoses no longer met these criteria. This finding suggests that intensive psychotherapy focusing on warded-off affect is helpful to a group of patients, in whom most studies report only moderate to poor outcome.

In sum, the evidence from the psychotherapy research just reviewed indicates that the explicit, conscious reported experience of emotion is an important ingredient in therapeutic success across all of the modalities listed above, including those such as behavior therapy and CBT that do not in theory explicitly rely on such experiences. Yet, a coherent theory of the cognitive processing of emotion in therapy must account for the fact that emotion activated in therapy may be adaptive or maladaptive. As illustrated by the work on emotional expression during debriefing immediately after trauma versus after PTSD has set in, emotions at times need to be regulated and modified and at other times accessed and used as guides.

This balance can be understood if one hypothesizes that the relationship between the degree of arousal and the ability to create mental representations of one's own emotional state is quadratic (inverted U) rather than linear. If emotional arousal is too intense, the mentalizing function mediated by a network including the medial prefrontal cortex (Amodio & Frith 2006) goes off-line, limiting the capacity for reflection in emergency situations. If arousal is very low, then cognitive processing of emotion is not likely to occur. Arousal needs to be moderate in the psychotherapy session: more arousing than non-emotive therapies, but less arousing than the trauma itself. This inverted-U effect for emotion and medial prefrontal cortex function is parallel to that for dopamine agonism or antagonism and activation in the dorsolateral prefrontal cortex during spatial working memory (Vijayraghavan et al. 2007). In order to reflect upon a given situation the context needs to be recalled and brought into working memory, which has been shown to involve this inverted-U function for dopamine. This inverted-U relationship is also expressed in the Yerkes–Dodson (Diamond et al. 2007) law of arousal and performance (both motoric and intellectual), which states that performance level for complex tasks is best when arousal level is neither too high nor too low. Neuroimaging evidence of the important role of superior medial prefrontal cortex in mentalizing on the one hand (Amodio & Frith 2006), and the positive correlation between activity in this region and vagal tone (which indicates that when arousal is high and vagal tone is low the activity in this region is reduced) on the other (Thayer et al. 2012), are consistent with the hypothesis that the process of creating mental representations of emotional experience is compromised when arousal level is too high.

The applicability of the inverted-U relationship between arousal level and mentalizing can be carried a step further in relation to the encoding of the original trauma. At extremely high levels of arousal during the traumatic event, one's ability to know what one was feeling at the time would be very limited. This is consistent with and extends the hypothesis (Nadel & Jacobs 1998) that high levels of arousal during trauma interfere with amygdala–hippocampal interaction such that encoding of context is impaired. As a result, when recalling what one experienced at the time the emotional content would be limited in detail and complexity.

At the opposite end of the continuum, the nature of the trauma may have been emotional neglect associated with depressed or listless affect associated with low arousal. Both extremes could contribute to the lack of encoding of what one experienced at the time of the trauma and later lead to impoverished detail when recalling the emotions associated with the trauma.

There are several principles that follow from this. First, if there are deficits in emotional encoding at the time of the trauma a complete account of what one experienced originally needs to be formulated for the first time in therapy. Second, if during therapy a client is at the low end of the arousal curve during recall, the arousal level needs to be increased to achieve sufficient emotion activation, whereas if the arousal level is too high, the arousal level needs to be decreased. Third, in conditions of high arousal, such as an emergency or traumatic situation, attention is narrowed and emotional experience, if it occurs, is simplified and streamlined, whereas the kind of corrective experience that leads to change is a more complex blend of emotions, such as feeling accepted and cared for while simultaneously fearing criticism and rejection, which requires more moderate levels of arousal. Effective psychotherapy occurs in conditions of safety promoted by a therapeutic alliance in which the client can rely on the therapist to facilitate experiences that are new but not overwhelming.

## 5. Interactions of emotion, stress, and memory

It has long been understood that memory is influenced by the presence of both emotional arousal and physiological stress, which are inherent components of distressing events. An extensive cognitive behavioral literature exists on the influence of emotion on attention and memory (for review, see Hoscheidt et al. 2013; LaBar & Cabeza 2006; McGaugh 2003; Roozendaal et al. 2009). For example, a person experiencing an emotional state will selectively attend to and process information that is consistent with her present emotional state, an attentional effect referred to as “emotional congruence.” Additionally, when a person experiences an event in a particular emotional state, the event is remembered best when the person is in a similar emotional state, referred to as emotion-dependent memory or more broadly, state-dependent memory (Eich et al. 1994). The intensity of emotion experienced during the original event, regardless of positive or negative valence, increases the likelihood that the memory will be recalled vividly and the original emotion re-experienced, including the visceral or bodily manifestations of that emotion (Talarico et al. 2004). These behavioral effects are likely mediated by interactions among many brain systems, including two that play an important role in mediating emotion and memory, the amygdala and the hippocampus. Considerable research with both animals and humans has shown that emotional arousal results in increased physiological interaction between the amygdala and hippocampus, which leads to enhanced encoding and long term consolidation of emotionally arousing information (Cahill 2000; Murty et al. 2010; Phelps 2004; Vyas et al. 2002).

The additional influence of stress on emotional memory is complex, sometimes resulting in enhanced memory for prior events, and sometimes resulting in impaired recollection (Kim & Diamond 2002; Lupien et al. 2005). The

effects of stress are due in part to the activation of the hypothalamic–pituitary–adrenal (HPA) axis, which results in a cascade of stress hormones culminating in the release of glucocorticoids (cortisol) from the adrenal cortex. Many of the brain regions important for emotional memory (hippocampus, prefrontal cortex, amygdala) have dense concentrations of glucocorticoid receptors and the function of these brain regions is influenced by elevated stress hormones (de Quervain et al. 2003). Although prolonged exposure to stress interferes with memory function, acute increases in glucocorticoids enhance the encoding and consolidation of new emotional memories (for review, see Lupien et al. 2005; Maren 1999; McGaugh & Roozendaal 2002). Interestingly, at the same time as enhancing memory for emotional experience, stress hormones may actually impair memory for the neutral elements of the same event (de Quervain et al. 2000, 2003). In a study by Payne et al. (2006), participants were subjected to a stressful social situation that resulted in increased cortisol levels, and then shown a narrated slide show that included both emotionally arousing and neutral information. Participants were impaired in recalling the neutral elements of the event immediately after the event, whereas memory for the emotionally salient and arousing information in the event was preserved relative to a no-stress control group. Subsequently, Payne et al. (2007) showed that after one week, memory was further enhanced for emotionally arousing material whereas memory for closely matched neutral material was impaired. These findings are consistent with the notion of tunnel memory, where high levels of arousal facilitate memory for central details (presumably those most relevant to the emotional content of the event) at the expense of peripheral details (Burke et al. 1992; Christianson 1992; Christianson & Loftus 1991).

Relevant to the present discussion are those cases where severe stress is experienced during an emotionally arousing event, such as rape, combat, witnessing an accident, or another personally traumatic event. In these circumstances, stress appears to enhance the encoding and subsequent memory for the emotionally-salient aspects of the experience. The emotionality of that subsequent recollection is probably further enhanced by the fact that neutral elements of the same event are less likely to be recalled later on. However, the encoding of the emotional responses at the time of a traumatic event may be compromised if the arousal level at the time is sufficiently high. For example, a large study of memory for the events of 9/11/2001 revealed that recall of the emotions experienced at the time event was worse than recall of the factual details (Hirst et al. 2009).

It is important to emphasize that participants in Payne et al. (2006; 2007) were exposed to social stress immediately prior to experiencing the to-be-remembered event, and therefore the results inform how stress affects the initial acquisition and early consolidation of emotional memories. In contrast, stress experienced during recollection of prior events consistently produces memory impairment, regardless of emotionality of the material (Kuhlmann et al. 2005a; 2005b). This is consistent with many real-world examples where stress during memory retrieval can have negative consequences, such as taking an examination or speaking in front of an audience. This interference with memory retrieval may actually have a beneficial effect during exposure therapy. Cortisol has a facilitative effect on fear extinction

(Soravia et al. 2006). Roozendaal and colleagues (Roozendaal et al. 2006; see also Vocks et al. 2007) have suggested that the fear extinction during exposure therapy may be further enhanced by the role of cortisol in attenuating retrieval of past traumatic events.

These mechanisms are relevant to the encoding and storage of highly emotional and stressful experiences that are later recalled and discussed in psychotherapy. For past events not associated with either extremely high or low arousal at the time of occurrence, emotional memories will be easily accessible later on, and recollection will likely emphasize the emotional elements of the memory, to the detriment of neutral information. Recollection under these circumstances is also likely to reinstate the emotional experience, including the visceral components of that emotion that were experienced originally. For past traumatic events at the extremes of arousal, however, accessing of details including what one experienced at the time may be much more limited because of the influence of arousal on initial encoding. Our discussion highlights the integral relationship between past memories and ongoing emotional responses, and also helps to explain how recollection of prior memories can be distorted over time as emotional components of experience take precedence over other, possibly more moderating, information. In fact, Rubin et al. (2008) have proposed that PTSD symptoms derive not from the emotional experience of the original event per se, but from the explicit memory for that event that is constructed and reconstructed through subsequent recollections. This leads us to a broader discussion of the dynamic nature of memories.

## 6. The dynamic nature of memory

Following the experience of an event, the memory for that event undergoes a process of stabilization, often referred to as consolidation, that renders the memory more resistant to interference from similar experiences, and more likely to be successfully recollected later on (Dudai 2004; McGaugh 2000). Consolidation, however, does not result in a memory representation that is immutable. Memories are not a perfect record of the past, but undergo revision and reshaping as they age and, importantly, are recollected. The notion of memory retrieval as a dynamic and constructive process rather than a mere replay of the original event has substantial empirical support, beginning with Bartlett's (1932) famous "War of the Ghosts" study. Using what he called the method of repeated reproduction, Bartlett showed that repeated recollections of the story typically led to a shortened, more stereotyped version of it, with details either discarded, transformed, or added. Bartlett's observational study was replicated empirically by Bergman and Roediger (1999), who also found that participants distorted information and imported novel propositions into the story, most prominently after a delay of six months.

Studies such as these focusing on memory for newly acquired short stories, or lists of words, pictures, or scenes, may have limited relevance to the remembrance of the rich and personally relevant emotions and details associated with autobiographical memories. In contrast to Bartlett's (1932) observations, autobiographical memories that are highly emotional and hold importance for the individual

often become increasingly consistent in the manner they are recalled, even “scripted,” across repeated recollections (Nadel et al. 2007; Neisser & Harsch 1992). Neisser and Harsch (1992) suggest that repeated retellings of these memories gives structure to the narrative that improves consistency over time. Interestingly, the retelling of these stories may also result in an increasing number of details being recalled across repeated retrieval sessions, even after a year (Campbell et al. 2011). Whether those additional details are accurate, however, is impossible to tell. Studies of autobiographical memory retrieval can rarely assess accuracy, because there is rarely a veridical account of the original event available for comparison. One notable exception is Ulrich Neisser’s (1981) analysis of the testimony of John Dean regarding his involvement in the Watergate scandal during the Nixon administration. Neisser compared Dean’s exhaustive accounts of intensely emotional and important meetings that transpired in the White House oval office with the original tape recordings of the very same meetings, made in secret by Nixon. Neisser found that Dean’s accounts were generally devoid of correct details, despite his high confidence in the accuracy of his recollections. Nevertheless, Neisser noted that the core information contained in Dean’s memories – who knew what, who did what – was accurate, even if each of the event memories themselves had been revised and reconstructed to a surprising degree, a phenomenon that Neisser dubbed “repisodic memory.”

Also relevant to this discussion is the recollection of flashbulb memories – vivid, long-lasting memories for emotionally arousing, often shocking events that carry strong social importance. These memories contain both an “event” portion and an “autobiographical” component – you remember what happened in New York on 9/11/2001 (the event) but also where you were, who you were with, who you told, and the emotional reactions of you and others around you (the autobiographical part). Participants are usually asked on two subsequent occasions to recall key pieces of personal information, such as where they were when they heard the news, and who told them the news. Even a year or more after the first recollection, 75% to 80% of people provide consistent answers to these questions (Berntsen & Thomsen 2005; Cohen et al. 1994; Davidson et al. 2006). However, consistency over time is not equivalent to accuracy. Pezdek (2003) found that nearly three-quarters of participants incorrectly reported that on 9/11/2001 they saw a videotape of the first plane striking the first tower. Similarly, Ost et al. (2002) reported that 45% of their United Kingdom sample reported that they had seen a videotape of the car crash that killed Diana, Princess of Wales. In both cases, no videotaped record exists of the incidents. Coluccia et al. (2006) suggests that, particularly after repeated recollections, additional information is incorporated into the memory that is either self-generated or experienced through other sources after the event (see also Neisser & Harsch 1992). The revised version of the memory is then recalled consistently over time. Interestingly, these changes in the details of the memory have no bearing on the confidence of the person remembering – what people “remember” at any given time is vivid and emotionally engaging, regardless of the veridicality of their recollection (Neisser & Harsch 1992; Talarico & Rubin 2003). A similar pattern is observed for traumatic event memories. A review (Van Giezen et al.

2005) of 17 studies of memories for both combat and non-combat traumatic experiences identified inconsistencies when participants were asked to recall the memories on two different occasions (for discussion, see Rubin et al. 2008).

The reconstructive nature of memory could be construed as a design flaw. Indeed, in the flashbulb memory literature, these changes in memory are referred to not merely as revisions, but as errors and inaccuracies. Why would a memory system exist that does not provide a stable and faithful representation of past events? Cognitive research has clearly demonstrated that people make errors during recollection, even when they are extremely confident in their attributions, and that these errors increase with time and repeated recollections. However, the dynamic nature of memory can also be construed as beneficial: It provides an important mechanism for understanding how existing knowledge can be updated in light of new information. Klein et al. (2002) describe the importance of memory as an adaptive function, one that can (and should) be updated over time depending upon new experiences and changes in the environment. Adaptive behavior, according to Klein et al. (2002) depends on an interaction between decision rules derived from multiple experiences that guide the behavior of the individual (semantic memory) and the recollection of specific events (episodic memories) that provide boundary conditions or expectations to those rules. Relevant to the current discussion, the notion of a dynamic and adaptive memory system is critical to understanding how memories that are painful or disturbing might be transformed through the process of psychotherapy and the corrective experience. The sections that follow discuss how memory updating and the interactive nature of episodic and semantic memories may provide insights into the mechanisms underlying therapeutic change.

## 7. Memory reconsolidation

As mentioned earlier, consolidation refers to the idea that event memories undergo a stabilization process that renders the memory less susceptible to interference from similar experiences, and more likely to be successfully recollected after the passage of time. In recent years, two rather different versions of what happens in the brain during consolidation have emerged. One version, often referred to as the “standard model of memory consolidation” (Squire & Alvarez 1995) emphasizes that the brain structures mediating retrieval shift over time, from medial temporal lobe structures including the hippocampus, to neocortical structures including the prefrontal cortex. Importantly, as this consolidation process and concomitant transition takes place, the content of memories presumably remains unchanged.

Nadel and Moscovitch (1997; Moscovitch & Nadel 1999) developed an alternative theory of memory consolidation, known as the multiple trace theory (MTT). Rather than focusing on the mere passage of time, the theory addresses the question of how repeated recollections of prior events lead to strengthening of the memory representation for the original event. Similar to the standard model of consolidation, MTT posits that the establishment of long-term memories involves a lengthy interaction between the

hippocampal region of the medial temporal lobes and neocortical regions. Unlike standard theory, MTT posits that the hippocampus remains an integral part of the memory trace and is thus always involved in retrieval of long-term episodic memories regardless of the age of the memory. Evidence supporting this view comes from neuroimaging studies showing that retrieval of detailed episodic memories activates the hippocampus no matter how old these memories are, even after 40 or more years (e.g., Ryan et al. 2001; see Moscovitch et al. 2006 for review).

The standard view of memory consolidation suggests that immediately after learning there is a period of time during which the memory is fragile and labile, but that after sufficient time has passed, the memory is more or less permanent. During this consolidation period, it is possible to disrupt the formation of the memory, but once the time window has passed, the memory may be modified or inhibited, but not eliminated. In contrast, MTT suggests that every time a memory is retrieved, the underlying memory trace once again enters into a fragile and labile state, and thus requires another consolidation period, referred to as “reconsolidation” (Nadel et al. 2000). The reconsolidation period provides an additional opportunity to amend or, under appropriate circumstances, even disrupt access to the memory.

MTT proposes that each time an episodic memory is recollected or retrieved, a new encoding is elicited, leading to an expanded representation or memory trace that makes the details of the event more accessible and more likely to be successfully retrieved in the future. This process is primarily initiated by active retrieval or recollection, although off-line reactivation that occurs during sleep and indirect reminder-induced reactivation can also trigger it (Hardt et al. 2010; Hupbach et al. 2007; Nadel et al. 2007; Wilson & McNaughton 1994). Critically, each time an event is recollected and re-encoded, an updated trace is created that incorporates information from the old trace but now includes elements of the new retrieval episode itself—the recollective experience—resulting in traces that are both strengthened and altered. This altered trace may incorporate additional components of the context of retrieval, new relevant information pertaining to the original memory, or even new information that is inadvertently (perhaps incorrectly) generated during the act of retrieval, as in the case of the flashbulb memories described earlier. In this regard, MTT holds that memories are not a perfect record of the original event but undergo revision and reshaping as memories age and, importantly, are recollected. The reconsolidation process, by this view, results in memories that are not just stabilized and strengthened, but are also qualitatively altered by the recollective experience.

This dynamic interplay between retrieval of the memory and reconsolidation has been demonstrated experimentally both in animals and humans. Animal studies have shown that well-established, supposedly consolidated, memories can be disrupted after reactivation (Nader et al. 2000), even when that reactivation is nothing more than a reminder of the spatial context of the original event. The utility of this to control fearful responses emerged from a study by Nader et al. (2000). In this study, rats were conditioned to fear a tone, and then up to 14 days later were presented with an unreinforced presentation of the tone. This “reminder” was followed immediately by an injection

into the amygdala of anisomycin, a protein synthesis inhibitor that blocks the consolidation of fear memories. Even though the time window of consolidation had passed, the rats that received anisomycin following the reminder failed to show evidence of conditioned fear on subsequent test trials. Rats injected with saline following a reminder showed normal conditioned fear. These results suggest that fear memories undergo reconsolidation every time they are retrieved, and that this reconsolidation process can be disrupted, apparently eliminating the previously well-learned fear responses.

In discussing memory reconsolidation it is important to distinguish it from the behavioral phenomenon of extinction. In animal studies of both reconsolidation and extinction, an element of the learning situation (the context, or a conditional stimulus – CS) is presented without its previous consequence—the unconditioned stimulus (US). In most of the experiments with rats the US is a shock administered through the grid floor. Because of this similarity, there has been some question about how to separate the two—and this has considerable importance in the present context, because reconsolidation is assumed to actually change components of the reactivated memory, whereas extinction is assumed to merely create a new memory that overrides the previously trained response (Milad & Quirk 2002). Thus, an “extinguished” response is not really gone, because it can spontaneously recover over time, or be reinstated if the organism is exposed to a relevant cue in a new context. Recent work has shown that the cellular/molecular cascades in these two cases are different, and that whether reconsolidation or extinction is initiated depends upon the temporal dynamics of the test procedure, and how recently the memory in question was formed and/or reactivated (de la Fuente et al. 2011; Inda et al. 2011; Maren 2011). At this time we can be certain that reconsolidation and extinction represent distinct reactions to reactivating a memory, but the conditions eliciting one or the other remain to be fully determined.

In humans, Hupbach et al. (2007, 2008) have shown that when memories are reactivated through reminders, they are open to modification through the presentation of similar material that then becomes incorporated into the original event memory. Using a simple interference paradigm, Hupbach et al. (2007) had participants learn a set of objects during the first session. Forty-eight hours later, one group of participants was reminded of the first session and immediately afterward learned a second set of objects. A second group received no reminder and simply learned a second set of objects. Another 48 hours later, they were asked to recall the first set of objects only, that is, the objects they learned during the first session. Participants in the “reminder” condition showed a high number of intrusions from the subsequently learned object set, whereas those who had not been reminded showed almost no intrusions. The results demonstrated that updating of pre-existing memories can occur in humans, and that this updating is dependent upon reactivation of the original memory. Hupbach et al. (2008) subsequently showed that reminders of the spatial context of the original event were the most effective in triggering the incorporation of new information into the existing memory.

The processes of reactivation and re-encoding, and consolidation and reconsolidation, have important clinical

implications for understanding the psychotherapeutic process. MTT provides a way of understanding how distressing emotional memories can be both strengthened over time and also altered through the corrective experience. Consider, for example, an emotionally distressing event such as a betrayal or abandonment. As we have seen, the emotional reaction is an integral component of the memory, connected via the spatial and temporal contexts to the event and bound to the self, forming an autobiographical memory. The more highly arousing the emotional reaction, the more likely the evoking situation will be remembered later on (McGaugh 2003). When a memory is recalled, the emotional response is re-engaged and the amygdala reactivates the sympathetic response. According to MTT, the recollected event and its newly experienced emotional response will be re-encoded into a new and expanded memory trace. Thus, memory for the original traumatic incident is strengthened, making it (and the now intensified emotional response) even more likely to be accessed in the future.

MTT also provides a mechanism for understanding how this same emotional memory might be revised. During therapy, patients are commonly asked to recall and re-experience a painful past event, often eliciting a strong emotional reaction. If the psychotherapy process leads to a re-evaluation of the original experience, a new, more adaptive and perhaps more positive, emotional response may ensue. The corrective experience occurs within a new context, the context of therapy itself, which can then be incorporated into the old memory through reconsolidation. It is important to reiterate that MTT suggests this process is not simply attributable to a new memory trace being created, but that the original event memory itself is transformed in fundamental ways. It is conceivable that once this transformation has taken place the original memory, including the associated emotional response, will no longer be retrievable in its previous form. By this view, psychotherapy is a process that not only provides new experiences, but also changes our understanding of past experience in fundamental ways through the manipulation of memory.

If experiencing a qualitatively different emotion during recollection can have a modifying effect on subsequent emotional responsiveness to memories, it is plausible that drug-induced blockade of the new memory formation can lead to the same result. Taking the notion of reconsolidation one step further in humans, researchers have now begun to investigate the possibility of modifying previously acquired traumatic memories by using drugs to block the emotional response during recollection. For example, administration of propranolol, a beta-adrenergic antagonist, may block reconsolidation of fear memory in rats by indirectly influencing protein synthesis in the amygdala (Debiec & Ledoux 2004). The effect of propranolol in altering the reconsolidation of emotional memories has been demonstrated in humans in an fMRI study (Schwabe et al. 2012). Propranolol has been administered to individuals immediately after experiencing a traumatic event (Pitman et al. 2002), and also to PTSD patients immediately after they recall traumatic memories (Brunet et al. 2008), blocking the emotional response to the memory and, in both studies, leading to decreased emotional responsiveness during subsequent recollections. Although promising, this treatment has initiated heated

debate regarding the legal and ethical issues associated with “memory dampening,” as it has been called (Kolber 2006; Tenenbaum & Reese 2007).

## 8. Semantic memory is integrated with autobiographical memory

Autobiographical and semantic memory seem, at least phenomenologically, quite different from one another. Autobiographical or episodic recollection involves thinking about a past event—it is personal, emotional, imbued with detail, and temporally and spatially unique; and it often has great relevance to our sense of self and the meaning of our lives. Semantic memory, on the other hand, has to do with the knowledge and rules governing behavior that have been acquired through a lifetime of experiences—it is factual and typically devoid of emotion or reference to the self or specific times and places. Although semantic knowledge conveys meanings, it is rarely the kind of personal meaning embodied in autobiographical and episodic memories. Instead, it provides us with expectations and enables us to predict the outcomes of new situations using the generic knowledge gained from similar situations in the past. The distinction, as outlined by Tulving (1983), focused originally on the different types of information processed by the two systems, unique spatial-temporal contexts for episodic memory, and facts and concepts for semantic memory. More recently, Tulving (2002; 2005) has emphasized that what distinguishes episodic memory is not so much the type of information being processed, but instead the phenomenal experience of remembering, or *autonoesis*. According to Tulving (2002; p. 5) “It [episodic memory] makes possible mental time travel through subjective time, from the present to the past, thus allowing one to re-experience, through autonoetic awareness, one’s own previous experiences. Its operations require, but go beyond, the semantic memory system.” This updated formulation suggests that episodic and semantic memory are representational systems that together capture both the regularities and irregularities of the world, allowing people to create concepts and categories (semantic memories) and also capture the time and place when one particular combination of entities was experienced, yielding an episode that may or may not be consistent with one’s prior expectations.

It has long been assumed that episodic and semantic memories are relatively independent of one another, both functionally and anatomically (Aggleton & Brown 1999; Schacter & Tulving 1994; Schacter et al. 2000; Tulving & Markowitsch 1998). Recent research, however, has called this independence into question (see Ryan et al. 2008b for review). In a series of functional MRI studies, Ryan and colleagues demonstrated that both semantic and episodic retrieval results in a similar pattern of hippocampal activation, particularly when the tasks were matched for spatial content (Ryan et al. 2008a, 2010; Hoscheidt et al. 2013). Consistent with Tulving (2002), semantic memory and episodic memory are seen as interactive and complementary systems. Both semantic structures and singular episodic memories are important for identifying familiar circumstances, interpreting novel events and predicting outcomes, and choosing appropriate behaviors in response to situations and personal interactions. Barsalou (1988) has

long championed the idea that semantic knowledge is embedded within a network of autobiographical memories. Episodes are represented as single events that are connected to other related episodes. Semantic memory is essentially derived from similar event memories that can be convolved to emphasize common information that is experienced across contexts, giving rise to what we call semantic memory. This idea is the basis of latent semantic analysis models (Landauer & Dumais 1997). By this view, semantic information may be indistinguishable from episodic memory at the level of the brain when it is first acquired, and only later becomes differentiated as similar experiences accumulate and structural regularities and rules are derived. The information can then be retrieved separately from a specific context if necessary.

According to Barsalou (1988), “There are no invariant knowledge structures in memory. Instead, people continually construct unique representations from loosely organized generic and episodic knowledge to meet the constraints of particular contexts” (p. 236). Instead of focusing on abstracted concepts, Barsalou emphasizes the critical role of personally relevant instances for generating semantic knowledge. A concrete example comes from a study by Ryan et al. (2008a). They asked participants to generate exemplars to the cue “kitchen utensils,” and then asked people to describe what they were thinking about as they generated the items. Their responses were at the same time similar and yet uniquely personal. Every participant reported something like, “I pictured myself standing in my kitchen, looking around the room, opening drawers and then looking in the cabinets.” Note that it is “my kitchen” that guided the responses of the individual, rather than a disembodied “typical kitchen,” leading a few individuals to give items like “espresso maker” a prominent place in the list. The observation is interesting because it suggests that semantic memory is not simply a stable record of past learning but something that is generative, flexible, contextually bound, and subject to revision through personal experience. Semantic memory is generated anew each time it is required, in much the same way as Bartlett (1932) and others (Bergman & Roediger 1999; Nadel et al. 2007) have noted: Episodic memories are reconstructed and revised over time through multiple retrievals. This stands in contrast to the classic distinction between episodic and semantic memories and the assumption that semantic memory, at least, is a faithful record of prior learning.

What are the implications of viewing episodic and semantic memory as interactive systems for understanding psychotherapy? It suggests that distressing or traumatic event memories that elicit emotional responses are incorporated into semantic structures that are used to predict the outcomes of subsequent experiences and to choose appropriate (or inappropriate) emotional and behavioral responses in novel situations. It is easy to see how highly emotional and accessible memories from the past become the dominant basis for maladaptive responses in novel circumstances that share some characteristics with the original distressing event.

Importantly, this formulation also suggests that there are multiple routes to behavioral change and the “working through” process. The new experiences in therapy that update prior event memories through reconsolidation also contribute to a change in semantic structures. Applying the new knowledge and experiencing the results in a

variety of contexts can be conceptualized as creating multiple episodic experiences that will broaden the range of applicability of new knowledge encoded in semantic memory. Linkage to emotional responses (as proposed in our integrated memory model) is expected to translate into greater adaptive flexibility and success relative to the difficulties that led the client to seek treatment.

## 9. Implications of this integrative synthesis

To reiterate, emotional responses, autobiographical memories, and semantic structures derived from them are inextricably linked. Together they form an integrated memory structure that can be accessed by many cues – emotional responses including action tendencies and behaviors expressive of emotion, perceptual details associated with the event (s), and the derived principles, rules, and schemas used to interpret novel situations. All of those elements have the ability to activate the memory structure, and importantly, once activated, any one of the components has the potential to update other components of the structure via reconsolidation. Emotional responding is not separate from the event memories that occurred when that response was first experienced. Nor are semantic structures accessed without reinstating personally relevant information, and, particularly under circumstances where the memory was strongly reconsolidated, the specific memories that add unique information to that structure.

Given these considerations, it becomes possible to understand each of the major modalities discussed above as focusing on a particular way of entering or engaging the integrated memory structure (see Fig. 1). Behavior therapy initially engages emotional responding with a greater emphasis on implicit rather than explicit processes. EFT also initially preferentially engages emotional responding but with a greater emphasis on explicit than implicit processes. CBT engages semantic memory initially, and Psychodynamic Psychotherapy, with its emphasis on the here and now in the transference situation and its relation to past experiences, focuses on autobiographical memory as a point of entry. As we discuss in sections 9.1–9.4, however, a more comprehensive understanding of how each modality works requires consideration of the entire memory structure.

The integrated memory model provides an opportunity to develop a common language that spans disciplines and a common mechanism underlying change in all psychotherapeutic modalities. We suggest that the 450 forms of therapy (MacLennan 1996), to the extent that they are effective, address different aspects of a common phenomenon, and the success of practitioners of a given modality

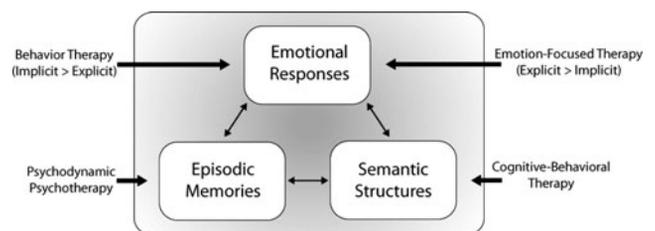


Figure 1. Points of entry into the integrated memory structure for four types of psychotherapy.

depends upon their ability to access an integrated memory structure that may include aspects of experience not typically emphasized in the formal explication of that modality. The model provides a way to highlight the unique aspects of each modality that may explain why each type of therapy is best suited to address particular types of maladaptive behaviors and distressing emotions. The model may also provide new information by suggesting ways to optimize change within each therapy modality. Although we cannot address each and every type of psychotherapy here, we will briefly discuss the implications of the integrated memory model for the four therapy modalities highlighted in this paper that focus primarily on one or another component of the model: autobiographical memory, emotional responding, the semantic structure, or some combination of these. The implications that we present in sections 9.1–9.5 are theory-driven and remain to be empirically tested.

### 9.1. Behavior therapy

Exposure therapy involves re-experiencing the emotionally arousing stimulus in conditions of safety and control. Research shows that physiological arousal is an essential ingredient of change (Foa et al. 1995). The success of therapy improves when the original emotional response that includes physiological arousal is sufficiently reactivated and is then subsequently attenuated during the therapy session (Foa & Kozak 1986; 1998; Lang et al. 1998). Thus, the initial intensity of arousal is important because it permits a greater attenuation of the arousal response over time. One way to understand this change, considering the integrated memory model, is that elicitation of the fear response is an expression of implicit emotion (visceromotor, neuroendocrine, and somatomotor responses) and the larger memory structure that is revised in the therapeutic context. What may be specifically therapeutic is the combination of the activation of the old response (as measured by arousal) and the activation of the new experience of safety that leads to updating of the memory structure. As noted above, this results in a change in the behavioral expression of emotion from one of avoidance to either non-avoidance, approach or a wider range of behavioral options, and a change such that the initially strong visceromotor response is attenuated.

Another implication is that behavior therapy is derived from the behaviorist tradition, which views behavior as understandable based on environmental contingencies and eliminated the need to postulate mental states as mediators. The evidence reviewed above, which reported that anxiety during therapy predicts therapeutic success, indicates that the intensity of emotional experience is a critical determinant of outcome. Also relevant here is the importance of the experience of safety in the therapeutic response.

A related issue involves the degree of arousal needed for the therapy to be successful. In therapies that require reflection and representation of emotional states, including CBT, EFT, and psychodynamic approaches, arousal level needs to be at the moderate level, as described above. In the theory of BT, which does not involve reflection, there is no upper limit on the level of physiological arousal required or desired. On the other hand, dropouts from BT occur commonly. This may be related to the ability of

clients to tolerate and integrate therapeutically induced arousal. Perhaps the level of arousal achieved during exposure therapy needs to be moderate enough to allow the simultaneous experience of the re-evocation of the old memory while also experiencing a sense of safety during the therapeutic interaction.

### 9.2. Cognitive-behavioral therapy

CBT focuses on identifying irrational thoughts that induce distressing emotions and changing the thoughts to bring about a different emotional experience (Butler et al. 2006). Beck's cognitive therapy for depression (Beck et al. 1979), for example, aims to reduce depressed feeling by having clients identify and reevaluate their negative thoughts, assuming that the depressed feeling results from maladaptive thinking. From the current perspective, these interpretations are driven by the semantic structures that derive from prior experience. New evaluative structures, once in place, enable one to experience the original eliciting circumstance or stimulus in the context of an altered emotional state that then permits updating through reconsolidation.

One of the differences between CBT and the present model is the priority given to semantic structure in eliciting distressing emotional responses. CBT presumes that irrational thoughts and maladaptive interpretations precede the emotional response to a novel situation. In contrast, the integrated memory model assumes that current cues and situational contexts that derive their salience and meaning from memories of past experiences trigger all components of the memory structure simultaneously. Emotional responding occurs in parallel with maladaptive thoughts, not as a consequence of them. By this view, focusing solely on thoughts and evaluations during distressing situations will not elicit change. CBT may use negative thoughts as a way to engage the memory structure, but without a new and more positive emotional experience to take the place of former responses, change cannot occur. This is consistent with Teasdale's view that CBT alters the attitude toward the thoughts (e.g., I'm having these thoughts but I could have others), not the thoughts themselves (Teasdale et al. 2002).

As such, although CBT traditionally focuses on emotion such as depression as an outcome, the current model highlights emotional arousal as a mediator of therapeutic success. Similarly, although CBT does not emphasize the exploration of past memories that originally led to development of the maladaptive response, it clearly uses exploration of similar, albeit more recent, experiences that have elicited distressing reactions. To the extent that these experiences share common characteristics with the original memories, they will also be subject to reconsolidation through the corrective experience.

The integrated memory model makes clear why "homework" is so important to effect change in CBT. Repeatedly becoming aware of the distorted thoughts that lead to maladaptive emotional responses is unlikely to elicit change. The individual must also engage in new evaluations of novel situations that lead to different, more adaptive, emotional and behavioral responses (Castonguay et al. 1996). Through homework, new emotional experiences may occur in a variety of contexts outside the therapy setting, increasing generalizability and the likelihood that the individual will be successful in applying new semantic structures

outside of the therapy situation. The practice of homework could also potentially have negative consequences. Homework practice instructs the individual to seek out situations that elicit negative thoughts and, by our view, their inherent negative emotional responses. Unless the person is successful in applying an alternative evaluation to the situation and thus experiencing a new, more adaptive emotional response, there is the danger that the old ways of responding will simply be strengthened further, as additional similar experiences are incorporated through reconsolidation.

This model highlighting the importance of new emotional experiences and the deleterious effect of reactivating familiar maladaptive emotional responses also provides an understanding of why negative rumination – repetitive thoughts focused on negative emotions, events, and their contexts (Martin & Tesser 1989) – may interfere with therapeutic progress. Although rumination can lead to positive outcomes in some circumstances, there is ample evidence that it is associated with the onset and maintenance of depression and anxiety disorders, as well as the recurrence of depression in the future (for an extensive review of the constructive and destructive aspects of repetitive thinking, see Watkins 2008). According to Nolen-Hoeksema (2004), rumination enhances the vicious cycle between depressed mood and negative, pessimistic thinking, thereby interfering with problem solving and the ability to experience positive emotional aspects of new experiences. By our view, negative rumination would not only interfere with new positive emotional experience, but will lead to strengthening of the existing negative memory constructs, increasing the likelihood that negative thoughts come to mind as they are reconsolidated across increasing numbers of contexts. This strengthening of negative thoughts and affect, and the generalizability of rumination across contexts, would increase the centrality of the negative events in one's life narrative (Berntsen & Rubin 2006; Rubin et al. 2008) and undoubtedly make the revision of such a memory structure more difficult to achieve.

### 9.3. Emotion-focused therapy

EFT, as a form of humanistic psychotherapy, suggests that it is possible to strategically and efficiently produce the juxtaposition of old emotional responses and new updated responses through an emphasis on “changing emotion with emotion.” In EFT, new emotional experiences in the context of old, familiar and maladaptive emotional experiences are facilitated by an active and engaged therapist using Gestalt techniques such as two-chair work, in which two sides of a conflict are expressed and the associated emotions are experienced from both perspectives in real time. The activation of strong emotional responses and the engagement of alternative emotional responses are key ingredients leading to change. The explicit recollection and understanding of developmental origins and past distressing memories or eliciting transference responses has been thought to be unimportant. Nevertheless, the emphasis on changing emotional schemes, which as noted above involves altering the integrated memory structure, makes clear how central memory processes are to EFT.

EFT proposes that what is being changed through this form of psychotherapy is the emotional response itself, which is revised through the elicitation of new emotions. The integrated memory model would suggest a broader

set of changes are taking place. The elicitation of a new emotional response in therapy comes about by having the individual consider alternative interpretations of a distressing situation. Thus, semantic structures associated with maladaptive emotional responses are being updated and transformed along with the emotional response, even though EFT does not consider those interpretations to be the basis for change. In addition, to the extent that a distressing situation is similar to prior experiences, these situations act as “reminders” to reactivate earlier memories and thereby include them in the updating process. As such, the focus on emotional responding and eliciting both the re-evaluation of semantic structures and an alternative competing emotional response during the therapy constitutes an effective way to update the memory structure and bring about change.

EFT and CBT share a common goal of undermining semantic structures and emotional responses as they are applied inappropriately to novel situations that resemble past experiences. Whereas EFT emphasizes emotional responding, CBT emphasizes the semantic structures that lead to and reinforce this maladaptive response. We suggest that both therapies are working towards the same goal via different routes that access the same integrated memory structure. By using Gestalt techniques such as role playing and two-chair work, EFT may be particularly efficient for inducing strong emotional responses during the therapy session. As discussed earlier, the intensity of emotional experience during the therapy session is universally identified as one predictor of therapeutic success. Once elicited, the semantic structures associated with this response can then be examined in the context of the therapy session, leading to a new emotional experience that is integrated into the memory structure.

### 9.4. Psychodynamics and psychoanalysis

For many years psychoanalysis as a field was averse to conducting objective research on its methods and outcomes for a variety of reasons, including concern that such research would irreparably alter the emotional milieu of the very therapy that was being studied. Furthermore, because of the challenges of formulating and testing hypotheses that could be falsified, the ability of psychoanalysis to survive in an era of evidence-based practice has been questioned (Bornstein 2001). A more recent recognition within the field of the necessity for research (Leichsenring & Rabung 2008; Shedler 2010) holds promise for its survival.

Although there are many different schools of thought within psychoanalysis, the common fundamental ingredients of transference and a developmental perspective are important to consider in light of the integrated memory model. Time and cost considerations aside, the technique of meeting three, four or five times per week for several years creates a special opportunity to activate old memories and observe their influence on present-day construals and emotional experiences with an emotional intensity and vividness that is difficult or impossible with other methods (Freud 1914/1958). As such, this approach has the potential to offer something not available with other modalities that can have pervasive effects on a person's functioning in a wide variety of social, occupational, and avocational settings. New learning can involve improvement in function above and beyond symptom reduction, such as better

self-esteem, greater ability to tolerate and manage stress, improved flexibility in social relations, a greater capacity for intimacy and the construction of a coherent life narrative that exceed what would be expected based on symptomatic improvement alone (Shedler 2010).

In the transference situation in psychodynamic therapy, the therapeutic action of the intervention becomes possible by experiencing the therapist as if she were an important figure in one's past. The corrective emotional experience occurs when the patient experiences the therapist as responding in a different (typically more positive) way than expected. This may be what Stern (2004) refers to as "critical moments" in the therapeutic encounter – when a situation arises that elicits a maladaptive response and the therapist, in turn, responds in a new and helpful way that differs from expectations. Note that this "moment," an autobiographical episode, has the potential capacity to alter underlying semantic structures and associated emotional responses. The corrective experience increases the likelihood that similar situations arising outside therapy will be interpreted differently by the individual, resulting in differences in expectations and ultimately different emotional responses.

In this modality, a key component of therapy is the recollection and discussion of the past experiences that led to maladaptive ways of responding to novel situations. Thus, for psychodynamic therapies, access to the memory structure is most often via old episodic memories. Although not the focus of these therapies, the corrective experience updates not only memories, but also the rules and expectations that derive from them, leading to changes in emotional responding. The new episodic experience in therapy shares situational cues with the original event. Reconsolidation revises the original memory by incorporating aspects of the new event, as well as the expectations and rules that will be applied to new situations.

For practitioners in this modality, the explicit recollection and understanding of the past experiences that account for perceiving and experiencing the therapist in a maladaptive way are thought to be critical. According to the integrated memory model, this may not actually be necessary in certain cases, and it may be important for the survival of the technique to determine under what circumstances it is needed or desirable. What appears essential is the juxtaposition of maladaptive emotional reactions and expectations with the novel response of the therapist, leading to a new emotional experience that is then incorporated into the existing memory structure. What is also critical is that this updating will occur optimally when the old memory is activated and available for transformation. Thus, there may be circumstances where an emphasis on past distressing experiences is warranted, such as with a patient in whom no single disturbing or traumatic memory has occurred, but for whom patterns of behavior and emotional responding have developed through repeated events that share common themes, such as being shamed as a child. In this case, bringing to mind specific old memories may more efficiently activate the emotional response and highlight the distorted perceptions and expectations of the individual, increasing the likelihood that the comparison to a present reality that is quite different will be made.

Another implication for psychodynamic psychotherapy involves technique. For some forms of psychoanalysis, it

has been thought that a passive, abstinent psychotherapist (responding minimally and sitting out of view of the patient) is a beneficial approach (Meissner 1998). However, from the current perspective, transformation can only take place to the extent that a corrective experience occurs. It is insufficient to have the prior memory reinstated unless some new experience occurs that shares common characteristics with the original event, leading to its transformation. According to the current model, the analyst needs to be experienced directly and counter to expectations in order for lasting change to occur. Many opportunities for having such new experiences are missed by having the analyst as a passive observer (Goldberger 1995). The current perspective places more emphasis on new emotional experiences that occur while old memory structures are activated, rather than simply revisiting old painful memories.

Additionally, consideration of the integrated memory structure and reconsolidation provides a way of understanding why psychoanalyses have at times been unsuccessful or interminable. Recall of past traumas or adverse experiences without competing emotional experiences will lead to a memory that is further reconsolidated and thus more likely to be retrieved during similar situations in the future. As the memory itself is strengthened, so too is the emotional response and the semantic structures that result in novel situations being interpreted in maladaptive ways. Recollection alone serves only to reinforce and further ingrain the patient's original version of the traumatic or adverse memories, and it is insufficient to bring about clinical change. That may be what transpired when catharsis alone was advocated. As noted above, a parallel phenomenon highlighted in the context of CBT is rumination, a perseverative thought process that prevents new emotional experiences from occurring (Ray et al. 2005) and further ingrains the patient's original version of prior experiences.

### 9.5. Implications for research

An advantage of the integrated memory model is that it provides new ways to think about and explore the mechanisms of therapeutic change experimentally. For example, we do not know how many repetitions of the corrective experience are needed to bring about change, or whether changing the situational context of the corrective experience, as we suggested above, increases the effectiveness and generalizability of change. We also do not know how intense these experiences need to be, what the optimal novel experience should be in order to update the memory structure or how these factors change as a function of individual differences (e.g., one's starting point on the inverted-U curve). Is the most efficient route of change through past memories, emotional responding, or cognitive structures, or in fact a combination of all three? Could it be that psychoanalysis has been right all along (at least in part) in emphasizing the importance of bringing to conscious awareness past memories of distressing situations and experiencing the emotions associated with these situations (as a prelude to a corrective experience)? Or, is the optimal route determined by the particular quality of the distress that compelled the individual to seek therapy in the first place? To what extent will the duration of change achieved be determined by the degree of emotional arousal, the extent of enhanced understanding, and the particular way that they are combined? We should apply questions such

as these to multiple modalities so that we can compare and contrast the predictors of success in each.

A key ingredient of all successful psychotherapy is establishing a therapeutic alliance and a safe environment for doing the work of therapy (Horvath & Luborsky 1993). A safe environment is associated with a sense of control and low physiological arousal (Abelson et al. 2010) that may be understood from the perspective of the autonomic and neuroendocrine systems. As noted above, neuroimaging has shown that superior medial prefrontal activity, a brain area involved in mental reflection (Amodio & Frith 2006), decreases activation when autonomic arousal is high (Lane et al. 2009; Thayer et al. 2012), suggesting that the ability to reflect on what is going on in one's own mind, or in the minds of others, may occur more readily in conditions of relatively low physiological arousal. Put another way, if one feels anxious and uncomfortable, the brain structures needed for the exploration of one's own thoughts and feelings, or the thoughts and feelings of others (in our terms, reflecting upon semantic structures), tend to go offline (Lane & Garfield 2005), consistent with the need for moderate levels of arousal during therapy that involves reflection and emotional experiencing. Building a strong therapeutic alliance—the supportive and trusted presence of the therapist—may be critically important in developing the sense of safety and hence, decreasing anxiety. One hypothesis that derives from this discussion is that incorporating methods that control high levels of physiological arousal while still allowing negative emotions to be experienced may enhance the ability to reflect on internal states and thoughts in order to reevaluate semantic structures. Clearly, there are new opportunities to evaluate the role of vagal tone during psychotherapy sessions and its relationship to the therapeutic alliance and a sense of safety. More generally, the hypothesized inverted-U relationship between arousal level and medial prefrontal cortex activity, and the corresponding capacity for mentalizing one's own emotional states, needs to be tested.

A related issue is the need to adjust the intensity of physiological arousal so that it does not interfere with memory reconsolidation. As discussed earlier, stress results in the release of cortisol (Abelson et al. 2010), which is necessary for the consolidation (and reconsolidation) of new emotional memories (McGaugh & Roozendaal 2002). Anxiolytic medications such as benzodiazepine may control anxiety, but they also decrease cortisol production and disrupt consolidation, which could compromise memory updating during therapy. Otto et al. (2010) suggest that propranolol, which blocks cortisol and interferes with memory consolidation, may be beneficial if used acutely after trauma to decrease the development of PTSD symptoms, but it may slow the reacquisition of safety if the treatment is continued during therapy, when patients are exposed to trauma cues under safe circumstances. It is possible that nonpharmacological methods, such as building the therapeutic alliance, are better for providing a sense of control and safety without impeding memory updating.

Another research implication of the integrated model that was not previously considered is the specific role of sleep in bringing about gains in psychotherapy. Clinicians have long understood that if a patient is not sleeping well because of depression, anxiety, or psychosis, the sleep problem is likely to interfere with clinical improvement. Indeed, healthy sleep may be essential for the consolidation

of new memories leading to positive change (Walker 2009). Rapid eye movement (REM) sleep has been shown to preferentially support the consolidation of emotional aspects of memory (Diekelmann et al. 2009). Medications that reduce REM sleep, such as selective serotonin reuptake inhibitors (SSRIs) (Tribl et al. 2013), may alter this conversion to long-term memory and impair the process of change in psychotherapy. Conversely, improving sleep through pharmacotherapy, or adding behavioral sleep interventions (Bootzin & Epstein 2011) may facilitate change in psychotherapy. Napping has also been shown to enhance explicit recall of verbal material both immediately and after a delay (Mednick et al. 2008). One might consider doing a trial of napping after therapy sessions to see if therapy progress is enhanced.

The relationship between basic and clinical research is bidirectional. Just as methods used in memory reconsolidation research can be applied to research in psychotherapy, so too can clinical observations influence how basic research is conducted. For example, the principle of “changing emotion with emotion” in EFT has implications for how aversive conditioning studies are performed in rodents. Instead of simply having the rat respond passively to the electric shock by freezing, rats can be taught to respond actively, as in the defensive burying procedure (e.g., De Boer & Koolhaas 2003), in which rats actively bury a shock prod if provided with wood shavings in the training context. A variant of this procedure has recently been suggested as a potential rodent model of PTSD (Mikics et al. 2008). This active approach might lead to alterations in the neural circuitry of conditioned fear, and provide a model for understanding how clients are helped to overcome apprehension with assertiveness by tapping into adaptive emotional responses such as anger during the therapy session (Greenberg 2010).

### 9.6. Differentiating between modalities

As noted above, we do not have a principled way of choosing between modalities based on client characteristics. Typically therapists have a primary modality that they profess to practice but evidence suggests that successful therapists who espouse different modalities share many characteristics, such as warmth, empathy, genuineness, and enthusiasm (Frank 1974b). This has led to invocation of the “dodo bird verdict” (Luborsky et al. 1975; 2002), which states that because of these common factors all forms of psychotherapy are effective and none is superior to any other.

A speculative alternative, offered from the vantage point of our unifying framework, is that a distinction between modalities may be based on the pervasiveness of the presenting problem or maladaptation. Behavioral (exposure) therapy may be indicated when there are specific, identifiable situations that elicit specific implicit emotional responses, such as a phobia. CBT and EFT may be indicated in symptomatic syndromes such as depression that are not situation-specific but are temporary disturbances in explicit emotional experiences. Insight-oriented therapies may be indicated when the difficulties are enduring trait characteristics of the individual that are not situation-specific or temporary. The fundamental process of change, however, may be shared by all of these modalities.

### 9.7. Implications for education

A challenge for mental health clinical training, and clinical practice generally, is to establish a rational basis for selecting a particular type of psychotherapy for a particular patient or particular problem. The predominant approach to clinical training is for a program to specialize in a particular mode of psychotherapy and have trainees select where they get their training. Complexity arises as professional oversight committees require proficiency in more and more modalities and trainees must somehow make sense of and integrate modalities from different theoretical and historical traditions. The model presented here potentially provides a unifying framework that can bring some coherence to psychotherapy education and can provide a rationale for combining or integrating modalities in the care of a specific client. The model also provides new opportunities for research for those training programs that value research as part of the clinical training.

#### ACKNOWLEDGMENT

The authors thank Drs. Nick Breitborde, Patrick Dust, Harald Guendel, Jerry Osterweil, Karen Weihs, and six anonymous reviewers for their detailed comments on a previous draft.

## Open Peer Commentary

### Psychopathology arises from intertemporal bargaining as well as from emotional trauma

doi:10.1017/S0140525X14000132, e2

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**Abstract:** The role of emotional trauma in psychopathology is limited. One additional mechanism is predictable from hyperbolic discounting: When a person uses willpower to control urges each success or failure takes on extra significance through recursive self-prediction, potentially motivating several constricting defense mechanisms. The need for eliciting emotion in psychotherapy is as the authors say it is, but their hypothesis about reconsolidation of memories adds no explanatory power.

There is wide agreement that fostering corrective experience entails re-creating avoided situations in real time, whether literally or in the transference, and supporting the person in “practicing a new way of behaving and experiencing the world in a variety of contexts” (Abstract). By contrast, a rationale for why a person’s symptoms have grown and persisted in the first place has escaped consensus over the years. The authors adopt a model of emotional trauma, “a single event” or “a repeated pattern of abuse or mistreatment” (sect. 2, para. 8), the effects of which do not fade with time because of the somewhat autonomous nature of emotion—that it may grow with rehearsal in the absence of new provocations (or unconditioned stimuli): “When a memory is recalled ... the recollected event and its newly experienced emotional response will be re-encoded into a new and expanded memory trace. Thus, memory for the original traumatic incident is strengthened” (sect. 7, para. 8). They say that such episodic

memories form “boundary conditions or expectations” for the person’s semantic “decision rules” (sect. 6, para 4.). They review recent research showing that rehearsal under new conditions changes original memories, and suggest, without specific findings, that successful treatment changes the rules by changing the memories.

This account may be true, but no reason is given for why a person must reconsolidate an original memory to overcome its effects. Furthermore, putting traumatic memories at the core of pathogenesis overstates the case. With the exception of post-traumatic stress disorder and, arguably, borderline personality disorder (Gunderson & Sabo 1993), most psychopathology does not originate in trauma (Wenar & Kerig 2006). Even phobia, the disorder one might think most likely to spring from trauma, cannot usually be traced to any such root (Poulton & Menzies 2002; Rachman 1977). Where a conditioning process can be seen, for example in the progression of panic attacks into panic disorder, the unconditioned stimulus for anxiety is panic itself, which is not externally caused (Bouton et al. 2001). Many causes have been proposed for the various disorders that respond to psychotherapy, but it is striking that most therapies have targeted misguided and overgrown attempts at self-control: “cognitive maps” (Gestalt), “conditions of worth” (client-centered), “musturbation” (rational–emotive), “overgeneralization” (cognitive–behavioral), and of course the punitive superego (summarized in Corsini & Wedding 2011). True, the person often ascribes these burdens to parental or social demand, but the great amount of projection that such reports usually represent leaves unexplained the person’s issues with self-control.

In most cases there has been no crucial event, but rather a long history of poor coping. People come to therapy entangled in a lot of old learning. We are high-strung organisms, prone to fears from our evolutionary past that require active learning to get over (Muris 2006; Poulton & Menzies 2002). The self-sustaining nature of emotion that the authors describe is undoubtedly another factor. Additionally, I have argued that we have an inborn warp in how we evaluate the future, and that our attempts to correct for this warp can account for a good deal of psychopathology in the absence of any victimization (Ainslie 1999, 2005). I summarize my proposal as one of an unknown number of contributing mechanisms: An inborn tendency to discount the value of future experiences as a hyperbolic function of expected delay is now well established (Bickel & Marsch 2001; Green & Myerson 2004; Kirby & Santiesteban 2003). The result is temporary preference for outcomes that we would avoid at a distance and which we regret afterwards. Many of the choices we face are asymmetrical situations in which slow-paying options that appeal to our reason are pitted against urges, a problem that is universal but which is magnified by inborn susceptibilities in some people (Goldsmith et al. 1997; Goodwin 1986; Van Houtem et al. 2013). Urges may feel negative but hard to resist (to panic, to attend to an obsession), or they may be consciously tempting (to use drugs or get into destructive relationships), but for all of them we face the choice of giving in or trying to control them. We monitor our attempts to control urges with recursive self-prediction, and in doing so create the history of successful and failed commitments that entangles us:

As we face particular kinds of urge repeatedly, we notice that our current choice predicts what we will choose next time, and so we increasingly come to act under the weight of our anticipated future. Our awareness of current choices as test cases for future choices creates personal rules, which are often *implicit*, in the authors’ terminology—we sense the extra significance of the choice but cannot articulate what is at stake. With high degrees of such awareness our decision-making becomes legalistic, abstracted away from the here-and-now—in clinical terms, *compulsive*. In effect we are playing repeated prisoner’s dilemma games with our expected future selves, the logic of which is weighted toward defection and self-mistrust (Monterosso et al. 2002). Lapses damage our confidence in our intertemporal cooperation,

engendering guilt and leading us to abandon attempts at self-control in areas where it has failed. Thereafter we avoid the kind of situation where we were overwhelmed, concluding that we “can’t face embarrassment” or “can’t stand heights,” thus establishing a circumscribed symptom. For addictive urges this abandonment is called the *abstinence violation effect* (Marlatt & Gordon 1980; Polivy & Herman 1985). To restore intertemporal cooperation we redefine our rules with rationalization, and we develop repression and denial to avoid recognizing lapses. Over time we accumulate commitments and failures of commitments that make us rigid in much the way old economies or bureaucracies become rigid (Olson 1982).

Defending brittle truce lines between urge and control may thus be a major motive – at least as great as that of escaping traumatic memories – for developing rationalizations, resistances, and other “avoidance of emotional pain through regulatory actions” (sect. 2, para. 13). In this view the role of psychotherapy is to encourage creative destruction of these truce lines. It does so by inviting the person into the situations that provoke relevant anxieties while supporting her trial of new responses, the same procedure indicated for overcoming emotional trauma, and, indeed, for psychotherapy generally.

#### ACKNOWLEDGMENT

This material is the result of work supported with resources and the use of facilities at the Department of Veterans Affairs Medical Center, Coatesville, PA, USA, and is thus not subject to copyright. The opinions expressed are not those of the Department of Veterans Affairs or of the US government.

## The importance of the rites of passage in assigning semantic structures to autobiographical memory

doi:10.1017/S0140525X1400034X, e3

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**Abstract:** As cultural anthropologists, we noticed an unexpected and interesting convergence of the therapeutic practices suggested in the target article and the rites of passage occurring across multiple societies, as individuals make the transition from one significant age or status to another.

The target article suggests an intriguing bridge between the two disciplines concerned with the complex well-being of humankind: psychology and anthropology. First, its conclusions are similar to and significant to the well-established findings of classical anthropology: namely, the efficacy of the *rites of passage* (Van Gennep 1909/1960), inherent to every form of rituality within traditional societies, in managing critical transitions in human development, whether they refer to the cycle of a person’s life (“birth, childhood, social puberty, betrothal, marriage, pregnancy, fatherhood, initiation into religious societies, and funerals” [Van Gennep 1909/1960, p. 3]); coming of age (Neagota 2011; Schlegel & Hewlett 2011), marriage and death (Benga 2011; Benga & Benga 2003); or to the “ceremonies of human passage ... occasioned by celestial changes, such as the changeover from month to month (ceremonies of the full moon), from season to season (festivals related to solstices and equinoxes), and from year to year (New Year’s Day)” (Van Gennep 1909/1960, p. 4), with both epical foundation rites and anniversary dramaturgy (Benga 2009). Secondly, the proposed integrative memory model, with its tripartite structure –

autobiographical memories, semantic structures, and emotional responses – design the therapeutic process much in the way society monitors individual passage through rites and rituals. Explicitly, the model aims to develop “a common language that spans disciplines and a common mechanism underlying change” (sect. 9, para. 2).

Our core idea is that the validity of the Gennepian sequence in the standard rite of passage, which is made of separation from the old state, transition, and reincorporation into a new state, transcends the “fixed form” of traditionally transmitted rituality and belongs ultimately to the inherent passage of human life. Human life, like all life, is change, itself. Managing perpetual change is linked to managing crisis: by means of rituality, within customary societies, and by means of therapy, with the dwindling of customary, tradition-bound institutions within (post)modernity (see also Arnett 2012). Crises, though – because of the constancy of human variables – all are describable by means of Van Gennep’s tripartite scheme. Seen under this light, the crises demanding therapeutic intervention from modern day psychiatry and psychology can all be included within the framework of the imperfect passage or transition: imperfect separation, prolonged transition (far beyond the concrete reorientation of the person towards an adjusted, more befitting, status), and unsuccessful reincorporation into the new condition. Disruptions within the development of the person throughout his or her ages, throughout the person’s growing up, growing mature, and growing old, result in accumulations of traumas. Resolving the traumas must involve considering the disruptive event and its significance within the personal history. The markers of the person’s fractured passage through his or her life are emotional memories of emotional experiences: the ways we all encode the Gennepian separation, transition, and unfinished reincorporation, within our autobiographical histories.

Thus, therapeutic change is expected to detect the prolonged transitional status and the incomplete passage, and convert it into the creation of the “coherent narrative account of what occurred” (sect. 2, para. 9). The similarities between traditional ceremonies involving larger group participation, and the psychotherapeutic (most often) one-to-one framework, needing to elicit a re-enactment of the stressful, unsolved situation, which is then incorporated within a corrective experience occurring in a new safe context, reside in the following aspects:

The re-enactment of a script in a dramaturgical form, condensing semantic information and epitomizing a category of real experiences in a dramatized form, easy to anticipate for the insider: Assigning roles for reproducing a mythical script and thus rehearsing an *illud tempus* drama (sect. 2, para. 8; Benga 2009);

The personal involvement, interest in the script – that is, probably setting the optimal arousal level for encoding, and further reconsolidating the integrative information (semantic, autobiographic and emotional) (sects. 3.1–3.3);

The presence and amount of the personal experience of the individual as actor or character in the script, which ensures the emotional involvement of the individual, as well as the activation of autobiographical memory;

The generation of a new narrative, based on the script, reproducing the narrative plot, yet loaded with both the emotional experiential load of the original plot, and the new emotional load – via the process of reconsolidation (sect. 4, para 6) (also considered a critical stage by trauma-focused interventions such as TF-CBT [see Cohen et al. 2006]); without the participants’ experiential involvement in the rites and rituals, we cannot speak of their anthropological validity as cultural facts;

The virtue of repeated retelling of memories (which may be cultural memories, as in myth and all the other epic genres) of improving consistency over time (sect. 5, paras. 4–5; sect. 6, paras. 1–4; sect. 7 paras. 1–3);

The concrete difference between the person having not yet undergone the therapeutic–dramaturgical script, and the individual

having covered the role in the script – be it collective, as in ceremonies, or bi-univocal, as in the modal therapeutic alliance;

The quest for change, in both instances: traditional and modern-therapeutic;

The concrete importance of the features and the quality of the plot (i.e., *semantic structures*) in ordering *autobiographical* emotions and memories, which in turn restructure semantic memory.

The structure of the *rites of passage* may be studied nowadays in ethnographic customary settings just as in those of yore. The more archaic a ceremony – for example, the Romanian Green Man at St. Georges’ (Neagota 2011), the therapeutic dance of the *Călușari* (Benga & Neagota 2010), and more – the more analyzable it is as a cultural fact of its own syntax. Anthropology describes, puts forward, and interprets the change; psychology interacts, probes to the core motivations of the person, provokes and endlessly drills for the meaning within change. But after all, the process of human change remains the same, and its corresponding drama is the passage of time itself: Some passages last longer than they should; some never reach the necessary threshold to suitably allow changing. Yet the common denominator of all these changes is that managing the change is always linked to giving weight and meaning to the autobiographical history of the self, whether suitably, properly recollected or not, as a result of the unsolved traumas across the individual pathway.

## Reconsolidation versus retrieval competition: Rival hypotheses to explain memory change in psychotherapy

doi:10.1017/S0140525X14000144, e4

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**Abstract:** I suggest it is premature to assume memory reconsolidation provides a unifying model of psychotherapeutic change given our current state of knowledge, and that other basic memory mechanisms, also supported by neuroscience, have a stronger claim at present. In particular, I propose that retrieval competition provides a more plausible alternative to memory reconsolidation.

Two opposing views concerning memory change have held sway in cognitive science as in psychotherapy research (Brewin 1989; 2006). One states that interventions such as supplying misinformation or conducting psychological therapy can in principle result in a permanent change in the underlying memory representation: Here, Lane et al. argue for this position and that it is attributable to a process of reconsolidation. The alternative view is that representations cannot be permanently altered, and that such interventions create new memories that leave the original intact. Whether old or new memories then determine behaviour is decided through a process of retrieval competition, with the most accessible memory having the greatest influence (Brewin 2006).

Reconsolidation has not yet been extensively studied in humans, and there is controversy over whether it has been unambiguously established. A number of studies have used reconsolidation manipulations to reduce people’s emotional response to a fear-inducing experience, an approach which leaves the declarative recollection of that experience intact. Other studies, such as those reported by the authors, have demonstrated changes in memory for one set of objects brought about by participants being given an indirect reminder of this set just before being exposed to a new set of objects.

Using this design, in which there is no explicit retrieval of the original memory, it is hard to prove unambiguously that reconsolidation has taken place, although other recent research has addressed some of these issues (Chan & LaPaglia 2013; Kroes et al. 2014).

Even if the manipulations in these studies are producing genuine reconsolidation effects on declarative memory, these are relatively small in absolute terms. They are also obtained with designs involving the memorisation of personally meaningless stimuli. Given apparent boundary conditions for reconsolidation effects (Alberini et al. 2013), such effects might not occur with memories of painful experiences that people have recalled and perhaps ruminated over dozens if not hundreds of times. Moreover, anxious individuals may be less likely to show fear-related reconsolidation effects (Soeter & Kindt 2013). Finally, the claim that memories have been permanently changed can logically only be studied by thorough retesting and trying to elicit the original memory in another way, something that remains to be done.

Some predictions made by Lane et al. do not obviously favour a reconsolidation approach. For example, one suggestion was that propranolol is likely to be contra-indicated in post-traumatic stress disorder (PTSD) therapy because it may slow the reconsolidation of memories that incorporate a new sense of safety. Preliminary evidence appears to support the use of propranolol, however (Brunet et al. 2011). The authors also suggested that selective serotonin reuptake inhibitors (SSRIs) are likely to impair the processes of change in psychotherapy because their adverse effects on REM sleep interferes with reconsolidation. However, most of the evidence suggests that psychotherapy in combination with SSRIs achieves better outcomes than alone (e.g., March et al. 2004; van Apeldoorn et al. 2008).

The main alternative possibility is that psychotherapy creates new memories that compete with existing ones. Many contemporary theories of human and animal cognition (e.g. Kesner & Rogers 2004; Poldrack & Packard 2003) favour the idea that learning produces a variety of new representations that can collaborate or compete with existing memories for control of behavior. Lane et al. mention extinction, a well-established therapeutic process which is thought to operate in this way, but do not explain why they consider reconsolidation to be a more likely candidate for explaining therapeutic change.

Among the advantages of a retrieval competition approach are that it does not assume a very malleable memory system that is constantly subject to change. In evolutionary terms, it would seem better to have a memory system that was able to keep a permanent record of extremely stressful or threatening events, because this information could be critical for survival. In fact, although it is fashionable to emphasise the malleability of memory, there is also plenty of evidence for its stability and reliability (Brewin & Andrews, submitted). This is hard to explain if memories are constantly being updated, leaving no trace of the original behind.

Another advantage accrues from the fact that relapse is reasonably common even after successful psychotherapy. This is hard to explain if it is assumed the underlying memory has been permanently updated. It is much more consistent with the idea that recovery is brought about by the creation of stable alternative memory structures but that the original remains able to be reactivated under a specific set of circumstances. This is a helpful model when teaching relapse prevention procedures to patients nearing the end of a course of therapy. It emphasises that the return of negative feelings and cognitions is a continuing hazard but one that is not catastrophic and that probably reflects the presence of specific triggers. Patients can then be encouraged to re-institute the coping mechanisms they have been taught rather than interpret the relapse as a sign of treatment failure.

At present our understanding of therapeutic change is rudimentary, and proposals for new mechanisms grounded in

cognitive neuroscience are extremely welcome. It is likely that the many varieties of transformation that patients undergo will never be explained by any one mechanism, whether reconsolidation or retrieval competition. Basic research on memory change does, however, constitute one of the most promising lines of enquiry presently available, and findings from both animal and human research have the capacity to deliver new insights into what makes therapy effective. Although I agree with the authors that different forms of memory, such as semantic and episodic memory, are strongly interlinked, this does not mean that they are all equally important in different types of psychopathology. There are also perceptual forms of memory that appear to be distinct from episodic memory and may become relatively disconnected within conditions such as posttraumatic stress disorder (Brewin 2014; Brewin et al. 2010). It seems highly likely that our understanding of different change mechanisms needs to develop in tandem with a more differentiated view of human memory systems.

## Clinical applications of counterfactual thinking during memory reactivation

doi:10.1017/S0140525X14000351, e5

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**Abstract:** The Integrative Memory Model offers a strong foundation upon which to build successful strategies for clinical intervention. The next challenge is to figure out which cognitive strategies are more likely to bring about successful and beneficial modifications of reactivated memories during therapy. In this commentary we suggest that exercising emotional regulation during episodic counterfactual thinking is likely to be a successful therapeutic strategy to bring about beneficial memory modifications.

Without a doubt, the Integrative Memory Model (IMM) offered by Lane et al. constitutes a parsimonious and elegant framework in which to understand the affective and cognitive processes underlying therapeutic success. Moreover, if we consider the therapeutic session a suitable context for reactivating injurious memory traces and modifying them into healthier ones after reconsolidation, then we have a strong foundation on which to build successful strategies for therapeutic intervention. The next task for researchers and therapists is to identify the cognitive processes that are more likely to generate successful and beneficial modifications of reactivated memories during therapy. In this commentary we want to put forth the hypothesis that exercising emotional regulation during episodic counterfactual thinking is likely to be a successful therapeutic strategy to bring about beneficial memory modifications.

Episodic counterfactual thinking (ECT) refers to our psychological tendency to mentally simulate alternative ways in which past personal events could have occurred but did not (De Brigard & Giovanello 2012; De Brigard et al. 2013a). As such, ECT is a subclass of our more general capacity to entertain thoughts about ways in which both personal and nonpersonal events could have been (Roese 1997). ECT is ubiquitous, and the past two decades have seen an explosion of research on its psychological mechanisms and effects on emotion and behavior. One consistent result is that engaging in counterfactual simulation amplifies emotions, which can be either negative, like the regret we feel when the counterfactual involves a better outcome than the one obtained (i.e., upward counterfactual), or positive, like the relief we feel when the counterfactual involves a worse outcome than the one obtained (i.e., downward counterfactual;

Kahneman & Miller 1986). Accordingly, it has been suggested that counterfactual thinking serves two different functions, depending on the direction of the mutation. Upward counterfactuals are said to serve a *preparative* function in anticipation to similar events that may occur in the future, whereas downward counterfactuals are said to serve an *affective* function that helps agents feel better about their experienced outcomes (Roese 1994; Roese and Olson 1995).

That view fails to account for the fact that sometimes we entertain upward counterfactuals about events that we know will not ever be repeated, however, as well as the fact that some downward counterfactuals elicit regret rather than relief. As a result, it was recently suggested that the function of counterfactual thoughts may differ depending on whether one focuses on comparing the simulated alternative against the actual event (evaluative mode) or simply on reflecting about the simulated alternative alone (reflective mode; Markman & McMullen 2003). Indeed, in an updated modified version of the functional view, Epstude and Roese (2008) suggest that the content and the emotion associated with the simulation are two different routes by means of which counterfactual thoughts can affect subsequent behavior. If so, it is worth wondering how one's affective response to a mental simulation interacts with the representational content of the counterfactual thought – or, to put it in terms of IMM, how is it possible that the emotion associated with ECT can affect one's subsequent reappraisal of the experienced event?

Our hypothesis – which is entirely consistent with Lane et al.'s IMM – is that, ordinarily, one of the reasons we engage in ECT is to “edit” the episodic autobiographical memories from which counterfactual simulations are construed. As Lane et al. point out, many studies have shown that, upon reactivation, memories are labile and prone to modification during reconsolidation (Nadel et al. 2012; Nader & Einarsson 2010; Schiller & Phelps 2011). Thus, because ECT requires the reactivation of a specific episodic autobiographical memory, we think it is likely that the experienced affect during reactivation, in addition to the direction of the mutation during counterfactual simulation, may alter the affective content of autobiographical memories upon subsequent reconsolidation.

Initial support for this hypothesis comes from a recent study showing that repeated reactivation of episodic counterfactuals of autobiographical memories decreases the subjective estimates of their perceived plausibility while increasing positive emotional valence (De Brigard et al. 2013b). In other words, the more we think about how a past event could have occurred, the less plausible it seems that such an event could have occurred as imagined, and the more positive our emotion is during the simulation. De Brigard et al. (2013b) hypothesized that this reduction in perceived plausibility as a result of repeated simulation is an adaptive feature of counterfactual thinking, as it helps to disregard events that did not occur to reduce our need to keep pondering about them. It seems as though ECT help us to come to grips with the past.

Now, when considered against the IMM, this result may actually be a manifestation of a more general effect. Ordinary instances of episodic counterfactual thoughts propitiate the healthy and often unassisted modification of an autobiographical memory trace by altering the original content and emotion associated with the past experience. The original content and emotion become new and better ones, elicited during the counterfactual simulation, a process that, for lack of a better pun, could be dubbed “memory mollification.” Sadly, though, individuals suffering from anxiety and depression do not experience such relief (Nolen-Hoeksema 2000). In fact, their propensity to ruminate on negative thoughts associated with past events and to repetitively fixate on regret-provoking counterfactuals is not only a critical predictor (Roese et al. 2009), but also a debilitating component of both anxiety (Harrington & Blankenship 2002) and depression (Spasojevic & Alloy 2001; Thomsen 2006). This suggests that, at least in individuals suffering from these conditions, ECT fails to mollify their reactivated memories.

Given that ECT is theoretically well-situated to enact therapeutic change, further research is needed to fully understand how the affective attitude, as well as the direction of the mutation during counterfactual simulations, can affect the phenomenological characteristics of the autobiographical memory from which they are derived. Nonetheless, we hope to have offered good reason to believe that episodic counterfactual simulations may be particularly effective in bringing about the kinds of memory modifications (and mollifications) suggested by the IMM.

## Changing maladaptive memories through reconsolidation: A role for sleep in psychotherapy?

doi:10.1017/S0140525X14000156, e6

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**Abstract:** Like Lane et al., we believe that change in psychotherapy comes about by updating dysfunctional memories with new adaptive experiences. We suggest that sleep is essential to (re-)consolidate such corrective experiences. Sleep is well-known to strengthen and integrate new memories into pre-existing networks. Targeted sleep interventions might be promising tools to boost this process and thereby increase therapy effectiveness.

We greatly appreciate the target article by Lane et al. highlighting the importance of recent findings in the brain sciences for understanding and improving the mechanisms of action in psychotherapy. We believe that it is high time to incorporate this knowledge into psychotherapy research, as well as into practical psychotherapy and education. Lane et al. discuss compellingly the role of maladaptive emotional memories in psychopathology and the possibility to change dysfunctional memories through new corrective experiences in the therapy setting via processes of reconsolidation. Although we are in perfect agreement with this account, we want to highlight a potentially crucial factor in this process: the functional role of sleep.

Sleep is well-known to enhance the consolidation of freshly acquired memories, particularly emotional memories (Payne & Kensinger 2010; Rasch & Born 2013; Stickgold & Walker 2013). Delayed memory retrieval is typically enhanced if the initial acquisition of new memories is followed by a period of sleep compared with an equivalent wake period, with sleep occurring shortly after learning being more effective than delayed sleep (Gais et al. 2006). Some forms of memory even require sleep during the first night after learning, with the new memory being entirely lost if sleep is forgone (Stickgold et al. 2000). For many forms of memory, brief naps of 40 to 90 minutes are sufficient to promote consolidation processes (Diekelmann et al. 2012; Mednick et al. 2003; Tucker et al. 2006). One study suggests that even a very short nap of only 6 minutes can improve memory performance even though longer naps provide stronger improvements (Lahl et al. 2008).

Apart from the strengthening and stabilization of memories, sleep also facilitates the integration of new memories into pre-existing schemas and semantic networks (Ellenbogen et al. 2007; Landmann et al. 2014; Tamminen et al. 2013), a function that seems to be of particular relevance in the context of changing and updating memories in psychotherapy. Reconsolidation of memories after reactivation during wakefulness (e.g., via retrieval) has likewise been suggested to benefit from sleep (Walker et al.

2003). It is generally believed that the consolidating function of sleep for memory relies on the neuronal reactivation (“replay”) of new in conjunction with older memory representations during sleep, possibly in concurrence with a selective downscaling process, such that the respective memories are stronger and better integrated after sleep (Diekelmann & Born 2010; Lewis & Durrant 2011; Tononi & Cirelli 2014).

Apart from this memory-improving effect of normal sleep, recent studies suggest that specific characteristics of sleep can be directly targeted to enhance sleep’s beneficial effect (Diekelmann 2014; Spiers & Bendor 2014). For example, facilitating memory reactivation by presenting olfactory or auditory cues during sleep that have previously been associated with the learning experience enhances memory consolidation (Oudiette & Paller 2013; Rasch et al. 2007). Such targeted memory reactivations can specifically enhance those memories that are cued during sleep while leaving uncued memories unaffected (Rudoy et al. 2009; Schonauer et al. 2014). Re-exposure of olfactory context cues during sleep that had been present during prior fear conditioning might even induce extinction of the conditioned fear response (Hauner et al. 2013; but see Barnes & Wilson 2014; Rolls et al. 2013).

Increasing slow oscillations (<1 Hz, the hallmark brain oscillation of slow wave sleep) by electrical transcranial direct current stimulation (tDCS) or auditory stimulation is another promising method to enhance sleep-dependent memory processing (Marshall et al. 2006; Ngo et al. 2013). Applying electrical currents that oscillate at the same frequency as natural slow oscillations intensifies endogenous slow oscillations and improves memory consolidation (Marshall et al. 2006). Similar increases in slow oscillations and associated memory performance are observed following timed auditory stimulation of slow oscillations (Ngo et al. 2013). A third way to manipulate sleep and memory relates to pharmacological interventions. Several drugs targeting different neurotransmitter systems have been proven effective to enhance memory during sleep, such as drugs manipulating neurotransmission of noradrenaline (Gais et al. 2011), dopamine (Feld et al. 2014), glutamate (Feld et al. 2013), and GABA (Kaestner et al. 2013).

Many psychiatric disorders are associated with impaired sleep and memory dysfunctions, such as post-traumatic stress disorder (PTSD) (Germain 2013), depression (Steiger et al. 2013), and schizophrenia (Lu & Goder 2012). Improving sleep in these patients might generally ameliorate disorder-related symptoms and improve cognitive performance. Patients with schizophrenia, for example, show reduced sleep-dependent memory consolidation (Goder et al. 2004), while electrical slow oscillation stimulation during sleep increases memory functions in these patients (Goder et al. 2013). Apart from a generally positive effect of restoring normal sleep patterns, we want to suggest that sleep can specifically support the strengthening and integration of emotional memories that have been updated during prior psychotherapy. Two recent studies provide first evidence that sleep after exposure therapy improves therapy outcome in spider phobia (Kleim et al. 2013; Pace-Schott et al. 2012). Patients underwent a virtual reality exposure session and were allowed to sleep for 90 minutes after the treatment (Kleim et al. 2013). At a follow-up test one week later, these patients reported significantly reduced fear and spider-related cognitions compared with a group of patients that had stayed awake after the treatment. It remains to be elucidated whether targeted sleep manipulations, such as cued memory reactivation and slow oscillation stimulation, can boost this effect further.

Based on this evidence, we suggest that sleep and specific sleep interventions can facilitate memory updating and thereby improve therapy gain in memory-related psychopathology. Future research should test whether certain sleep interventions are more effective for certain types of psychotherapy and how sleep interventions can best be incorporated into the therapy setting to optimize outcome. We believe that sleep interventions are highly

promising new therapy tools as they do not only bear a strong potential to increase therapy success but at the same time are cost-effective and have no to little side effects.

## Minding the findings: Let's not miss the message of memory reconsolidation research for psychotherapy

doi:10.1017/S0140525X14000168, e7

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**Abstract:** That memory reconsolidation is the process underlying decisive, lasting therapeutic change has long been our proposal, and the recognition of its critical role by Lane et al. is a welcome development. However, in our view their account has significant errors due to neglect of research findings and neglect of previous work on the clinical application of those findings.

Lane et al. provide masterful coverage of learning and memory as relevant to psychotherapy. However, we take issue with their account of memory reconsolidation. Despite their central focus on reconsolidation, and despite affirming (rightly, in our view) that “clinical change occurs through the process of memory reconsolidation” (sect. 1, para. 8), their article provides no account of (a) abundant research findings that have identified the specific process of memory reconsolidation, or (b) extensive previous development by others of the article’s main themes – the use of reconsolidation for psychotherapy and for a new framework of psychotherapy integration – or of the challenge that reconsolidation poses to nonspecific common factors theory (Ecker 2008; 2011; 2013; Ecker & Toomey 2008; Ecker et al. 2012, 2013; Welling 2012).

Throughout the twentieth century, myriad studies of extinction demonstrated that the memory circuits of a conditioned (learned) response are suppressed temporarily, but never erased, by extinction. Researchers concluded therefore that the brain lacks any neuroplastic process that could truly delete a learning that has been installed in long-term memory by the process of consolidation (whereas new learnings are unstable and disruptable prior to consolidation). Consolidation was believed irreversible, and consolidated memory circuits were believed to be stable and indelible for the individual’s lifetime (e.g., LeDoux et al. 1989).

Then, during the late 1990s, several studies, culminating with that of Nader et al. (2000), found that the neural circuitry encoding a consolidated learning transformed into a deconsolidated, destabilized, disruptable state following a reactivation of the learning by cues that were salient features of the original learning experience. The existence of deconsolidation meant that memories also reconsolidate, and that the target learning could be completely eliminated while destabilized, not just suppressed temporarily. Erasure occurs either endogenously, through new learning that re-encodes the unlocked neural circuitry, or exogenously, as when chemical agents prevent circuits from reconsolidating, destroying them.

However, it was not until 2004 that the brain’s inherent rules for launching deconsolidation/reconsolidation were identified (Pedreira et al. 2004), with subsequent confirmation by many other studies (for a list, see <http://tiny.cc/7yutfx>, Ecker 2015 or Ecker et al. 2012, p. 21). Those studies, taken together, have clarified what the brain requires for deconsolidating the neural encoding of a target learning or schema: (1) The target learning or schema has to be reactivated, vivifying its expectations of how the world or self will operate, and (2) concurrently the subject also has to experience something saliently novel or discrepant in

relation to what the target learning expects or “knows” according to its schematic or semantic content or model.

Those two concurrent conditions constitute what reconsolidation researchers term a “mismatch experience” or “prediction error experience,” and what we have termed a “juxtaposition experience” in the clinical context (e.g., Ecker 2008; Ecker et al. 2012; 2013). Reactivation without concurrent discrepancy fails to induce deconsolidation, and the memory remains stable (e.g., Sevenster et al. 2012). Lane et al. contend every reactivation of a memory is destabilizing, which has already been disproved. Neuroscientists view reconsolidation as the brain’s process for updating memories because it launches only if discrepant experience accompanies schema reactivation. Lane et al.’s central message appears to be that emotional arousal is necessary for inducing memory reconsolidation. The research shows otherwise. The mismatch requirement has been detected for many types of memory ranging from cortical, factual learnings having no emotional content (e.g., changed set of syllable pairings; Forcato et al. 2009) to subcortical, intensely emotional learnings (e.g., change of safety position in animal studies; Morris et al. 2006). The brain clearly does not require emotional arousal per se for inducing deconsolidation. That is a fundamental point. If the target learning happens to be emotional, then its reactivation (the first of the two required elements) of course entails an experience of that emotion, but the emotion itself does not inherently play a role in the mismatch that then deconsolidates the target learning, or in the new learning that then rewrites and erases the target learning (discussed at greater length in Ecker 2015). Naturally, target learnings or schemas in psychotherapy usually are emotional, and the observable emotion accompanying their reactivation is a key marker of adequate reactivation. For those reasons, emotional arousal is usually present during moments of deep therapeutic change, but Lane et al. conflate that phenomenology of emotion with the mismatch phenomenology that deconsolidates the reactivated learning and allows transformational change.

The same considerations imply that “changing emotion with emotion” (stated three times by Lane et al.) inaccurately characterizes how learned responses change through reconsolidation. Mismatch consists most fundamentally of a direct, unmistakable perception that the world functions differently from one’s learned model. “Changing model with mismatch” is the core phenomenology. Emotions then change as a derivative effect of change in semantic structures (models, rules and attributed meanings).

Lane et al. propose a psychotherapy integration scheme based on the structure of memory. We have proposed a psychotherapy integration framework centered on the brain’s required steps that induce schema destabilization and erasure (Ecker 2011; Ecker et al. 2012, pp. 126–56), and have shown that the diverse systems of therapy can be unified by identifying how their distinctive methodologies do, or do not, facilitate those critical, universal steps. This approach creates “a shared, empirically based frame of reference and a shared vocabulary, allowing these practitioners to discuss their methods in a manner meaningful to each other and to practitioners of yet other clinical systems” (Ecker et al. 2012, p. 152). We predicted that the sequence of experiences required for schema destabilization and erasure could be found in any therapy sessions that produce deep, lasting change.

Furthermore, we argued (Ecker et al. 2012, pp. 153–55; Ecker 2013) that if transformational change of acquired responses indeed requires the specific behavioral steps that induce deconsolidation, then those steps constitute specific factors that are responsible and indispensable for decisive therapeutic change. This would mean that memory reconsolidation challenges the assertion of nonspecific common factors theory that specific factors can never be a major determinant of clinical outcome (e.g., Wampold 2001).

In short, reconsolidation research findings have far-reaching ramifications for psychotherapy, warranting close attention and nuanced understanding.

## A clinician's perspective on memory reconsolidation as the primary basis for psychotherapeutic change in posttraumatic stress disorder (PTSD)<sup>1</sup>

doi:10.1017/S0140525X1400017X, e8

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**Abstract:** Lane et al.'s proposal that psychotherapeutic change comes about through memory reconsolidation is compelling; however, the model would be strengthened by the inclusion of predictions regarding additional factors that might influence treatment response, predictions for improving outcomes for non-responsive patients, and a discussion of how the proposed model might explain individual differences in vulnerability for mental health problems.

Lane et al. provide a well-constructed argument that psychotherapeutic change primarily comes about through the updating of emotional memories via memory reconsolidation. We particularly appreciated the discussion of psychotherapists facilitating the process of memory reconsolidation as a specific mechanism typically attributed to the so-called non-specific effects of psychotherapy or to the therapeutic relationship in general. As clinical psychologists who primarily study, assess, and treat posttraumatic stress disorder (PTSD), we frame our commentary with five questions of significant clinical interest to us.

First, how applicable is this model to mental health problems other than PTSD? The authors seem to suggest the proposed model is equally applicable to all types of mental health problems. Although we believe the proposed model is highly relevant as a model of therapeutic change in PTSD, we questioned whether this same mechanism of change applies equally well to other types of mental health problems. For example, the relevance of the model to the treatment of serious mental illness or more future-oriented anxiety disorders, such as generalized anxiety disorder, was unclear to us. Treatment of these and many other disorders tends to be much less focused on processing prior stressful or traumatic experiences, which the proposed model appears best suited to explain. The authors also note that the presence of rumination would make it more difficult for patients to successfully revise their memory structures, and we agree. However, we would add that rumination is relatively common among clinical populations and just one of many issues that clinicians routinely face when treating challenging patients (e.g., patients with multiple disorders). Thus, although the model seems well suited to explaining psychotherapeutic changes in relatively "straightforward" cases of PTSD, its potential to explain therapeutic change in more complex cases is unclear.

Second, how does the proposed model account for individual differences in treatment response? In many ways, this was our main concern regarding the usefulness of the model. In our opinion, a useful model of psychotherapeutic change should help to explain why some individuals do not benefit from psychotherapy and point toward ways to improve treatment outcomes for these individuals. To that end, we wonder how the proposed model accounts for treatment non-response among patients for whom existing treatments do not result in successful memory reconsolidation. For example, might there be structural or functional differences in the integrative memory systems of these patients compared with treatment responders? If the authors believe

this to be the case, then clearly delineating the hypothesized differences between responders and non-responders would be useful so that these aspects of the model could be tested. Conversely, might the authors posit that individual differences among therapists (e.g., individual differences in "common factors") largely account for individual differences in treatment response? In addition, specific suggestions regarding potential enhancements that might improve therapeutic outcomes for non-responsive patients would be particularly helpful.

Third, how might the model account for, or relate to, individual differences in vulnerability to PTSD and other disorders? Although we recognize that the theory does not claim to be etiological in nature, we can't help but wonder how the theory might relate to individual differences in vulnerability. It is widely accepted that there are significant individual differences in genetic vulnerability to PTSD, with heritability estimates ranging from 30% to 40% (Stein et al. 2002; True et al. 1993). Thus, how might genetic or biological vulnerability factors (e.g., increased amygdala reactivity) believed to be associated with increased risk for PTSD relate to the integrative memory model? The specification of these and other relationships between the proposed model and the known biology of PTSD could also substantially aid in stimulating additional research in this important area.

Fourth, how does the model account for the effectiveness of other forms of psychotherapy not discussed in the article? Although we appreciate the authors' coverage of four relatively diverse forms of psychotherapy, their selection of treatments was by no means exhaustive. We wonder, for example, how their theory might relate to "third-wave" treatments such as dialectical behavior therapy (Linehan, 1993) and acceptance and commitment therapy (Hayes et al. 2012)? In particular, how is the effectiveness of mindfulness—which does not appear to involve memory reconsolidation—explained by their model of therapeutic change? We were also somewhat surprised that the authors did not discuss Interpersonal Psychotherapy (IPT; Klerman et al. 1984), as their model appears well suited to explaining therapeutic change in IPT.

Finally, at a broader level, we wonder if the authors could clarify whether they believe the process of memory reconsolidation is both necessary and sufficient to bring about positive changes in psychotherapy? Although we would agree that memory reconsolidation is likely sufficient to bring about therapeutic change in many instances, it is not clear to us that memory reconsolidation is *necessary* for psychotherapeutic change. Moreover, given that there are pharmacological interventions that appear to produce outcomes similar to psychotherapy, one can't help but wonder if a more biologically based mechanism of change that could account for the effectiveness of both psychotherapy and pharmacotherapy would not be more useful. The proposed model relies heavily on psychological constructs to describe what must ultimately be a biological process.

In sum, we believe that the proposed model makes a substantial contribution to the literature and agree with many of the ideas contained within the manuscript; however, we also felt that the model would benefit from additional theoretical work aimed at developing specific hypotheses regarding: (1) Factors that underlie poor treatment response; (2) procedures to improve psychotherapy outcomes for non-responsive patients; and (3) how the proposed model might account for, or relate to, biological vulnerabilities for the development of mental health problems.

### ACKNOWLEDGMENT

This research was supported by a Career Development Award-2 (1IK2CX000525-01A1) from the Clinical Science Research and Development Service of the VA Office of Research and Development to Dr. Kimbrel. This work was also supported by resources from the Durham Veterans Affairs (VA) Medical Center, the VA Mid-Atlantic Mental Illness Research, Education, and Clinical Center, the VA VISN 17 Center of Excellence for Research on Returning War Veterans, the Central Texas Veterans Health Care System, Texas A&M University

Health Science Center, and Duke University Medical Center. The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the VA or the United States government.

NOTE

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**The nature of the semantic/episodic memory distinction: A missing piece of the “working through” process**

doi:10.1017/S0140525X14000181, e9

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**Abstract:** The relations between the semantic and episodic-autobiographical memory systems are more complex than described in the target article. We argue that understanding the noetic/autonoetic distinction provides critical insights into the foundation of the delineation between the two memory systems. Clarity with respect to the criteria for classification of these two systems, and the evolving conceptualization of episodic memory, can further neuroscientifically informed therapeutic approaches.

Lane et al. have done a valuable service analyzing therapeutic interventions that trade on the conceptual re-categorization of trauma experiences. Their work sheds new light on how memory-updating processes contribute to the mechanisms underlying positive therapeutic change.

Although we applaud their efforts, there are aspects of their model – in particular their conceptualization of memory – we feel merit attention. We focus on an issue we feel to be of critical importance – that is, to what do the authors refer by the terms *episodic* and *semantic* memory? Does their usage cut nature at its Platonic joints?

Because their model pivots on these constructs, conceptual precision is a matter of focal concern. We limit our critique to discussion of the conceptual criteria the authors adopt to differentiate the contributions of episodic and semantic memory to the therapeutic process. A salutary consequence of this focus is that, in the process, definitional concerns also are given a voice.

In 1985, Tulving found it necessary to downplay his original three-pronged criterion of memory-types (whereas episodic memory contains spatial and self-referential content, but semantic memory largely is devoid of such contextual content; Tulving 1972) in favor of a partitioning predicated on the manner in which content is made available to consciousness (i.e., his autonoetic/noetic awareness distinction; e.g., Tulving 1985; 2005). One problem with the original criteria was that since the early 1980s it repeatedly had been demonstrated that self-referential, spatial, and temporal information *can* characterize both episodic and semantic memory (for recent review, see Klein 2013). Accordingly, a dichotomy between semantic and episodic memory admits to considerable ambiguity when analysis of mental content serves as the basis for categorization. For example, I can know that I drove past a bookstore in Flagstaff, Arizona, on my way to the Grand Canyon in 1989 (i.e., knowledge contextualized with respect to time, space, and self) without being able to episodically recollect (i.e., re-live) the act of having done so.

Although Lane et al. mention Tulving’s (1985) experiential revision, they frequently revert to the idea that episodic and semantic memories are empirically separable in virtue of the content made available to awareness. This simply will not do. It is the manner in which autonoetic and noetic awareness are conjoined

with content during the act of retrieval, not the content per se, which determines how a memory experience is categorized (Klein 2013; Markowitsch & Staniloiu 2011b).

Based on these concerns, it becomes apparent why a number of the authors’ assertions – for example, that episodic memory (or as we currently favor to term it: episodic-autobiographical memory; Markowitsch & Staniloiu 2011b; 2012) entails recollection of “events” – appear unwarranted. For example, although “single events” can be the target content of recollection, mental states that do not entail memory of events can as well. Thus, I can episodically recollect that a word appeared on a list (as opposed to simply knowing that it appeared, or feeling it to be familiar). This hardly does justice to the meaning of “event.” Problems such as this stem from a failure to distinguish the content of an occurrent mental state from the manner in which that state is given to awareness (e.g., Klein 2013, 2014; Markowitsch & Staniloiu 2011b): It is the autonoetic aspect of retrieval, not simply the content of retrieval, that makes a mental state an episodic (-autobiographical) experience (see Fig. 1).

Consider, for example, individuals who suffer profound retrograde episodic-autobiographical amnesia, such as patient A. Z. (Markowitsch & Staniloiu 2013). Despite of his inability to episodically recollect *any* personal experiences, he was able to re-learn specific temporal and spatial details of his personal past and also knew details about celebrities. However, he experienced this content as semantic facts rather than episodic-autobiographical recollections. Similarly, Klein and Nichols (2012) presented patient R. B., who temporarily lost his ability to conjoin autonoetic awareness with occurrent mental content. He could remember richly contextual details of his past experiences, but he did not take those details to be personal memory (he stated his “memory” experiences felt unowned – they seemed like facts he had been told by others, lacking the warmth and intimacy associated with episodic-autobiographical recollection; (e.g., James 1890). However, when his autonoetic abilities returned, these same details were now experienced as re-living personal memories.

To generalize, in both organic and dissociative amnesia there is overwhelming evidence for a differentiation between largely preserved semantic memory (see Fig. 1) and largely impaired episodic-autobiographical memory (Markowitsch & Staniloiu 2012; Staniloiu & Markowitsch 2014). This general observation furthermore strongly supports Tulving’s (1985) distinction between these two memory systems and speaks against the use of the term “declarative memory” as an umbrella of the two (cf. also Tulving & Markowitsch 1998).

Of course, Tulving’s autonoetic/noetic criterion presents serious – though not intractable (e.g., the remember/know paradigm) – difficulties for empiricism, because it trades on the subjectivity of the remembering agent. However, current methodological limitations should not sanction avoidance of core properties of the construct(s) under scrutiny (e.g., Klein 2014). If current methods are inadequate, the appropriate scientific move is to adapt method, not to excuse foundational aspects of a construct from empirical analysis.

In conclusion, the authors’ model adds to existing work on the memorial underpinnings of traumatic disorders in important ways. Although other researchers have focused on the etiology and therapeutic resolution of the traumatic effects of disturbing memories (e.g., Brewin et al. 2010; Ehlers & Clark 2000; Rubin et al. 2008), the reconsolidation hypothesis presents a more sophisticated treatment of the memorial contributions to both the trauma experience and the recovery process.

However, because the model is grounded by the notions of episodic(-autobiographical) and semantic memory, it is incumbent on the authors’ to provide a conceptually coherent and empirically warranted treatment of these focal constructs. Absent such a clarification, the present model, though perhaps therapeutically efficacious, ultimately will be found limited in its generalizability by the failure to situate its foundational constructs in a solid theoretical framework.

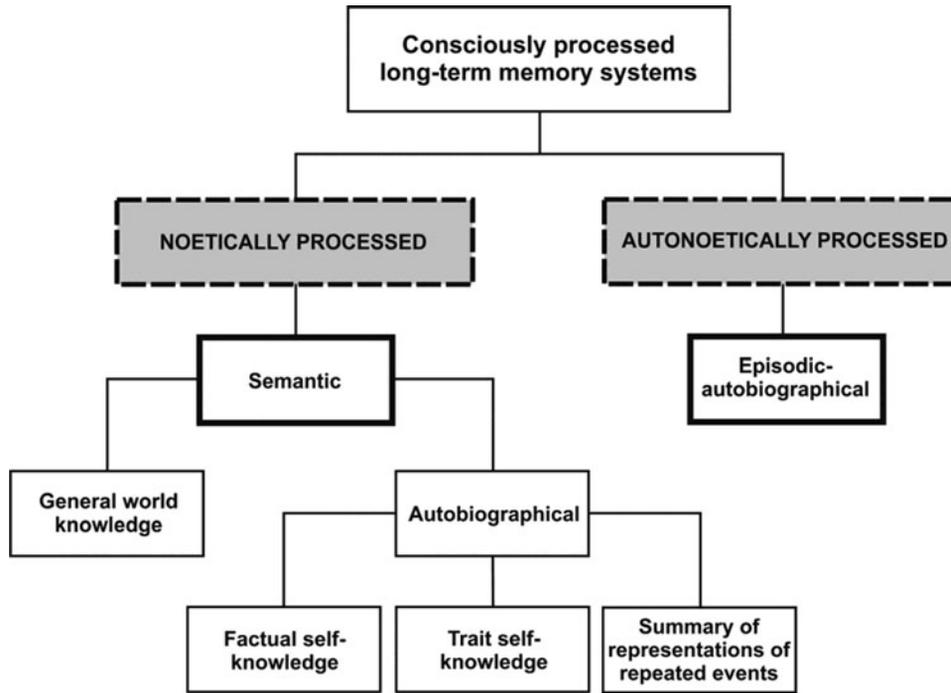


Figure 1 (Klein & Markowitsch). Sketch of the division into semantic and episodic-autobiographical memory. The figure includes ideas from Klein and Nichols (2012), Markowitsch and Staniloiu (2012), and Picard et al. (2013).

### Therapeutic affect reduction, emotion regulation, and emotional memory reconsolidation: A neuroscientific quandary

doi:10.1017/S0140525X14000193, e10

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**Abstract:** Lane et al. emphasize the role of emotional arousal as a precipitating factor for successful psychotherapy. However, as therapy ensues, the arousal diminishes. How can the unfolding therapeutic process generate long-term memories for reconsolidated emotional material without the benefit of arousal? Studies investigating memory for emotionally regulated material provide some clues regarding the neural pathways that may underlie therapy-based memory reconsolidation.

Lane et al. propose that emotional arousal and memory reconsolidation mechanisms are integral to successful behavior change during psychotherapy. However, the neural mechanisms that integrate these processes to achieve the therapeutic goals are unknown. Here I discuss why this proposal presents a quandary to existing neurobiological accounts of emotional memory. Memory reconsolidation has been studied in nonhuman animals using predominantly pharmacologic and cellular neuroscientific techniques to identify the molecular pathways involved. Existing studies have focused on conditioned fear or conditioned reward memories, which have revealed a critical role for the amygdala in memory reconsolidation through engagement of intrinsic second messenger systems, protein synthesis, and a wide range of neuromodulatory influences (Diergaarde et al. 2008; Nader & Hardt 2009). Recent extensions of this work to humans have confirmed enhanced amygdala activity during the reactivation of a conditioned fear memory (Agren et al. 2012), which leads to less of a need for ventromedial prefrontal regulation during extinction training (Schiller et al. 2013).

Conditioning may be a special case, as the amygdala itself may serve as a permanent site of storage of the fear memory. Attempts to translate memory reconsolidation mechanisms to other aspects of human memory, as well as pharmacologic manipulations of reconsolidated conditioned memories, have yielded mixed results to date (Schiller & Phelps 2011). Although conditioning paradigms may provide a useful model for some aspects of anxiety disorders, many therapeutic efforts are focused on altering episodic memories of prior emotional experiences, which involve brain regions beyond the amygdala. McGaugh's memory modulation hypothesis proposes that the amygdala serves to enhance consolidation processes occurring in other memory systems, such as the hippocampus, through both direct neural interactions and indirectly through the release of stress hormones (McGaugh 2000). This hypothesis, however, does not deal directly with reconsolidation processes, which are not necessarily synonymous with initial consolidation processes (Besnard et al. 2012). Nor is it known how the amygdala interacts with other brain regions at a neural systems level to support the reconsolidation of episodic emotional memories.

Neuroimaging studies of emotion regulation provide a further complication to incorporating the reconsolidation idea into a neural systems framework. Down-regulation of negative affect consistently reduces amygdala activity but increases activity in lateral prefrontal regions (Ochsner et al. 2012). The degree of amygdala reduction is correlated with individual differences in cognitive abilities and is functionally coupled to enhanced activity in the ventrolateral prefrontal cortex (Wincoff et al. 2011). This pattern of results is exactly opposite to that shown by the initial neuroimaging studies of conditioned fear memory reconsolidation discussed above. One challenge in integrating these research domains, beyond a difference in memory systems, is that laboratory studies of emotion regulation typically use novel stimuli whose representations are being actively altered in working memory rather than operating on a reactivated long-term memory trace. Nonetheless, similar ventrolateral prefrontal cortex results are found when regulating autobiographical memories (Kross et al. 2009).

A final issue is that most laboratory studies of emotion regulation do not investigate how the corticolimbic interactions change

with prolonged practice. The therapeutic process is dynamic, and as therapy ensues, emotional arousal is reduced. Given that emotional arousal is a key factor in enhancing consolidation, the memory modulation hypothesis would predict less consolidation for later stages of therapy, with weaker memories being formed of the modified representations. Therein lies the full conundrum: If amygdala-dependent processes are key to (re)consolidation mechanisms, why would amygdala activation decrease as memories are being reworked, and how would the reconsolidated memories get encoded into long-term storage in the absence of high emotional arousal?

Importantly, Lane et al. propose that other factors contribute to the reworking of memories in the therapeutic context, including semantic elaboration processes and affect labeling. These processes are associated with ventrolateral prefrontal cortex function, which sometimes reduces amygdala activation but increases hippocampal activation to consolidate material into long-term memory (Dolcos et al. 2004; Lieberman et al. 2007). Deep semantic processing of emotional material enhances memory, even in amygdala-lesioned patients (Phelps et al. 1997). Therefore, prefrontal-hippocampal pathways may provide a means by which new information integrated into the prior trauma episode can get consolidated into long-term memory even in the absence of amygdala-dependent, arousal-mediated (re)consolidation mechanisms.

Hayes et al. (2010) provided initial empirical support for these putative frontolimbic interactions that integrate emotion regulation and memory consolidation processes. In this functional magnetic resonance imaging (fMRI) study, participants engaged in cognitive reappraisal or expressive suppression of emotional pictures, followed by a memory test for the regulated material and for passively viewed emotional and neutral pictures. Relative to passive viewing of emotional pictures, both forms of emotion regulation reduced amygdala activation and valence ratings. Despite the overall reduction in amygdala activity, the residual amygdala activation remained functionally coupled with the hippocampus to predict subsequent memory but only in the reappraise condition. The reappraise condition also uniquely engaged ventrolateral prefrontal cortex interactions with the hippocampus to predict later memory. The reappraised emotional pictures had the highest memory scores overall, likely due to this selective “double boost” in hippocampal function. These results are consistent with a depth-of-processing account of emotion regulation (Dillon et al. 2007), which argues that beneficial regulatory strategies, such as cognitive reappraisal, that foster semantic encoding of the reappraised material will enhance memory despite a reduction in arousal. By contrast, regulatory strategies that promote shallow processing of the regulated material, such as expressive suppression or attentional distraction, will impair memory.

Although these considerations provide some insights into the putative neural interactions involved, clearly more empirical research is needed to identify emotional memory reconsolidation mechanisms of the sort envisaged by Lane et al. In particular, there is a strong need for a broader neural-systems perspective on memory reconsolidation processes that go beyond intracellular amygdala-dependent mechanisms identified for conditioned learning. Future validating studies should integrate emotional memory, emotion regulation, and reconsolidation into a single paradigm that also accounts for the temporal dynamics that unfold over multiple sessions.

## Memory reconsolidation, repeating, and working through: Science and culture in psychotherapeutic research and practice

doi:10.1017/S0140525X1400020X, e11

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**Abstract:** Hypothesizing that an effective common feature in divergent forms of psychotherapy is a process of memory reconsolidation integrating new emotional experiences, Lane et al. usefully shift the focus away from established and/or specialized techniques to deeper questions about the underlying principles of psychotherapeutic change. More research attention to cultural factors influencing the definition and treatment of psychopathology is also needed.

Taking off from Freud’s (1909/1957) influential observation that many of our patients “suffer from reminiscences,” Lane et al. offer a convincing and well-documented variation on a popular theme in contemporary psychoanalytic literature, namely that current neuroscientific models of the mind fit well with certain key features of psychoanalytic theory and practice. The authors provide similar arguments with respect to behavior therapy, cognitive-behavior therapy, and emotion focused therapy. To summarize their detailed and complex argument in the broadest terms, Lane et al. show that the potential therapeutic benefit of these four different models of psychotherapy can be supported, *mutatis mutandis*, with evidence from controlled studies of the nature and functioning of human memory, and more specifically, that disturbed memories, evoked under optimal conditions of emotional arousal, can be “reconsolidated” in more adaptive forms.

Lane et al. have done the field of psychotherapy a great favor by distributing the evidence equally among four such distinct, but representative, treatment modalities. In doing so, they help to move us toward a more flexible understanding of what psychotherapeutic treatment can accomplish and how. While suggesting that different and seemingly opposite approaches may actually share common mechanisms of action, the study also lends credence to a widely held intuition in the field, namely that therapeutic success is partly dependent on contextual elements, including the temperament and personality structures of both therapist and patient, and various cultural factors still awaiting specification in systematic research. The authors rightly conclude that psychotherapy education needs to become less centered on the inculcation of specific technical ideologies, more focused on the underlying principles of psychic change.

Conventionally, we think of scientific evidence as supporting or contradicting a particular treatment model. For example, psychoanalysts such as myself might well feel that Lane et al. are showing us how the psychoanalytic paradigm might be confirmed (or not) by evidence from brain science. Practitioners working in the other modalities may have similar feelings. But I think it would also be useful for us to think beyond the immediate need for methodological validation and bureaucratic credibility.

To illustrate this point, I would like to introduce a speculative hypothesis: that the role of unconscious cultural factors in shaping modern psychotherapy (and also psychotherapy research) constitutes a significant blind spot in the theory and practice of the mental health field. I would suggest that any confidence we may derive from neuroscientific evidence is vitiated by the possibility that what is really being confirmed is not an objective scientific method of psychological treatment (if such a thing exists), but rather the influence on our thinking of an underlying cultural narrative. Could it be, for example, that certain aspects of Freud’s early groundbreaking work on childhood trauma, and all the various forms of psychotherapy that have ensued, including and especially psychoanalysis itself, are scientifically alloyed secular variants of the Judeo-Christian paradigm (see Kirschner 1996) of life as a fall from grace, a struggle to make sense of the consequent suffering, and a hoped-for redemption through personal reintegration—what the poet Wordsworth (1965, p. 460) described in secular terms as “emotion recollected in tranquility”?

The striking alignment between Lane et al. and Freud’s initial hypotheses is interesting to consider in its own right. Is this apparent match a scientific confirmation of Freud’s early speculations? Or is it some sort of coincidence that we should investigate further?

It needs to be remembered that Freud’s early theories about treatment presupposed a simplified clinical situation in which discrete, locatable events can be singled out for what we now are

calling “memory reconsolidation” and “corrective emotional experience.” Freud struggled throughout his long career to keep this relatively straightforward, objectivistic, and operationally manageable picture of treatment intact; so has the rest of the profession. But as Freud and others continued to explore the new territory of psychotherapy, this kind of thinking gave way to the pressure of more complicated and intractable forms of mental suffering whose etiology could not be traced so confidently. In this later work, Freud and later analysts postulated that the clinician is often disarmed of established techniques and needs to remain open to the irruption during treatment of bizarre and unexpected sources of emotional disturbance and/or to focus intensively with the patient on minute qualities of their emotional interaction in the therapeutic process. I suspect it will be quite some time before the scientific community will figure out how to evaluate these more intricate aspects of the psychotherapeutic situation.

I am inspired in all my work by recent scientific research into psychotherapy outcomes, the discovery of neuroplasticity, and also the fascinating developments in neonatology and developmental psychology since 1975. But this exciting new science never gives me the impression that what I am doing with my patients is “evidence based” in some glorified scientific sense. I hope that my colleagues who have been trained in the delivery of other treatment modalities share this skepticism about the “objective” truth of what they are delivering to their patients. Few things are more dangerous in the field of direct health care than dogmatic self-certitude on the part of the practitioner.

The potential for cultural over-determination of hypotheses and results, acting at many levels in the mental health field—socially, politically, institutionally, and individually (constituting a generalized pressure to conform to a certain narrative or ideological model, for whatever reason)—should become a more recognized consideration of our research agenda, even though it might resist the logic of evidence-based treatment by introducing questions whose exploration is more difficult to operationalize in terms of brain science or quantitative research alone. To address the possibility of a cultural blind spot in mental health research, we would also have to contend with the possibility that the “normal science” of the post-Freudian theory of mind—and psychotherapy has a tendency to reproduce the same basic answers, with predictable variations, to the same standard questions. That such a possibility emerges implicitly through the integrative approach of the target article is one of this paper’s many intriguing features.

## Memory reconsolidation and psychotherapeutic process

doi:10.1017/S0140525X14000363, e12

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**Abstract:** Lane et al. propose a heuristic model in which distinct, and seemingly irreconcilable, therapies can coexist. Authors postulate that memory reconsolidation is a key common neurobiological process mediating the therapeutic effects. This conceptualization raises a set of important questions regarding neuroscience and translational aspects of fear memory reconsolidation. We discuss the implications of the target article’s memory reconsolidation model in the development of more effective interventions, and in the identification of less effective, or potentially harmful approaches, as well as concepts of contextualization, optimal arousal, and combined therapy

I am not at all in disagreement with you, not at all inclined to leave the psychology hanging in the air without an organic basis. But apart from this I do not know how to go on.

–Freud letters to Fliess in September of 1898 (Masson 1985)

Are we better equipped today to anchor psychological processes in a biological foundation than Freud was in 1898? The manuscript of Lane et al. speaks to the core of these questions: Do advances in neuroscience offer us tools and knowledge to explore the biology of psychological concepts, and how does “psychotherapy ultimately use biological mechanisms to treat mental illness” (Ledoux 2002, p. 299)? In their target article, Lane et al. propose a heuristic, integrated model with an overarching conceptual structure in which effects of seemingly distinct and presumably irreconcilable therapies can be understood and reconciled within their proposed framework, without over- or undervaluing any particular approach. Based on the suggested model, both episodic and semantic memories and the associated implicit and explicit emotional experiences are seen as components of a single integrated memory network that is stable but also plastic under certain conditions. Activation of a node in this network (accessed via different therapeutic approaches) triggers all other nodes, making the system malleable to therapeutic change. Thus, the pathological memory “system” can be accessed and modified through its different features.

One important and unique aspect of the proposed model is the anchoring of the psychotherapeutic process in the current understanding of cognitive and affective neuroscience (see Freud’s lamentation above). The manuscript places recent work on memory reconsolidation as a central, key process in psychotherapeutic change. Memory reconsolidation has indeed been both a promising and controversial concept in the context of psychotherapy. Although it offers a plausible candidate mechanism for the process of therapeutic “change” in old memories and percepts, it was described primarily in animal models and in relationship to relatively simple memory traces of fear conditioning. More complex memory systems in humans might work differently. Does memory plasticity and reconsolidation extend to complex traumatic memories with emotional and autobiographical elements that are repeatedly reinforced through time? Also, animal lesion studies suggest that overtrained or highly aversive memories survive hippocampal inactivation (Garin-Aguilar et al. 2014; Markowitsch et al. 1985), demonstrating resistance to modification and independence from the hippocampal memory system, a key system in proposed reconsolidation. Are repeatedly reinforced, traumatic memories in humans more like overtrained rodent memories, and therefore not subject to reconsolidation?

Alternatively, is it possible to explain effects of therapy by a process of contextualization rather than reconsolidation of memory (Liberzon & Sripada 2008; Maren et al. 2013)? Contextualization is conceptualized here as a process that updates old memories by adding novel contextual elements to them, and it does not require bringing the old memory into a state of instability that allows it to be altered before being reconsolidated. Another question that arises about extension of reconsolidation research to psychopathology is that reconsolidation is performed days to weeks after learning. Human “pathological” memories can be present or even repeated similarly, and consolidated over many years. The question here is: How long is too long a lapse between the event and the reconsolidation for reconsolidation to happen? Addressing these questions and better defining the real boundaries of reconsolidation processes in the context of psychotherapy will further enhance the utility of the proposed model.

Are there clinical implications for Lane et al.’s conceptualization? Is it at all fundamentally different from stating that every therapy could be effective? True understanding of the mechanisms involved in therapeutic change should be able to help in developing more effective interventions, as well as predicting what will not be effective, or what could even potentially be harmful. From this perspective, the proposed model indeed suggests that combining therapeutic techniques from different modalities might be more effective than adhering to a single orthodoxy. Similarly, it predicts that some approaches might not be useful or could even be counterproductive if they recapture but do not modify traumatic or negative experiences. For example, it

emphasizes the importance of an empathic and supportive therapist in helping patients modify and update trauma or fear memories, as opposed to a “blank screen” approach that might recapitulate prior experience of an unempathic caregiver. Similarly, it suggests that in trauma-processing groups, repeated retelling of trauma memories, without correction of cognitive distortions or reflection on authentic emotions, might lead to further consolidation of fear memories rather than their modification through reconsolidation. Finally, in behavioral therapy, in vivo exposure conducted without establishment of a safe environment and perceptions of self-efficacy might lead to a higher than optimal level of arousal, preventing reconsolidation and reinforcing avoidance.

Lane et al.’s model raises additional questions in the clinical context. It suggests, for example, that the integrated memory structure can be approached through each of its nodes. If that is indeed the case, how does it explain the differential efficacy of therapeutic approaches? For instance, cognitive and interpersonal therapies have been particularly effective in treatment of depression, whereas behavioral (exposure) therapy is most effective for treatment of phobias or anxiety. Psychodynamic principles are used in treatments of personality disorders but there is no evidence for their effectiveness in treatment of obsessive-compulsive disorder. It is also argued that there is an optimal level or “window” of emotional arousal for psychotherapy to work. However this observation is based on correlational and not causal data. It is plausible for example that patients who respond better to treatment may be able to better tolerate their emotions and higher arousal. Empirical research that manipulates arousal level during memory reconsolidation will have to address the question of optimal arousal level. If indeed excessive arousal can impair treatment efficacy, the establishment of “optimal arousal” levels could guide more sophisticated use of combined psychotherapy and pharmacotherapy. Here, excessive levels of arousal can be reduced to “optimal” levels with the judicious use of anxiolytics. The same medications may impair reconsolidation of memories, however, further underscoring the urgent need to advance accurate understanding of the specific mechanisms involved in therapeutic change. The target article offers an important conceptual step indeed in the ongoing process of discovery.

## Reconsolidation or re-association?

doi:10.1017/S0140525X14000211, e13

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**Abstract:** The target article argues memory reconsolidation demonstrates how therapeutic change occurs, grounding psychotherapy in brain science. However, consolidation has become an ambiguous term, a disadvantage applying also to its derivative—reconsolidation. The concept of re-association (involving active association between memories during rapid eye movement [REM] dreams followed by indexation and network junction instantiation during non-rapid eye movement [NREM] periods) brings greater specificity and explanatory power to the possible brain correlates of therapeutic change.

Reconsolidation and consolidation have various connotations (Llewellyn 2013b): (re)stabilization; (re)strengthening; (re)storage; and (re)resistance to interference. Although consolidation originally implied progressive stabilization (Müller & Pilzecker 1900), dynamic memory reorganization is now also subsumed under (re)consolidation. Indeed, Stickgold and Walker (2005) suggest consolidation and reconsolidation probably reflect memory organization and reorganization. (Re)consolidation also confounds two distinct neurobiological levels: first, synaptic,

through Hebbian plasticity (Hebb 1949) and long-term potentiation (Bliss & Collingridge 1993); and second, system, to integrate recent memories with remote ones (Dudai 2004; Frankland & Bontempi 2005; Tamminen et al. 2010). Given this ambiguity, (re)consolidation may obscure rather than enhance understanding.

Long-term episodic memories are represented in cortical networks (Fuster 1997; 1999; 2006; 2009). If therapeutic change impacts on long-term memory, then memory networks must be modified in some way. The exploration of a remote disturbing memory during therapy creates a new memory that, we hope, acquires some positive connotations. The reconsolidation concept implies plasticity and synaptic weight changes (the first level referred to above), through new more positive associations *within* the old disturbing memory network pathway. But reconsolidation leaves the second, system integration level, an open question: How is this recent memory of exploring the old traumatic memory within therapy integrated with other memories, resulting in associations *between* different memory networks.

Integration and segregation are fundamental to cortical network organization (Tononi et al. 1994; Zeki 1978; Zeki & Shipp 1988). Networks intersect abundantly; some intersections are omnidirectional junctions (Fuster 1997; 1999). Neurons at an omnidirectional junction collectively define the meaning or significance of the several memory pathways that meet there (Buzsáki 2005). Consequently, therapeutic change may involve: first, introducing some positive associations into the memory pathway and, second, integrating this memory to others with positive connotations at a new omnidirectional junction that defines their shared meaning. Indeed, the latter may rely on the former.

Re-association, through new junction instantiation, would involve dynamic modification to the cortical network connectivity matrix. Memory representation most likely uses structural plasticity (or re-wiring) alongside the better recognized, synaptic weight changes (Chklovskii et al. 2004; Sporns et al. 2004). Re-wiring implies memory network reorganization—the latter is known to occur during sleep, enabling flexible generalization from several memories (Ellenbogen et al. 2007; Wagner et al. 2004), congruent with making associations between different memory networks.

During slow wave sleep, effective corticocortical connectivity breaks down (Massimini et al. 2005; Spormaker et al. 2010), reducing cortical integration (Esser et al. 2009) and, possibly, reflecting some network reorganization to enable new integrative memory associations in later sleep stages. In the REM-rich second half of the night, hippocampal associational function may identify the collective significance of several memories, portraying this meaning as an associative REM dream image, and enabling a new integrative omnidirectional junction to be instantiated in cortical networks at a subsequent NREM Stage 2 period (Llewellyn 2013a).

These processes may serve both emotional memory encoding (the identification of meaningful associations) and retrieval (the same associations trigger the memory) (cf. Tulving & Thomson 1973). Indeed, in accordance with the indexing theory of hippocampal function (Hirsh 1974; Teyler & DiScenna 1986; Teyler & Rudy 2007), REM dream scenes may be retained as unconscious hippocampal indices that match the omnidirectional junctions where several cortical network memories meet and can be found (Llewellyn 2013a). Physiologically, the temporal coincidence of hippocampal sharp wave-ripples with neocortical spindles signals network integration (Tamminen et al. 2010) and may reflect indexation and NREM junction instantiation respectively.

The configuration of conscious, segregated episodic memory pathways whose collective meaning is represented at integrative, unconscious omnidirectional junctions may resonate with conscious and unconscious memory. As discussed in the target article, the unconscious has an adaptive, evaluative, processing function (Gazzaniga 1998), congruent with identifying the meaning of several associated memories. Contemporarily, “meaning” has abstract definition, the expression of an idea in

language but, as pointed out in the target article, “meaning” can imply concrete, personal significance. REM dreams may identify the collective significance of several associated memories for the needs, desires, or goals of the dreamer, having either broadly positive (if congruent with needs, etc.) or negative (if not) emotional impact. Emotional arousal in REM dreams would result from revealing the significance of related experiences for needs and so forth, and it may explain why emotional arousal signals successful therapy.

If an old, disturbing memory is highly traumatic, especially if perceived as life threatening at the time, it may be too negative to be associated with other memories in a REM dream. Normally REM dreams portray elements of several memories (Fosse et al. 2003; Hartmann 1996; Hobson 1988, pp. 36–38; Walker & Stickgold 2010), consistent with an associational function. When a memory is replayed in entirety in nightmares, as observed in post-traumatic stress disorder (PTSD; Nielsen & Stenstrom 2005) this may reflect a failure of association, resulting in a lack of integration with other memories at an omnidirectional junction. The memory would be retained in the cortex but not fully incorporated—as an assimilated life experience—in the integrative network. Therapy that introduces some positive associations into the old memory may be successful in enabling later association with others in a REM dream.

Re-association offers a more nuanced and dynamic account of the neural substrates of psychotherapy than the over-stretched reconsolidation concept does. If life experience has failed but therapy succeeds in introducing more positive associations into a traumatic memory, two more stages may integrate this memory into cortical networks. First, this new recent memory is actively and consciously associated with other more remote memories in a REM dream scene. Second, this REM dream scene is retained as an unconscious hippocampal index and instantiated during NREM as a new unconscious omnidirectional junction in episodic cortical networks. This two-stage process shows how re-association involves indexation and instantiation also. It also explains how unconscious memory influences thought and action because unconscious associations are processed on episodic memory retrieval after matching between hippocampal indices and omnidirectional cortical junctions.

On this account, “the unconscious” is not localized but dispersed throughout the cortex at omnidirectional junctions, which, after the association of several episodic memories in REM dreams, represent their collective meaning. Free association to the dream may uncover these memories and their shared significance. Freud (1899/1999) famously declared, “The interpretation of dreams is the royal road to a knowledge of the unconscious activities of the mind.” On this version of relevant neural events, retained dreams are the unconscious, so he has to be right!

## The relevance of maintaining and worsening processes in psychopathology

doi:10.1017/S0140525X14000375, e14

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**Abstract:** The states called “psychopathology” are very diverse, but Lane et al.’s single-process explanation does little to account for this diversity. Moreover, some other crucial phenomena of psychopathology do not fit this theory: the role of negative evaluations of conscious emotions, and the role of emotions without physiological correlates. And it does not consider the processes maintaining disorders.

The target article proposes a unifying theory of psychopathology based on two hypotheses, one concerning the genesis of psychological disorders and the other concerning the psychotherapeutic process leading to change. We focus on the first hypothesis: Psychopathology depends on poor processing of emotions related to traumatic experiences. Four crucial phenomena do not fit this single-process explanation. First, the states called “psychopathology” are very diverse, but Lane et al.’s theory does little to account for this diversity. Indeed, how can a common cause yield a diversity of psychological illnesses? For example, if all psychopathologies are ascribable to the same sequence – trauma → no mentalization of the concomitant emotion → psychopathology – how can different psychological disorders occur? And why does one patient become borderline whereas another patient becomes agoraphobic?

Second, how does patients’ awareness of traumatic emotions contribute to psychopathological suffering? Many patients can be aware of traumatic emotions and even evaluate them negatively. This evaluation, not a lack of awareness, exacerbates their suffering. Anxious patients, for example, evaluate their fear as a proof of their weakness. Patients are depressed, for example, not only because they judge their retirement as a sign of uselessness, but also because they consider their lack of interest and energy as a further evidence of uselessness. Such ruminations about depressive symptoms are a key risk factor in clinical depression (Nolen-Hoeksema 1991; 2000). Patients are often disturbed about their disturbances (Ellis 1980) and unintentionally give themselves two problems for the price of one (Clark & Beck 2010; Dryden 2000).

Third, how does psychopathology arise from explicit components of emotions? In some cases, an awareness of an emotion and the safety-seeking behaviors that are elicited, such as avoidance of the feared object, can occur without any physiological correlates of the emotion itself (Mauss et al. 2003). This lack of correspondence between subjective reports of anxiety and physiological arousal in anxious patients is supported in a number of studies, showing a dissociation between state anxiety and physiological arousal (heart rate, blood pressure, noradrenaline, cortisol response), with the former being stronger compared with the latter (Alpers et al. 2003; Van Duinen et al. 2010).

Fourth, the theory in the target article fails to account for the persistence of psychological disorders. It does not consider research suggesting the existence of two classes of processes that maintain and worsen psychological disorders: those linked to cognitive processes (e.g., Harvey et al. 2004) and those linked to interpersonal ones (e.g., Alden & Taylor 2004). Regarding cognitive processes, together with Johnson-Laird we have argued that psychological illnesses arise from pathological emotions, and different emotions lead to characteristic pathologies. Cognitive processes, such as reasoning, strive to reduce the impairments giving rise to the hyper emotions, but they often serve to maintain or exacerbate the illness (Johnson-Laird et al. 2006). A hypochondriac patient, for example, focuses on a danger, such as a bodily feeling, which leads to an unconscious transition to a great anxiety that he or she is seriously ill. The anxiety drives cognitive processes in a prudential way: The patient is more likely than others to attend to information related to the illness (see Owens et al. 2004), to identify harmless physical sensations as signs of serious illness (see Haenen et al. 1997), and to be biased toward confirming its occurrence (see de Jong et al. 1998; Gilbert 1998). The processes aimed at preventing harm have the opposite effect. They strengthen patients’ beliefs that they are ill and help to maintain or increase the hypochondria. Likewise, patients suffering from anxiety, OCD, or depression use their emotions as a source of evaluations. If they feel anxious about something, they overestimate the danger (Arntz et al. 1995). This mechanism is common to those with a tendency to obsessive compulsions (Davey et al. 2003; Gangemi et al. 2007), and those suffering from depression (Kaney et al. 1997). This process too implies vicious circles that strengthen

negative emotions, appraisal, and beliefs that cause these psychological disorders.

For the interpersonal processes, several studies have demonstrated that anxious people behave in ways that lead to negative reactions from other people, thus establishing dysfunctional interpersonal cycles between themselves and others (Clark 2001). These interpersonal cycles could be responsible for the maintenance of the disorders. For example, people with social anxiety and with social phobia display distinctive and less-functional social behavior (i.e., anger, criticism, dependency) than people without those conditions (Alden & Taylor 2004). They also fail to reciprocate others' self-disclosures, a strategy that led others to perceive targets as dissimilar and uninterested in them, factors that weigh heavily in relationship formation (Alden & Bieling 1998; Papsdorf & Alden 1998). Depression is also associated with negative social responses (Alden et al. 1995). Segrin (2001) found for example, a relationship between social skills deficits and interpersonal connections as maintaining factors of depression.

In sum, the sequence of events following traumas, including inadequate emotional reactions, may lead to certain psychological illnesses. But, other factors matter too. They include the nature of the emotions themselves, which tend to characterize different illnesses; the subjective experience of emotions, which, even in the absence of physiological reactions, can contribute to illnesses; the differences in how individuals react to emotions; the interplay between their emotions and cognitions; and interpersonal processes in maintaining illnesses.

#### ACKNOWLEDGMENT

We would like to thank Philip N. Johnson-Laird for valuable comments and suggestions on an earlier draft of this manuscript.

## Social-psychological evidence for the effective updating of implicit attitudes<sup>1</sup>

doi:10.1017/S0140525X14000223, e15

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**Abstract:** Recent findings in social psychology show how implicit affective responses can be changed, leading to strong, fast, and durable updating. This work demonstrates that new information viewed as diagnostic or which prompts reinterpretations of previous learning produces fast revision, suggesting two factors that might be leveraged in clinical settings. Reconsolidation provides a plausible route for making such reasoning possible.

Lane et al. contend that past trauma gives rise to maladaptive or inappropriate emotional responses that become incorporated into semantic structures that are inappropriately overapplied to future situations. The authors argue that therapy is most effective when it can *alter* the memory structures responsible for these responses in order to give rise to more positive emotional experiences and outcomes.

Recent research in social cognition on the antecedents of implicit attitude revision can inform the central question of when implicit affective change may be possible in clinical settings. Traditionally, implicit attitudes have been assumed to consist of associative mental processes that operate irrespective of the perceived truth or endorsement of the attitude (Rydell & McConnell 2006; Rydell et al. 2006; 2007; Sloman 1996; Strack & Deutsch 2004; cf. Ferguson et al. 2014). They have been assumed to be relatively difficult to update, especially through the negation of past learning (Deutsch et al. 2006; Gawronski et al., 2008; see also

Gawronski & Bodenhausen 2006; 2011). Revision of implicit responses seems to occur mostly only after extensive retraining (e.g., Kawakami et al. 2000), and these new attitudes are assumed to not replace the initial attitude but rather coexist with it, allowing the original response to resurface (e.g., Gawronski et al. 2010; Petty et al. 2006; see Bouton 1994; Gawronski & Cesario 2013). Given that implicit attitudes uniquely predict many everyday behavioral responses (Cameron et al. 2012; Galdi et al. 2008; Greenwald et al. 2009; McNulty et al. 2013; Perugini et al. 2010; Towles-Schwen & Fazio 2006; cf. Oswald et al. 2013), and potentially play a role in dysfunctional interpersonal relationships (see McNulty et al. 2013; Towles-Schwen & Fazio 2006), this traditional view of implicit attitudes suggests that the clinician's role in updating maladaptive implicit affective memories seems necessary but challenging.

In contrast to this view, our recent work suggests that implicit attitudes can indeed be updated in some circumstances in a way that results in strong, fast, and durable revision. These circumstances include the importance of the perceived *diagnosticity* of the new information (Cone & Ferguson 2015; in preparation), as well as the extent to which this new information successfully *recasts* old information, leading participants to reinterpret its meaning (Mann & Ferguson, in press). In one line of work, the extent to which participants were able to successfully incorporate new information about a person toward whom they had previously held a well-established implicit attitude, depended on how diagnostic participants believed that new information to be in terms of the "true nature" of the person (Cone & Ferguson 2015). Even after forming an initial implicit attitude toward the person by learning about 100 of the person's behaviors, participants were able to completely reverse their implicit impression of the person after learning about a single, counterattitudinal behavior that was judged as highly diagnostic of the person's true character. In other work, participants learned new information that the character of two social groups (whether each was "good" or "evil") over time switched from what they had learned previously. Their implicit attitudes toward these groups were fully revised only when participants believed that social groups more generally are capable of changing in this way (Cone & Ferguson, in preparation). These two lines of work point to the crucial role of participants' *beliefs* about the reliability of the updated information. As extrapolated to the therapeutic context, changing patients' implicit responses may depend on how much they believe the therapist is telling them something that seems true, and predictive of what will likely happen in the future.

In another program of work, we have shown that implicit attitudes can be durably reversed when participants are given information that helps them *reinterpret* past information (Mann & Ferguson, in press). After learning about someone who enacted many negative acts, participants learn about a single new behavior that either explains and recasts the initial acts as in fact being positive, or does not. When given an explanation for all the initial negative behavior, participants were able to readily update their implicit impression of that person, moving from a strongly negative to a strongly positive implicit reaction to the person. Importantly, we found evidence that this effect was driven by an active (effortful) reappraisal of past learning, and was limited to new information that *explained* past behavior rather than simply added to it. This updating also showed signs of being durable, as it emerged just as strongly three days later. These findings reveal the power of reinterpretation in implicit attitude change. We argue that a person's ability to put a negative behavior in a different explanatory framework may be a crucial ingredient in implicit updating.

Thus, emerging evidence in social cognition suggests that implicit attitudes (affective responses; Amodio & Devine 2006) can sometimes be quickly and durably altered, contrary to traditional views of these types of evaluations as being resistant to alteration. From a clinical perspective, our findings suggest that a patient must ultimately come to believe that new information or a

reinterpretation of old information provided by a therapist is diagnostic for future situations. Therapists can leverage such deliberative processes in order to successfully induce relatively rapid changes in the implicit responses that give rise to the trauma.

A point of convergence among Lane et al.'s thesis and our own work on implicit attitude revision is that we both consider the recollection of past learning to be an important factor in effective updating. This claim is suggestive that reconsolidation is a potentially important factor necessary for such updating to occur. However, this still remains to be tested for both therapeutic approaches (e.g., psychodynamic therapy), as well as implicit attitude revision.

In the meantime, emerging findings from social cognition are starting to align with the main tenet of Lane et al.'s integrative memory model: that maladaptive affective responses can in fact be truly changed, possibly through active reasoning about old and new information.

NOTE

1. Thomas C. Mann and Jeremy Cone contributed equally to the preparation of this commentary.

**Top-down versus bottom-up perspectives on clinically significant memory reconsolidation**

doi:10.1017/S0140525X14000235, e16

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**Abstract:** Lane et al. are right: Troublesome memories can be therapeutically recontextualized. Reconsolidation of negative/traumatic memories within the context of positive/prosocial affects can facilitate diverse psychotherapies. Although neural mechanisms remain poorly understood, we discuss how nonlinear dynamics of various positive affects, heavily controlled by primal subcortical networks, may be critical for optimal benefits.

Since the onset of psychotherapy with Freud's novel technique of psychoanalysis, proliferation of schools of psychotherapy – from 1 to more than 400 (Karasu 1986) – suggests that theoretical orientations are not critical to identify what makes for successful psychotherapy. An alternative is to specify universal neuropsychological elements that cut across all theoretical orientations. Lane et al. advance a top-down integrative solution for understanding memory reconsolidation psychotherapies, some of which are already manualized (e.g., Ecker et al. 2012). Reconsolidation, first discovered by preclinical investigators (from Lewis et al. 1968; Misanin et al. 1968; to Nadel et al. 2012; Nader et al. 2013; Schwabe et al. 2014) may explain how emotionally troubling memories are transformed by being retrieved and recontextualized in positive/supportive affective contexts. Accordingly, psychotherapies may also be facilitated by pharmacological facilitators – for example, glycine receptor partial agonists such as d-cycloserine and GLYX-13, which appear effective antidepressants that work by directly promoting positive social affects, as evaluated in preclinical models (Burgdorf et al. 2011).

We applaud the search for neurobiological underpinnings of psychotherapies that improve client care. However, we find the extensive use of “implicit emotions” in the target article to be problematic, (i) because it suggests affective experiences cannot be had without explicit syntactic reflections, properly called “awareness,” (ii) which would seemingly exclude other animals from being affectively vibrant creatures, a view not supported by cross-species data (Panksepp 1998), and (iii) as a result of the debatable quality of data summarized supporting unconscious

emotions, where many cited studies (e.g., Winkielman & Berridge 2004) may have missed experiential shifts because the most sensitive tools were not deployed (e.g., Shevrin et al. 2012).

Although top-down perspectives on emotional feelings are widespread among investigators of human emotions, bottom-up affective neuroscience perspectives highlight that rewarding and punishing circuits in animal brain, constituting affective experiences, arise from subcortical circuits (Panksepp & Biven 2012). Memory reconsolidation is surely critical for psychotherapeutic change, with affective reshaping of troubling memories being critical for all successful psychotherapies, from cognitive/behavioral to psychodynamic ones. Still, memory reconsolidation may be an outcome of successful treatment, rather than its sole driving cause. There is more to effective therapeutic engagements than just memory reconsolidation.

We also need to place memory reconsolidation that results from high positive affective arousal in evolutionary/developmental frameworks of attachment theory. This includes explicitly recognizing the negative affect of separation distress as aroused by PANIC circuitry in the brain (please note that capitalizations are our standard nomenclature for primary-process, subcortical affective systems; below we also include the best vernacular descriptor of the feeling each system promotes; please see Panksepp 1998). This also includes various interrelated subcortically concentrated positive emotions, especially SEEKING, CARE, and PLAY (Panksepp 1998; Panksepp & Biven 2012). All are critical for optimal therapeutic benefits (Marks-Tarlow 2012; 2014; Panksepp et al. 2014). Mere activation of the SEEKING circuit through deep brain stimulation (DBS) can alleviate depression (Schlaepfer et al. 2013). So can medicines, such as GLYX-13, which was discovered by analysis of PLAY networks (Burgdorf et al. 2011; fast-tracked by the FDA [http://www.news-medical.net/news/20140304/Naurexs-GLYX-13-receives-FDA-Fast-Track-designation.aspx]). Such unconditional benefits are attributable not just to reconsolidation, but also to shifts in the unconditional affective dynamics that redirect cognitive activities.

Cognitive processing is essential for conscious “awareness,” but primal affective experiences (qualia), inferred from rewarding and punishing brain states, do not require the neocortex (Merker 2007; Panksepp 1998; Solms & Panksepp 2012). Well-timed arousal of primal affective processes without reflective cognitive experiences (which Lane et al. would call “implicit”) may be essential for memory reconsolidation to proceed. This vision respects evolutionary levels of the mind, evident in the neuroanatomy and functions of basic emotional systems (e.g., those that survive neo-decortication in animal models). Affectively instigated memory reconsolidation may proceed by “Laws of Affect” yet to be neuroscientifically deciphered (Panksepp 2011). It is possible that troubling memories are transformed by subcortical neurochemistries that mediate primal positive affects, especially of SEEKING, CARE, and PLAY (see Panksepp & Biven 2012). Without such perspectives, namely compelling bottom-up affective neuroevolutionary views, the “neuro-psycho-mechanics” of successful psychotherapy may never be understood. Therapeutic reconsolidation, at its best, may reflect the psychodynamic induction of affectively positive “attractor landscapes” during the recall of miserable memories, yielding new ways of being that can yield lasting changes in character structure.

A comprehensive understanding of memory reconsolidation may also require conceptual frameworks of dynamic systems theory. Rather than functioning as linear processes that move from past to present to future, memory reconsolidation may represent a nonlinear neurodynamic where experiences of past, present, and future, evolutionary and existential, promote new psychic coherences (Marks-Tarlow 2008).

From bottom-up perspectives, perhaps reconsolidating therapeutic transitions reflect positive primal (unreflectively experienced) affective systems being aroused, such that they recontextualize troubling cognitive perspectives, with ancient regions of the mind controlling how more recent ones think

(Panksepp & Biven 2012). Amplifying Lane et al.'s position, we propose that skilled therapists are adept at promoting affectively positive attractor landscapes in the midst of emotionally troubling therapeutic cognitive conversations, softening painful edges of memories, yielding new cognitive perspectives.

Emotional arousals evoked by therapeutic interactions often push therapist/patient dyads far from equilibrium, into negative, trauma-ridden, affective spaces that need repair. Therapists who explicitly wish to promote reconsolidation may need to skillfully coax primal affective tone toward more positive, reparative brain-mind dynamics. In therapeutic exchanges, skilled clinicians must intuitively navigate, like sailboats in brisk winds, with raw affective energies (subcortically mediated) recontextualizing associated cortico-cognitive information through temporarily open affective boundaries. Here, far from equilibrium, at the edge of chaos, positive affective arousals can soften troubling cognitive complexities in highly beneficial ways. But that can happen only if the right subcortical affective gusts can be evoked—the ones that promote reconsolidation processes to change past negativistic perspectives through bottom-up “Laws of Affect” barely understood (Panksepp 2004; 2011). The remarkable positive affective power of PLAY (Marks-Tarlow 2015; in press; Panksepp 2008), which remains poorly conceptualized in most psychotherapies, may provide, with due sensitivity, clinical climates to promote successful treatments.

Therefore, we share cautionary notes about treating memory reconsolidation too reductively or mechanistically, before we understand the extensive experiential nature of raw affects, which clearly have many subcortical loci of control, in the neuro-mental economy, a neuroscientific project that has barely gotten off the ground. This said, we both enthusiastically agree that reconsolidation is a major breakthrough toward our future understanding of how clinically beneficial memorial/psychotherapeutic dynamics emerge within the brain (Nadel et al. 2012; Nader et al. 2013; Schwabe et al. 2014).

## Trade-offs between the accuracy and integrity of autobiographical narrative in memory reconsolidation

doi:10.1017/S0140525X14000247, e17

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**Abstract:** Lane et al. propose an integrative model for the reconsolidation of traces in their timely and impressive article. This commentary draws attention to trade-offs between accuracy and self-narrative integrity in the model. The trade-offs concern the sense of agency in memory and its role in both implicit and explicit memory reconsolidation, rather than balances concerning degrees of emotional arousal.

Recent findings on the relation between memory storage and retrieval provide empirical support to the reconsolidation hypothesis Lane et al. defend. The integrative memory model they propose seems to be the best way to accommodate a vast amount of data, including findings on how emotion shapes and informs cognition in memory storage and retrieval (e.g., LeDoux 1996). According to that integrative model, when a memory is retrieved there is a critical process of reconsolidation, which presents the opportunity to amend or even disrupt the memory's content at retrieval, based on contextual information and emotional feedback (Nadel et al. 2000). Lane et al. review this body of evidence with rigor and clarity, so I shall not elaborate on the experimental merits of their proposal. Rather, I shall highlight some theoretical difficulties that lie ahead for their reconsolidation hypothesis, and suggest one way to address them.

The theoretical problems I would like to raise concern the nature of reconsolidation as a process that affords access to information about events in the past. The interactive components that Lane et al. propose create three trade-offs concerning the balance between the epistemic value of a memory trace (i.e., the accuracy of the information that makes knowledge about the past possible) and its narrative value (i.e., the contextual coherence of the information in an overall self-narrative and what it evokes in the subject). It is not entirely clear how the integrative model achieves this balance.

Striking this balance is crucial for the process of reconsolidation. As Lane et al. argue, reconsolidation may alter the original emotional aspects of memories and also recontextualize or modify their content. Ideally, however, epistemic information contained in episodic memories, or the accurate information that leads to knowledge of past events, should be preserved across reconsolidations. Episodic memories seem to require a format for storage and retrieval that frames information metrically, according to temporal tags that depend on time-keeping mechanisms (Gallistel & King 2009; Montemayor 2013). Lane et al.'s integrative memory model is interactive and proposes that reconsolidation modifies memory traces; their model creates the theoretical problem that it is not clear how this metric information is guaranteed to be systematically preserved, as will be elucidated below.

First, there is a trade-off between the *rigidly* itemized storage and retrieval of event-traces and the *flexibly* reconstructive reproduction of traces. Emotional and social aspects of a trace may modify how the trace is stored and contextually interpreted, thereby changing or even eliminating epistemic features of the trace. Reconsolidation must neither modify the trace to a degree that it loses its epistemic characteristics nor preserve it in a rigid way, such that it cannot be interpreted in different forms.

Second, there is a trade-off between the quality of access to traces and their semantic or episodic detail. Remembering events in excruciating detail is one extreme of the spectrum of semantic and episodic accuracy, and remembering events in the most abstract and ambiguous way is at the other. Evidence shows that the brain normally strikes a balance between these extremes (Quiroga 2012).

If traces are very malleable, however, it is difficult to guarantee that enough accurate detail will be preserved in reconsolidation. So-called reality monitoring requires that memory traces retain an adequate amount of detail for the identification of the causal origin of such traces (see Johnson 1991). When the emotional response components of the integrative model interact too much with episodic information or with semantic structures, that can jeopardize the retention of information required for reality monitoring. Another related difficulty is the existence of evidence suggesting that the emotional malleability of semantic information may render the memory system epistemically inadequate, leading to systematic confabulation (Loftus 2005). Without suggesting that the integrative memory model suffers from problems concerning confabulation, it is clear that a balance between malleability and accuracy is needed. More information is required in order to determine fully how such a model may achieve this balance.

Lane et al. are right, however, in claiming that accuracy cannot be the sole purpose of the memory system. The evocative power of a set of memories cannot be captured by their accuracy, temporal order, or causal origin *alone*. How, then, should we understand such evocative power in terms of information processing? Stored memories are a “pile” of traces and for them to become evocative, autobiographical narrative must be infused into the information they contain. Such infusion, however, could be elicited in many ways, including modifications in perspective from the first to the third person point of view (Rice & Rubin 2009).

A third trade-off is that the more one stays within a structure that is ordered linear-metrically, the less accurate the description of the stream of consciousness *as one experiences* it from different vantage points will be, and the more one departs from a linear narrative, the higher the risks of confabulation. Findings suggest that

social interactions may help stabilize the malleability of traces (Wegner 1986), but the exact role of social interactions for the integrative memory model is unclear.

These three trade-offs are crucial to clarify the distinction between implicit (or unconscious) and explicit (or conscious) memory reconsolidation, which features centrally in the integrative model. Could it be that the implicit system has different rules for balancing these trade-offs? Presumably, the explicit system plays a major role in autobiographical memory, but the implicit system, as Lane et al. explain, is evolutionarily more primitive and is frequently involved in reconsolidation. Evidence on the sense of agency in reconsolidation may help clarify how the integrative model balances the tradeoffs and complexities of memory, both implicit and explicit. If the implicit system obeys different rules for reconsolidation, detailed evolutionary explanations of the older emotional-organismic system and its relation to conscious autobiographic memory – which probably evolved recently – could be helpful in clarifying this aspect of the integrative model (see Cosmides & Tooby 2013 for the adaptive value of the implicit memory system).

## Emotion regulation as a main mechanism of change in psychotherapy

doi:10.1017/S0140525X14000259, e18

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**Abstract:** A model that suggests reconsolidation of traumatic memories as a mechanism of change in therapy is important, but problematic to generalize to disorders other than post-traumatic and acute-stress disorder. We suggest that a more plausible mechanism of change in psychotherapy is acquisition of adaptive emotion regulation strategies.

Lane et al. suggest that a core element in therapeutic change (the reduction in clinical symptoms after psychotherapy) is reconsolidation of traumatic memories. This supposedly occurs through the activation of autobiographical memories, associated emotional responses, and semantic structures. Lane et al. suggest that this mechanism underlies the therapeutic change in a variety of treatments, including behavioral therapy, cognitive behavioral therapy (CBT), emotion-focused therapy, and psychodynamic therapy. We agree that this account may be plausible for post-traumatic stress disorder and acute stress disorder, which result from specific stressful events. Hence, in these disorders, activation and reconsolidation of traumatic memories may constitute a core psychotherapeutic change mechanism. However, Lane et al. have made a far broader suggestion for psychotherapy in general, in which “change occurs by activating old memories and their associated emotions, and introducing new emotional experiences in therapy enabling new emotional elements to be incorporated into that memory trace via reconsolidation” (sect. 1, para. 7). This suggestion consists of an underlying assumption that the etiology of psychiatric disorders in general relates to identifiable traumatic events that can undergo reconsolidation. This assumption is unsupported. Examine, for example, specific phobia, which can be considered a prototype of fear conditioning. Most patients do not recall any memories of direct, vicarious, or

informational learning (Ollendick et al. 2002). Thus, autobiographical memories of the onset of specific phobia are the exception rather than the rule.

One of the principles of CBT, which is considered a first-line treatment for various disorders (Hofmann et al. 2012; Tolin 2010; Vocks et al. 2010), is focusing on the present. Moreover, effective emotion regulation strategies such as labeling (an integral part of self-monitoring) and reappraisal (often termed cognitive restructuring) constitute main ingredients of CBT treatment (Arch & Craske 2009). Lane et al. suggest that change during CBT occurs through exploring recent events and their outcomes and “to the extent that these experiences share common characteristics with the original memories, they will also be subject to reconsolidation” (sect. 9.2, para. 3). However, reconsolidation necessitates a highly specific reminder stimulus activating the memory of the original fear response (Quirk & Milad 2010; Schiller et al. 2009). Nevertheless, if such a memory does not exist or is inaccessible, the suggestion is problematic that a core element in therapeutic change is reconsolidation and modification of memories. It is well established that schemas (or semantic structures), through which an individual understands and interprets the world, evolve as a result of life experiences (Kellogg & Young 2006). However, this does not necessarily indicate that the therapeutic change occurs through activation and reconsolidation of autobiographic memories that formed the basis for the development of these schemas. Although we agree that activation of emotional arousal is essential for effective treatment, we disagree with the proposition that this should occur through the activation and modification of traumatic memories.

We suggest that acquisition of adaptive emotion regulation strategies, rather than memory reconsolidation, may be a transdiagnostic core process underlying all approaches described in Lane et al.’s paper. Emotion regulation is defined as “the processes by which individuals influence which emotions they have, when they have them and how they experience and express them” (Gross 1998b). Various psychopathologies are strongly associated with deficits in emotion regulation, including depression, anxiety disorders, bipolar disorder, borderline personality disorder, substance abuse, and eating disorders (Aldao et al. 2010; Amstadter 2008; Carpenter & Trull 2013; Kring & Werner 2004).

Evidence in recent years suggests that emotion regulation has an important role in the process of change and outcomes in therapy in various disorders and psychotherapy modalities (Azizi et al. 2010; Baer 2003; Berking et al. 2008; Geller & Srikameswaran 2014; Mennin 2004; Whelton 2004). Understanding the role of emotion regulation in psychopathology and psychotherapy led to the suggestion that treatment in emotional disorders should include three fundamental factors: training in reappraisal, prevention of emotional avoidance, and changing action tendencies that are related to the maladaptive emotional reactions (Barlow et al. 2004). This suggestion is in line with the transdiagnostic treatment approach, which highlights the common factor in emotional disorders and uses unified protocols instead of developing different treatment protocols for each emotional disorder (Ellard et al. 2010). The transdiagnostic treatment includes emotion regulation components, such as cognitive reappraisal and emotion awareness training (Wilamowska et al. 2010). The unified protocol has demonstrated high effectiveness in various disorders including generalized anxiety, panic and agoraphobia, social anxiety and major depressive disorders (Ellard et al. 2010). Moreover, different psychotherapeutic approaches aim (either explicitly or implicitly) at enabling learning of emotion regulation skills (Whelton 2004). For example, there are various interventions that include mindfulness – an emotion regulation skill that enhances the awareness and experience of emotions (Chambers et al. 2009). Examples of two approaches that use mindfulness as a core component are dialectical-behavior therapy (DBT) and acceptance and commitment therapy (ACT). These approaches further emphasize other forms of emotion regulation. In DBT, learning emotion regulation skills (including mindfulness) is considered to be a main

mechanism of change during therapy, and patients learn how to be aware of their emotions and regulate them adaptively through individual, as well as group skills sessions (Lynch et al. 2006). ACT encourages patients to accept their emotional experiences instead of avoiding them as a means of regulating emotional intensity (Blackledge & Hayes 2001).

Taken together, the studies mentioned above demonstrate that learning to regulate emotions and to modify negative emotional experience can be construed as an alternative common mechanism of change during therapy. However, reconsolidation of memories may also be a complementary process to emotion regulation. In recent years, there has been growing evidence regarding successful outcomes in reducing clinical symptoms using imagery rescripting, which includes changing the meaning of traumatic events using imagery (e.g., Arntz et al. 2007; Cooper 2011; Frets et al. 2014). Imagery rescripting involves modification of traumatic memories, and also incorporates emotion regulation skills (e.g., mindfulness, training in positive interpretation bias; Holmes et al. 2007). Hence, memory reconsolidation may serve as a potential complementary process to enhancement of emotion regulation skills when traumatic memories are available.

## How do we remember traumatic events? Exploring the role of neuromodulation

doi:10.1017/S0140525X14000260, e19

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**Abstract:** The seemingly puzzling datum that behavior decreases after punishing stimulation while individuals are still able to remember traumatic episodes is discussed in relation to dopaminergic and noradrenergic neuromodulation. The described mechanisms may contribute to an understanding of how occurrences of learning reconsolidation yield different outcomes across intra- and extra-therapeutic settings.

Lane et al. propose a model that includes the role of learning reconsolidation in bringing about change in a psychotherapeutic setting. An important propaedeutic issue regards how we remember traumatic, aversive events in the first place. A question that has been discussed in the literature concerns the contradiction inherent in the observation that behavioral responses decrease after aversive events while individuals are still able to remember the punishing episode (e.g., Gaffan 1985; 2002). Such discrepancy may be resolved by considering that stimulus-response relations (e.g., the presentation of a tone evoking a lever press) and stimulus-stimulus relations (e.g., a lever press occurring when a tone and a light are presented together, but not when the tone and the light are presented by themselves [e.g., Kehoe 1988]) are supported by different areas (basal ganglia and the hippocampus, respectively) and these areas are dissimilarly influenced by neuromodulation. Specifically, neuromodulation in the basal ganglia is tightly controlled by dopamine, but not other neurotransmitters (e.g., noradrenaline) that respond differently – compared to the dopaminergic system – to salient environmental events. Although dopaminergic neuromodulation is enhanced by reinforcers and not by punishers (punishers lead to a decrease below baseline in dopaminergic responses innervating the basal ganglia; e.g., Schultz 2007), noradrenergic neuromodulation is enhanced by *both* reinforcing and punishing stimulation (Sara 2009).

In memory research, since episodes are typically characterized as unique configurations of stimuli, episodic memory can be considered one-trial learning of stimulus-stimulus relations (e.g., Ortu & Vaidya 2013). As mentioned earlier, the hippocampus is critically involved in selection of stimulus-stimulus relations and receives

concurrent neuromodulation by multiple neurotransmitter systems, including noradrenaline. Importantly, the fact that noradrenergic neuromodulation affects the hippocampus, and many other areas with the exception of the basal ganglia (Sara 2009), grants the relative independence of selection of stimulus-response relations from selection of stimulus-stimulus relations. Such arrangement allows reinforced motor behavior to be more likely to occur again in similar environments, whereas punished motor behavior is less likely to reoccur; at the same time, stimulus-stimulus relations are selected both after punishing and reinforcing stimulation, allowing episodic learning of events with both positive and negative valence. During ontogeny, the adaptive value of learning stimulus-stimulus relations correlated with punishment may be to allow unique configurations of stimuli to gain a specific stimulus function. For example, without the capability of learning stimulus-stimulus relations correlated with punishment, the organism would be prevented from learning an escape response in presence of a specific environment.

Within a psychotherapeutic intervention, emotional responses of negative valence are of crucial importance as they often represent the motivational factor leading the patient to seek therapy. Respondent, emotional responses are typically correlated with traumatic events and are often re-experienced when remembering occurs. In some cases after highly traumatic events, individuals report re-experiencing sensory-perceptual and emotional responses with high frequency during their daily lives, leading in some cases to a disruption of their daily routines. Considering post-traumatic stress disorder (PTSD) as a prototypical example of maladaptive remembering, we can link two of the PTSD recognized clusters of symptoms: (1) re-experiencing traumatic episodes and (2) avoiding stimulation related to aversive events to, respectively, (1) selection of stimulus-stimulus and (2) stimulus-response relations. Specifically, persistently reliving traumatic episodes is a form of recurrent remembering in which presentation of a subset of the original stimulus-stimulus configuration leads – presumably via hippocampal pattern completion – to a full-blown recollection of the traumatic event, including the emotional/respondent components. With regard to the second cluster of symptoms, the individual affected by PTSD typically learns to avoid forms of stimulation that may lead them to relive the traumatic events. Stimuli that are correlated with the original stimulus-stimulus configuration tend to acquire avoidance function, thereby decreasing the probability of hippocampally mediated remembering triggered by a subset of the original traumatic stimulus-stimulus configuration.

The authors describe how learning reconsolidation occurring in the therapeutic setting may lead to therapeutic advantages. This perspective should be reconciled with the fact that in disorders such as PTSD, reconsolidation by definition occurs a large number of times without necessarily bringing about any relevant therapeutic improvement. However, compared to reconsolidation occurring in nontherapeutic environments, reconsolidation occurring in the therapeutic setting may allow for novel stimulus-stimulus relations and stimulus-response relations to be selected. For example, while the traumatic episode is remembered and described, the patient is staring at the therapist who is nodding with approval. The sensory-perceptual response elicited by the face of the therapist may enter the traumatic stimulus-stimulus configuration and, importantly, some of the emotional responses of positive valence elicited by social reinforcement (the therapist's approval), may replace the emotional responses of negative valence triggered by the original episode due to the inherent incompatibility of those responses. Reconsolidation occurring in a therapeutic setting may therefore lead to different effects compared to reconsolidation occurring in a non-therapeutic setting because the therapist is in a position to arrange specific learning contingencies to modify the previously acquired stimulus-stimulus and stimulus-response relations.

Summarizing, I propose here that although a drop in the level of dopaminergic neuromodulation during traumatic events weakens stimulus-response relations leading to a decrease in the

rate of the punished behavior, a concurrent increase in noradrenergic neuromodulation may lead patients to episodically learn the aversive events. Although such a mechanism makes it less likely for the individual's behavior to be punished, it also allows the person to re-experience the punishing episode, sometimes in a pathological manner as in the case of PTSD. Finally, reconsolidation occurring in the therapeutic session may lead to different effects compared to reconsolidation occurring outside therapy because the therapist can arrange specific learning contingencies to modify the previously acquired stimulus-stimulus and stimulus-response relations.

## Memory reconsolidation keeps track of emotional changes, but what will explain the actual "processing"?

doi:10.1017/S0140525X14000387, e20

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**Abstract:** We question memory reconsolidation and emotional arousal as sufficient determinants of therapeutic change. Generating new feelings and meanings must be contrasted with activating and stabilizing the evolving memories that reflect those novel experiences. Some therapeutic changes are not attributable to a memory model alone. "Emotional processing" is also needed and is often an undeclared form of complex executive problem solving.

**Change versus the record of change.** We agree with Lane et al.'s model of how affective arousal and memory reconsolidation is related to the process of change. The process of memory reconsolidation is like moving a bookmark of self-awareness forward as one progresses in therapy and memories change and are re-storied. This is essential but more is needed: A memory model fails to explain how the story itself "gets written." Alexithymia ("no words for feelings") describes clients' difficulties in identifying and elaborating their emotional experience. Other clients fail to regulate negative affect, or are simply less reflective on their experience (i.e., less psychologically minded). Still others have difficulty shifting between different emotional states (affects and meanings) that are activated by a presenting situation. These obstacles to mental health are arguably unrelated to painful memories as such, as are the executive abilities that are drawn on when working through painful experiences.

**Some changes are not attributable to memory.** Client improvements in psychotherapy reflect not only narrative or memory revisions (explicit or implicit, as Lane et al. discuss), but also new creative ways of engaging with emerging experience. Process research has shown that skill in emotional processing at the onset of therapy is not as critical to the successful treatment of depression as the client's aptitude for increasing this ability during therapy (Pos et al. 2003). Similarly, alexithymia is conceptualized as a trait deficit in the cognitive processing of emotional experience and therefore presents therapists with a difficult challenge (Ogrodniczuk et al. 2011). However, one of the few treatment studies to examine it as an outcome observed a 68% reduction in the number of clients meeting criteria for alexithymia post-treatment (cited in Paivio & Pascual-Leone 2010). Findings on changes to processing styles such as these are difficult to explain using only a model of memory processes and affective arousal.

Another line of research shows that transforming painfully maladaptive emotion is not just a process of generating new or more positive experiences, but rather one of evoking another feeling in parallel, and in contrast to, the maladaptive feeling (Greenberg 2002; Pascual-Leone & Greenberg 2007). As Fredrickson (2001) has observed, key components of "positive" emotions are incompatible with "negative" emotion and the effects of a negative emotion are not "replaced" but rather "undone" (i.e., dialectically elaborated) by positive emotions. Lane et al. observe that emotional arousal is an important ingredient in this process, and the co-activation of contrasting emotional networks will form new facets of the revised memory. However, memory reconsolidation does not, by itself, explain how inherently contradicting emotional experiences can be brought together to synthesize a different, healthy and internally coherent, emotional state.

Emotional processing occurs whether or not participants are encouraged to work with *their own* memories. A study on expressive writing randomly assigned trauma survivors either to write about their real experiences or to write about some fictional trauma-experience that was not their own (based on related narratives). Even so, both groups enjoyed similar positive changes, significantly greater than those of a control (Greenberg et al. 1996). Given the effect cannot be explained in terms of explicit re-appraisals, Lane et al. have attributed such findings to changes in implicit memory. However, there was no advantage to working directly with one's own painful memories, which suggests that working through emotional problems in general might be the main developmental factor.

**Emotion processing is a kind of problem solving.** Becoming more emotionally aware, more insightful, or more emotionally flexible, or gaining emotion-regulation skills, cannot be explained by transformations in memory, without referring to new emotion and new executive skills. In short, engaging an old memory to modify it is different from engaging an old memory with the use of new executive skills. The framework of the target article is married to empirical research on memory; but here, memory is essentially taken as the product of associative learning. However, without *emotional problem solving* that brings truly novel solutions, memory and learning by themselves may not clarify personal (i.e., emotional and cognitive) existential learning (Greenberg & Pascual-Leone 2001; Pascual-Leone & Johnson 2004). Emotional change in psychotherapy pertains to subjective (or better *meta-subjective*) problem solving and the concurrent constructivist learning of these insights. Working through moments of emotional pain (i.e., relationship break-ups, major disappointments, or simply feeling overwhelmed) are emotion-laden *tasks*. After all, these are emotional problems, not memory problems; and as such they represent fuzzy constructivist puzzles that are often resolved through categorically novel solutions in functioning (Pascual-Leone et al. 2014; Pascual-Leone et al., in press). This aspect of emotional change is overlooked when researchers or clinicians focus on the contents of therapeutic changes (i.e., new narratives, less dysfunctional beliefs, productive emotions), without also considering the operative mental processes a client needed to manipulate those objects of experience.

Thus, solving emotional problems demands working in a manner that goes beyond experience itself. *Subjective* experience can be understood as "personal data" that (as Lane et al. claim) is encoded, consolidated, and reconsolidated in memory. In contrast, *meta-subjective* is a term for describing a higher level of self-reflective processing, which must be deployed to clarify and internally negotiate painful experience (Pascual-Leone 1997; 2013). Thus, using a meta-subjective perspective instead of a simpler observer's point of view, clients dynamically develop emotional problem-solving models of their own change. This internal dialectical process attempts to coordinate incongruent facets of meaning (subjective feelings, past event, and future possibilities). Resolving *personal* difficulties is not just information processing. Resolving emotional problems requires the use of effortful mental attention, with its activation, inhibition, and executive

functions—all operating on the ongoing flow of emotional arousal (Greenberg & Pascual-Leone 1995; Pascual-Leone & Johnson 2004). This process depends on, but is not reducible to, remembering things differently. A memory model explains the accumulation of how progress is updated but it does not explain the actual mechanism of generating new emotional experiences or insights: For that, emotional problem-solving processes are also needed.

## Let's be skeptical about reconsolidation and emotional arousal in therapy

doi:10.1017/S0140525X14000272, e21

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**Abstract:** Lane et al. imply hypotheses that are questionable: that emotional arousal is a cause of positive change and reconsolidation research can be applied to therapy to alter memory. Given the history of problematic attempts to incorporate memory distortion or high emotional arousal into therapeutic techniques, both of which heralded premature optimism and hubris, I urge open-minded skepticism.

If high emotional arousal were as therapeutic as claimed, perhaps the article by Lane et al. itself could be given to memory and clinical psychology researchers of a skeptical bent as a trigger. There are two main problems with the article: the assertion that high emotional arousal during therapy is beneficial, and the way reconsolidation research is applied to therapy. With regard to the former problem, I question whether emotional arousal in cognitive behavioral therapy (CBT), behavioral, and exposure therapies is actually a causal factor in positive therapeutic change. In discussing CBT the authors state, “Eliciting emotional responses through role-playing, imagination, and homework exercises is key to the identification and reformulation of these maladaptive thoughts” (sect. 1, para. 4). This is a rhetorical stretch, because CBT does not aim at high emotional arousal, nor does it always induce it, and yet it works well for a number of conditions (Butler et al. 2006).

An exception could be that exposure therapy can often arouse emotions, but that is not to say that emotional arousal is the causal agent of positive change. In section 4, paragraph 2, the authors cite Jaycox et al. (1998) as evidence that high emotional arousal in exposure therapy led to positive outcomes for patients with post-traumatic stress disorder (PTSD). However, Jaycox et al. actually found that those who exhibited high initial emotional arousal and gradual habituation improved more than those with high initial emotional arousal without habituation. Thus it is probably not the high initial engagement that matters; it is whether they habituate to the exposure therapy.

Lane et al. claim (sect. 1, para. 4) that a study by Missirlan et al. (2005) provides evidence that emotional arousal is a predictor of therapeutic success. However, I find further reason for doubt because Table 3 in Missirlan et al. shows that after adjusting for other variables, emotional arousal was *not* a significant predictor of reduction in post-therapy depression. Sample size in that analysis was only 31. Indeed, Model 4 in Table 3 shows that Levels of Client Perceptual Processing (LCPP) accounts for more of the variance than emotional arousal. High LCPP includes the processing of information, reevaluation, integration, and a controlled and reflective manner of processing. Perhaps it is this perceptual cognitive processing, much like that found in CBT that is driving the positive self-report.

Lane et al. write that research shows re-experiencing a memory of the original traumatic event strengthens the memory (sect. 7, para. 8). Strengthening a traumatic memory might not be helpful. Indeed, although debriefing therapy is mentioned in

the article (sect. 4, para. 6), and Lane et al. acknowledge the problematic nature of the intervention, they do not seem to notice that the failure of debriefing therapy (Van Emmerik et al. 2002) contradicts their theory that emotional arousal in therapy is a driving force of improvement.

The idea of high emotional expression during therapy is not new (e.g., Hart et al. 1975; Janov 1970) nor is the idea that memory distortion might be used to undo traumatic memory (see Janet 1894, p. 129). Recent research on memory reconsolidation is exciting and has made it into the news and the top journals *Nature* and *Science*. Even if we put aside doubts about reconsolidation (Miller & Matzel 2000) and assume reconsolidation research is reliable and not overstated, we *still* must take care extrapolating from basic neuroscience to the therapy room (for a grounding in neuroscience skepticism see Lilienfeld & Satel 2013; Weisberg et al. 2008). Memory distortion phenomena probably happen in a number of ways neurologically, and the specific mechanism identified in reconsolidation may be just one of many routes to distortion. If reconsolidation is defined as a specific mechanism (e.g., involving Zif268, see Lee et al. 2004), we do not know whether that mechanism specifically is occurring in any of the therapies mentioned in the article. Typically, the type of foundational reconsolidation studies (which uncover the specific mechanisms distinct to reconsolidation) involve the elimination of fear responses to electric shocks in animals; neither the stimuli nor the subjects are generalizable to the kind of rich autobiographical memories involved in therapy. Much in the same way that finding “false memories” in rodents (Ramirez et al. 2013) or memory distortions in people with superior memory (Patihis et al. 2013) does not legitimize such techniques in therapy, the evidence that memory alteration happens in reconsolidation experiments does not mean it *should* happen in therapy. The application of basic neuroscience to therapy leapfrogs over some important proximal sciences (e.g. social, cognitive, and clinical psychological science).

There is insufficient evidence for the claim that changing memories causes improvement in therapy. Even if it were true, I would question how ethical the manipulation would be, given that changing memories may undermine a person's ability to predict future events accurately. Changing emotional memories may also be unfair to people involved in the client's revised memories – especially family members such as parents – if that change is towards a more strongly negative emotional reaction. Fear extinction may be acceptable in therapy, but reconsolidation is taken to mean more than mere extinction (see Merlo et al. 2014).

Finally, the target article seems to be something of a Trojan horse in that it promotes high emotional arousal and memory change and thus implicitly endorses one of the author's (Greenberg) therapeutic interventions, called emotion-focused therapy (EFT). The Trojan horse itself involves a well-informed account of memory research, although its length and interpretations could be seen as obscurantist. It should also be noted that *emotion*-focused therapy is apparently different from *emotionally* focused therapy, and care should be taken not to take evidence for one as evidence for the other. Emotion-focused therapy appears to often involve individual therapy in which clients re-experience early traumatic memories and focus on the emotions that arise (Greenberg 2004). For example, one case study reads:

*One of her earliest memories was of her father forcing her and her siblings to watch him drown a litter of kittens. This was to “teach her a lesson about life” and the client believed that he enjoyed it. The client accessed a core self-organization, which included her ‘suppressed scream of horror’ from this experience. While imaginatively reliving this scene in therapy the therapist guided her attention to the expression of disgust in her mouth while she was feeling afraid. (Greenberg 2004, p. 13).*

## ACKNOWLEDGMENTS

Thanks to Carol Tavis, Linda Levine, Monica Pignotti, Craig Stark, and Larry Squire for their comments.

## Multiple traces or Fuzzy Traces? Converging evidence for applications of modern cognitive theory to psychotherapy

doi:10.1017/S0140525X14000399, e22

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**Abstract:** Neurobiologically informed integration of research on memory, emotion, and behavior change in psychotherapy is needed, which Lane et al. advance. Memory reconsolidation that incorporates new emotional experience plays an important role in therapeutic change, converging with evidence for Fuzzy Trace Theory. Applications of Fuzzy Trace Theory to Cognitive Behavioral Therapy (CBT) for youth at risk for psychosis, and to other aspects of behavior change, are discussed.

We applaud Lane et al.'s modern, neurobiologically informed integration of research on memory, emotion, and behavior change in psychotherapy. Indeed, we have applied a similar "multiple trace theory" to enhance cognitive behavioral therapy (CBT) for adolescents who are prodromal for paranoid delusional psychosis, with promising preliminary results (Landa 2012; Landa et al. 2015). The theory is called "Fuzzy Trace Theory" (e.g., Reyna 2008) and it distinguishes gist memory (representations of bottom-line meaning) from verbatim memory (representations of exact details). Verbatim memory is subject to interference (e.g., from strong emotions), and it fades rapidly; in contrast, gist memory is more stable and generalizable. Thus, fostering reliance on gist in CBT is predicted to produce greater and more enduring behavior change.

Adolescence is an important transitional period in which decision processes shift to greater reliance on gist. Onset of psychosis also typically occurs during adolescence and can have profound adverse impacts on social and cognitive development. The onset of psychosis is preceded by attenuated psychotic symptoms and decline in psychosocial and cognitive functioning. Preventative interventions during this phase can improve the course of illness, facilitate recovery from an at-risk mental state, and prevent future illness.

However, CBT has not kept pace sufficiently with new developments in cognitive theory, a crucial gap that the proposed framework addresses (see also Brainerd & Reyna 2005). Hence, to the degree that Fuzzy Trace Theory and the proposed framework overlap, the large literature on memory, decision making, and behavior change supporting our theory also supports the approach taken in the target article (Reyna et al. 2015; in press). Applying such new developments in cognitive theory is critical to enhancing the efficacy of CBT.

The mechanisms we have applied to CBT, such as inculcating new gist representations of experience, are loosely analogous to changing "semantic structures" in the target article. Also somewhat analogous, in Fuzzy Trace Theory, we emphasize re-interpreting episodic memories of the gist of past experience. Each type of memory representation in our theory supports alternative modes of processing: a "verbatim-based" analytical mode (processing precise literal details of experience) and a gist-based intuitive mode. The gist-based intuitive mode operates on simple, bottom-line representations of the meaning of experience, a target for CBT (Reyna 2012).

The third major component of the Lane et al. model (emotional responses) is also present in Fuzzy Trace Theory. Rivers et al. (2008) describe how emotion interacts with these different modes of thinking, reviewing research on emotion as valence (positive–negative), arousal (excited–calm), feeling states (moods), and discrete emotions (e.g., anger vs. sadness). The literature on valence, for example, supports its interpretation in terms of gist representations, including evidence for long-term retention in memory, a hallmark of gist. Rivers et al. also review research on mood congruency, affect-as-information, memory and emotion,

and the relation between arousal and inhibition. Thus, emotions conceived as valence, arousal, feeling states, or discrete emotions color information processing.

Contrary to aspects of the proposed framework, emotional arousal can foment false memories for the gist of experience (although negative valence does so even more than arousal), and intense emotion can interfere with the ability to recognize the gist of when a threat is present (or not). Different emotions also shape gist interpretations of experiences and pre-load responses to risk (e.g., anger encouraging risk-taking and fear discouraging it) regardless of memory for verbatim facts (Lerner & Keltner 2001). Unlike the proposed framework, verbatim and gist memories have been shown to be dissociated, rather than growing out of one another or interacting. Thus, the familiar characterization of memory as "constructive" in line with results for the "War of the Ghosts" (Bartlett 1932; but see Bergman & Roediger 1999) has been disproven, although some features of schema theory and constructivism are preserved in Fuzzy Trace Theory through the notion of gist representations.

Lane et al.'s thesis about different points of entry is broadly consistent with the disassembling of insightful gist-based intuition from rote (verbatim) behavioral memorization or conditioning, but, according to Fuzzy Trace Theory, these modes of behavior change are distinct. An individual can observe that specific behaviors do not "pay off," and change those behaviors (win: stay; lose: shift) without insight or transfer to superficially different – but essentially similar – situations. This lack of insight contributes to the often-observed fadeout effect of interventions, as opposed to the enhanced transfer and long-term retention of gist (Reyna & Mills 2014). More generally, the paradoxes of implicit versus explicit memory (including neuroscience research) can be accounted for more easily by assuming that distinct verbatim and gist memories underlie judgments of recollection (true and phantom recollection) versus familiarity (Brainerd et al. 2011).

In sum, like Lane et al.'s proposed framework, Fuzzy Trace Theory draws on research about memory, emotion, semantic structures, and the brain (Reyna & Huettel 2014). Therefore, the evidence base for much of the proposed framework is broader and deeper than indicated in the target article. Moreover, Fuzzy Trace Theory has been successfully applied not only to prevention and behavior change in adolescents (evaluated using randomized experimental designs; Reyna & Mills 2014), but to behavior change in nonsymptomatic adults (e.g., Wolfe et al. 2015) and to adult patients (e.g., Fraenkel et al. 2012, increasing value-concordant medication decisions from 35% to 64%). This track record of successful application of Fuzzy Trace Theory augurs well for the proposed model and its implications for psychotherapy, especially for CBT. Specific details regarding information processing differ between Fuzzy Trace Theory and the proposed framework, however, which should motivate future research testing alternative frameworks.

## How does psychotherapy work? A case study in multilevel explanation

doi:10.1017/S0140525X14000284, e23

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**Abstract:** Multilevel explanations abound in psychiatry. However, formulating useful such explanations is difficult or (some argue) impossible. I point to several ways in which Lane et al. successfully use multilevel explanations to advance understanding of psychotherapeutic effectiveness. I argue that the usefulness of an explanation depends largely on one's purpose, and conclude that this point has been inadequately recognised in psychiatry.

Lane et al. note that there is no universally accepted account of how psychotherapy works. They draw on neurological and psychological data to develop a theory about the relationships between memory, emotion, and semantic structures; they then put this theory to work in explaining how psychotherapy works and how it can be made more effective. Because it draws on biological, psychological, and social elements, Lane et al.'s account of psychotherapeutic effectiveness can be deemed a "multilevel" explanation.

Understanding and treating mental illness is recognised by many psychiatrists to require consideration of biological, psychological, and social perspectives; yet organizing these perspectives into useful, coherent explanations remains fraught with difficulty. Some, such as Christopher Frith, hold that multilevel explanations are, in an important sense, unintelligible and uninformative (Frith 1992, p. 26). Others, such as Marmot (2005, p. 53) and Ghaemi (2010, p. 58ff), view multilevel explanations as impracticably complex, believing that for practical purposes it is necessary to constrain one's thinking to a single level when trying to understand a medical phenomenon.

Despite these concerns about multilevel explanations, Lane et al.'s account of psychotherapeutic effectiveness provides a case study of the usefulness of multilevel explanation. I identify three specific ways in Lane et al. advance understanding of psychotherapeutic effectiveness by drawing on multilevel insights. I then argue that whether a given explanation is useful depends largely on what purpose one intends the explanation to serve, and that this point has not been adequately recognised in psychiatry.

First, Lane et al. note that attention to one level can lead us to revise beliefs about the composition of another level. For example, they note that memory reconsolidation – which involves changes in recalled memories – is behaviourally similar to so-called extinction, in which a new memory overrides an old one. Extinct memories, unlike earlier versions of reconsolidated memories, can reappear over time. Lane et al.'s account of psychotherapy depends upon reconsolidation and extinction being distinct psychological processes. The claim that they are *psychologically* distinct is supported by their *biological* differences: Lane et al. note that the two processes differ at the cellular/molecular level. As such, a multilevel explanation of these processes advances understanding of them.

Second, sometimes there is no single-level explanation for why a given phenomenon exists. Lane et al. answer the question of why our memories admit of revision through reconsolidation by appealing to Klein et al.'s (2002) argument that this feature is adaptive because it enables us to update existing knowledge in light of new information. Appealing to adaptiveness in this way explains a *psychological* phenomenon (the mutability of memory through reconsolidation) in *biological* (evolutionary) terms. Confining ourselves to the psychological level makes it hard to see how this feature of memory could be advantageous; indeed, the flashback memory literature in psychology conceives it chiefly in terms of a vulnerability to error, as Lane et al. note. Multilevel explanation of memory reconsolidation, then, helps us understand it better.

Third, psychiatry is a goal-directed enterprise: Its goal is to prevent, cure, and/or manage mental illness. A multilevel understanding of how a desired effect occurs can reveal new ways of achieving that effect, thereby opening up new possible treatment routes. Lane et al. draw on their *biologically* informed understanding of the *psychological* processes underlying psychotherapeutic success to suggest ways of pharmacologically bringing about the results of successful psychotherapy. Whilst psychotherapy is one way of effecting desirable memory modification, pharmacologically manipulating patients' emotional responses during recollection could be another. Lane et al. note that efforts to develop such treatments are already under way: Propranolol, a beta-adrenergic antagonist, has been used to block the formation (or strengthening) of traumatic memories in patients with (or at risk of) post-traumatic stress disorder. Further multilevel insights into the biology of psychotherapy could reveal new opportunities for pharmacological intervention.

Lane et al. make use of these and other multilevel explanations in understanding psychotherapeutic effectiveness and considering how its effectiveness can be improved. Reflecting on their article reveals not only that multilevel explanations can be useful, but also that the usefulness of a multilevel explanation – or, indeed, any explanation – depends largely on what one wants from it. Frith's complaint that the multilevel explanation "alien thoughts are caused by inappropriate firing of dopamine neurones ... is clearly inadequate" might be reasonable given his wish to learn about "the nature of hallucinations" and "the role of dopamine neurons within the physiological domain" (Frith 1992, p. 26). Yet the explanation that Frith finds inadequate is useful if our aim is, instead, discovering whether pharmacologically manipulating dopamine neurons is likely to be an effective way to control alien thoughts. Similarly, Marmot's and Ghaemi's complaints that multilevel explanations are best avoided if we are to avoid becoming "paralysed by complexity" (Marmot 2005, p. 53) is reasonable in cases where one's aims are most effectively realised by considering only single-level explanations, but not in cases – like that of Lane et al.'s attempt to explain how psychotherapy works – where achieving one's aims requires consideration of multilevel factors.

I remarked above that combining the perspectives of different levels into coherent explanations of mental illness is a difficult task. Although impressive work has been done – particularly by Kendler (e.g., 2008; 2012) and by Kendler and Campbell (e.g., 2009; 2014) – to demonstrate the need for multilevel explanations in psychiatry and to consider how they are best formulated, the question of what makes a good explanation *for a given purpose* has been ignored. We know, for example, that some cases of depression are best explained primarily in terms of psychosocial factors such as bereavement, and that others are best explained primarily in terms of biological factors such as abnormal brain activity – but what factors *in general* determine whether and when attention to one or another level, or to multiple levels, is explanatorily more appropriate and useful, is an issue that requires further investigation.

#### ACKNOWLEDGMENT

This work was produced with the support of the Oxford Loebel Lectures and Research Programme.

## Reconsolidation: Turning consciousness into memory

doi:10.1017/S0140525X14000296, e24

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**Abstract:** The purpose of learning is not to maintain records but to generate predictions. Successful predictions remain implicit; only prediction errors ("surprises") attract consciousness. This is what Freud had in mind when he declared that "consciousness arises instead of a memory-trace." The aim of reconsolidation, and of psychotherapy, is to improve predictions about how to meet our needs in the world.

**Introduction.** I write as a psychoanalyst trained in the Freudian tradition (at the Institute of Psychoanalysis in London, which also entails the Kleinian tradition). I do not have expertise in other forms of psychotherapy. I was pleased to be invited to comment on this paper mainly because it is encouraging to see that such topics are now being discussed in the pages of *Behavioral and Brain Science* (BBS), but especially because the authors of this paper do indeed seem to identify a core mechanism of change in psychotherapy. Moreover, they approach this mechanism from both a psychological and a physiological viewpoint. This

seems to me the only sensible way to proceed when trying to discern laws concerning the mental apparatus, the part of nature that uniquely presents both as a bodily organ and as subjective experience. The fact that it *feels like* something to be a brain has profound implications for how it works. Trying to understand the organ of the mind while excluding half of the available data has always been a fool's errand.

**Prediction error.** I have recently developed a theoretical formulation of the mechanism of psychotherapeutic change which is remarkably consonant with the one presented here by Lane et al (Solms 2013; 2014; Solms & Panksepp 2012). Central to this formulation is something that is perhaps not sufficiently emphasised in the target article, namely the very purpose of learning and memory. Reminding ourselves of the biological purpose of learning and memory helps to make sense of the phenomenon of reconsolidation, which lies at the heart of the proposed mechanism of psychotherapy.

The purpose of memory is not to maintain veridical records of the past so much as to guide *future* behaviour on the basis of past experience. The purpose of learning is, in a word, to shape predictions, predictive models of reality, predictive models of how we can meet our needs in the world.

That is why memory functions implicitly for the most part; it serves no useful purpose to be consciously aware of the past basis of your present actions, so long as the actions in question bring about the predicted (desired) outcomes. In fact, conscious reflection upon an automatised motor programme undermines the intended behaviour because it destabilises the underlying programme. It becomes necessary to bring past experience to consciousness only when predicted outcomes fail to materialise, when prediction *error* occurs. Friston (2010) calls this “surprise.” Prediction error renders the basis of present actions salient again – and deserving of attention (of consciousness) once more – precisely because the prediction that was generated by the past learning episode *is now in need of revision*. Reconsolidation, then, simply improves prediction.

Biologically successful memories are reliable predictive algorithms – what Helmholtz (1866) called “unconscious inferences.” There is no need for them to be conscious. In fact, as soon as they become conscious they no longer deserve to be called memories, because at that point they become labile again. This seems to be what Freud had in mind when he famously declared that “consciousness arises instead of a memory-trace” (Freud 1920, p. 25). The two states – consciousness and memory – are mutually incompatible with each other. They cannot arise from the same neural assemblage at the same time.

**Consciousness and affect.** Our understanding of the purpose of explicit cognition, including conscious remembering, is deepened when we recognise that the most fundamental form of consciousness is *affect* (Freud 1895; 1900; 1911). This is not the place to set out the accumulated evidence for the view that consciousness consists essentially in upper brainstem and limbic activation of intrinsically unconscious thalamo-cortical representations (see Damasio 2010; Merker 2007; Panksepp 1998; Solms 2013; Solms & Panksepp 2012). Suffice it to say that the affective core of consciousness attributes *meaning* to experience, within a biological scale of values: “Is this new experience (this surprise), good or bad for my survival and reproductive success, and therefore, how do I respond to it?” The affective basis of consciousness explains why it (consciousness) is required to solve the biobehavioural problem of meeting our needs in unpredicted (or unpredictable) situations, and why it is superfluous in relation to successful predictive algorithms. This is also not the place to speculate about how the conversion of affect into representational consciousness occurs, through what both Freud and Friston – following Helmholtz – call “binding” of “free energy” (Carhart-Harris & Friston 2010; Freud 1911; Friston 2010; see Solms 2014).

**Repression.** Unconscious cognitive processes do not consist only in viable predictive algorithms. Although it is true that the ultimate aim of learning is the generation of perfect predictive

models – a state of affairs in which there is no need for consciousness (Nirvana) – the complexity of life is such that this ideal is unattainable. Real life teems with uncertainty and surprise, and therefore with consciousness. That is to say, it teems with unsolved problems. As a result, we frequently have to automatise less-than-perfect predictive algorithms so that we can get on with the job of living, considering the limited capacity of consciousness (Bargh 2014). Many behavioural programmes therefore have to be automatised – rendered unconscious – before they adequately predict how to meet our needs in the world. This applies especially to predictions generated in childhood, when it is impossible for us to achieve the things we want – when there is so much about reality that we cannot master.

The consequently rampant necessity for *premature automatization* is, I believe, the basis of what Freud called “repression.” I hope this makes clear why repressed memories are always threatening to return to consciousness. They do not square with reality. They give rise to constant “surprise,” for example, in the transference. I hope this also clarifies why the repressed part of the unconscious is the part of the mind that most urgently demands reconsolidation, and therefore most richly rewards psychotherapeutic attention.

## Disruption of reconsolidation processes is a balancing act – can it really account for change in psychotherapy?

doi:10.1017/S0140525X14000405, e25

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**Abstract:** Lane et al. argue that any psychotherapeutic intervention at its core acts on reactivated memories via the process of reconsolidation which leads to modified memory traces. From our perspective, this model (1) only explains a small subsegment of psychotherapeutic mechanisms and (2) ignores the difficulties of generating reliable experimental conditions that allow interference with reconsolidation processes and – if successful – their transient nature.

In their target article Lane et al. attempt to provide a general model for “therapeutic change.” The authors argue that any psychotherapeutic intervention at its core acts on reactivated memories via the process of reconsolidation, leading to modified memory traces. From our perspective, this ambitious approach is flawed by two major concerns: (1) the authors ignore that therapeutic change is processed by a multiplicity of diverse mechanisms, whereof change of dysfunctional emotional memory processing is only one of many; (2) given that guided adaption of dysfunctional memory traces is an important component of psychotherapeutic mechanisms, it remains unclear whether the mechanisms of memory consolidation as studied under experimental conditions can be transferred to therapeutic practice.

(1) Psychotherapy is an iterative process aiming to adapt client’s dysfunctional experience and behaviors to a normative social environment. Based on many years of our own work in psychotherapy research and development, we can state that in modern psychotherapeutic treatments the selected targets are based on individualized functional analyses including cognitive, emotional, behavioral, neurobiological, and social aspects. Therapeutic interventions and techniques are selected according to predefined treatment algorithms or by the intuitive wisdom of the

therapist. The variety of evidence-based therapeutic mechanisms can be structured in (1) more general interventions – for example, psycho-education, relaxation-training, metacognitive awareness, cognitive restructuring, contingency management, skills acquisition, and problem solving, and (2) disorder-specific interventions – for example, training in impulse-control in ADHD, coping with illusions and coping with family interventions in schizophrenia, emotion regulation in borderline personality disorder, anti-craving skills in substance dependence, shifting of attention in social phobia, physical activation in chronic fatigue, imagery rehearsal therapy for nightmares, and sexual therapy for sexual dysfunctions. These interventions are not, or are only in part, processed by changes of the emotional memory system. Thus, the idea to propose changes of emotional memories not only at the core, but as “the essential ingredient” (target article, sect. 4, para. 7) of therapeutic change might be a bit simplistic.

(2) Disrupting reconsolidation processes is a tricky act of balance. In fact our own experience from many years of research on reconsolidation, as well as a very careful analysis of the limited number of original investigations in laboratory animals (Tronson & Taylor 2007) and humans regarding this phenomenon, tells us that it is extremely difficult to generate a reliable experimental condition that allows interference of reconsolidation processes, and, if successful, the interference is usually of a transient nature.

From a molecular perspective, memory reconsolidation requires new protein synthesis. More than 50 studies in rodents have examined the effects of protein synthesis inhibitors after reactivation of a previously consolidated memory. Protein synthesis inhibitors were given either intracerebroventricularly or brain site-specifically (e.g., to the hippocampus, amygdala, or other site), and disruption of reconsolidation was usually tested 24 hours later. In approximately 20 studies, protein synthesis inhibition did not disrupt reconsolidation, despite this being an essential prerequisite for the reconsolidation theory. There are also many conflicting findings on the existence of reconsolidation per se. The problem is that the existing literature shows only the tip of the iceberg in terms of negative findings of reconsolidation effects. As so often happens in science, many laboratories have tried to study the phenomenon of reconsolidation without success – and have not reported their findings, as scientific journals are not keen on reporting negative results. Another complicating factor is that each nonreinforced reactivation session designed to induce memory retrieval and reconsolidation also involves extinction mechanisms to a certain degree, which makes the interpretation of results difficult.

These complications by no means imply that memory reconsolidation phenomena do not exist, but they certainly suggest that these phenomena do not translate to all memories, and likely occur under very specific experimental conditions that make good reproducibility very difficult to achieve. Hence, the current state of knowledge does not allow us to clearly define determining factors and experimental conditions that can be transferred to a psychotherapeutic setting. We do know that the age of a memory, memory strength, and in particular the length of the reactivation session is of importance for determination of the reconsolidation process; however, brain scientists do not know about the causality of these factors and cannot provide guidance for psychotherapy. It is obvious that, for example, memories strengthened during 20 years of cigarette smoking, which likely involves millions of repetitions of inhalation plus smoking cue associations, cohere into an extremely strong, habitual memory that is very difficult, if not impossible, to disrupt or modify – an assumption that is underlined by the fact that relapse can occur even after decades of abstinence. On the other end of the spectrum, a person who suffers from one clearly described traumatic experience is perhaps more likely to be responsive to disruption of that particular memory. It is thus not surprising that positive results in the human literature have primarily been obtained with disruption of reconsolidation of human fear and episodic memories (Schwabe et al. 2014). But most patients who seek psychotherapy

are suffering from highly distinct and complex emotional and motivational disturbances, which make it less likely to define any general rules and guidelines for reactivation of a distinct memory that is amenable to disruption of reconsolidation.

Finally, little is known about the lasting nature of treatment success, as only a handful of papers have described memory disruption more than 24 hours following reactivation manipulations. To date there are no reports that demonstrate permanent alterations in memory; at best these disruptions have been demonstrated to last up to a few weeks.

In conclusion, changing emotional memories is an important mechanism in psychotherapy, but it is one among many. It fits into some models (e.g., trauma-memory processing). However, more complex issues that are fundamental to psychotherapy, such as changing human habits, learning social skills, developing compassion, modifying human values, reappraising social issues under different social conditions, and so forth, are beyond the scope of the reconsolidation phenomenon.

## Deconstructing the process of change in cognitive behavioral therapy: An alternative approach focusing on the episodic retrieval mode

doi:10.1017/S0140525X14000302, e26

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**Abstract:** Lane et al. view the process of memory reconsolidation as a main ingredient of psychotherapeutic change. They ascertain that in cognitive behavioral therapy (CBT) high priority is given to the “semantic structure.” We argue that memory-related mechanisms of change in CBT are more nuanced than the target article presents. Furthermore, we propose to partially shift the focus from the process of reconsolidation to the retrieval operations.

Both *what* individuals recall and *how* individuals retrieve mnemonic information are of crucial importance for therapeutic work (Lemogne et al. 2006; Parikh et al. 2007; Staniloiu & Markowitsch 2012; Zaretsky et al. 2005; 2007). Active ingredients of the therapeutic change in cognitive behavioral therapy (CBT) encompass the alteration of retrieval style and retrieval mode (Lepage et al. 2000) and the revision (shift) of the *rememberer's* (Tulving 2005) perspective (see also Alston et al. 2013; Lemogne et al. 2006; McBride et al. 2007; Williams et al. 2000).

As the authors of the target article are likely aware, Tulving described the SPI (serial, parallel, independent) model, which posits that mnemonic information is encoded serially, may be stored in parallel in different long term memory systems and can be retrieved independently of the long term memory system in which encoding occurred (Fig. 1). The retrieval of information from episodic (i.e., episodic-autobiographical) memory system (the recollection) is assumed to engage the so-called episodic retrieval mode (Lepage et al. 2000). Mnemonic information recollected via the episodic retrieval mode has several cardinal characteristics. The recollected information is made of unique personal events (experiences), which feature a time and spatial situation. It has perceptual details, affective connotation, self-relevance, and a particular *rememberer's* perspective (first-person or field perspective versus third-person or observer perspective). Furthermore, it is accompanied by a special phenomenological conscious experience (the autonotic

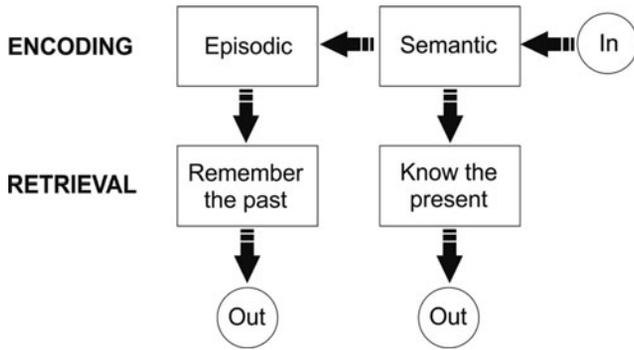


Figure 1 (Staniloiu & Zaretsky). Functional process-specific relations between episodic-autobiographical and semantic memory, as described in Tulving’s SPI-model. Information can be encoded into the semantic memory system independently of the episodic-autobiographical memory system. However, it must be encoded into the episodic-autobiographical memory system *through* the semantic one. Corresponding information can be stored in both systems (“parallelity of storage”). Stored information is potentially available for retrieval from one of the two systems, or from both of them. (Modified after Fig. 1 from Tulving and Markowitsch [1998] and from comments from Tulving [2005].)

consciousness) (see Markowitsch & Staniloiu 2013; Markowitsch et al. 2003; Piolino et al. 2009). As Markowitsch and Staniloiu (2011a; 2011b), Piolino et al. (2009), Lemogne et al. (2009), and other authors described, the *rememberer’s* perspective reflects the degree of emotional involvement with past experiences and/or the personal meaning or relevance of the mnemonic material at the time of the retrieval; it may have specific neural underpinnings (Eich et al. 2009). The third-person retrieval perspective can be construed as an avoidant mechanism that may subserve successful coping with certain personal memories in healthy individuals but also may take pathological dimensions and hinder treatment in various psychiatric conditions, such as dissociative disorders (Fujiwara et al. 2008; Lemogne et al. 2009; Markowitsch & Staniloiu 2011a; 2011b; 2012).

Altering retrieval styles and promoting in particular the retrieval of *positively valenced* personal experiences via the *episodic* retrieval mode have been an explicit or implicit focus of CBT interventions in patients with active or remitted major depressive disorder. The overgeneral memory (as assessed with the Autobiographical Memory Test [AMT]) (Williams & Broadbent 1986) was identified as a cognitive vulnerability for depression and linked to an increased risk for suicide in actively depressed individuals (Williams & Scott 1988); furthermore, this characteristic was found in abused and neglected children (Valentino et al. 2009). Studies have shown that this cognitive vulnerability is, however, amenable to CBT interventions, which might manipulate and influence the retrieval style (McBride et al. 2007; Watkins et al. 2000; Williams et al. 2000). Enhanced cognitive flexibility might partly account for reducing the overgeneral memories after Mindfulness-Based Cognitive Therapy (MBCT) (Heeren et al. 2009). This finding is in agreement with the largely accepted contribution of executive functions to the episodic-autobiographical memory recall; however, which subcomponents of the executive system are involved in different components of the episodic-autobiographical memory is still a matter of debate. Although the AMT paradigm does not explicitly incorporate Tulving’s distinction between episodic and semantic memory systems, the description of specific memories seems to share certain similarities with that of episodic memories, whereas that of general memories reminds to a certain degree of semantic memories (Söderlund et al. 2014).

Using different instruments for assessing episodic (i.e., episodic-autobiographical) memory than the ones employed by Williams

et al., such as the Autobiographical Interview (Levine et al. 2002) or adaptations of the Autobiographical Memory Interview (Kopelman et al. 1990), retrieval deficits in the episodic-autobiographical memory domain were confirmed in major depressive disorder and attributed to multifaceted mechanisms. Lemogne et al. (2006, 2009) found that patients with major depressive disorder have a “global” episodic impairment of *positive* memories with respect to specificity, level of consciousness (auto-noesis), and self-perspective. Markowitsch and Staniloiu (2011a) argued that in patients with major depressive disorder an increase in the suicidal risk might partly arise from a diminished capacity to imagine (construct) *positive* personal future episodes (Szpunar et al. 2013). They linked this particular deficiency in self projection to the impaired ability of depressed patients to retrieve *positive* personal experiences (events) via the episodic retrieval mode; they argued that this valence-dependent deficit might reflect the possible existence of different neural substrates for processing negative versus positive memories (Markowitsch et al. 2003; Sharot et al. 2007). These considerations suggest that therapeutic techniques focused on enhancing the capacity to retrieve positive personal events might augment the capacity to generate specific positive personal memories of the future (Ingvar 1985; Sharot et al. 2007; Szpunar et al. 2013; Williams et al. 1996) and reduce the psychopathological load.

Another target of therapeutic intervention that might promote change is the *rememberer’s* perspective. Studies carried out in patients with active and remitted major depressive disorder indicated that the retrieval of positive (but not negative) personal experiences from a third-person (observer or theatrical) perspective is a marker of cognitive vulnerability for depression (Lemogne et al. 2006; 2009). The third-person-perspective retrieval of positive past experiences might lead to discarding positively valenced memories of personal experience and subsequently to strengthening maladaptive patterns of discounting the positive (Beck 2008; Dorahy & van der Hart 2007; Staniloiu & Markowitsch 2012; Staniloiu et al. 2010). These findings and considerations support therapeutic interventions that concentrate on the revision (manipulation) of the rememberer’s perspective for *positive* personal memories in patients with major depressive disorder or in individuals with vulnerabilities for depression (Libby et al. 2005; Sutin 2009).

In conclusion, the framework for memory-related modifications in psychotherapy that the authors of the target article put forth has several merits. However, additional memory-related mechanisms might be at stake, and their incorporation in the proposed model might aid the “deconstruction” of the process of therapeutic change (Beck 2008; Parikh et al. 2013).

## Focus on emotion as a catalyst of memory updating during reconsolidation

doi:10.1017/S0140525X14000314, e27

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**Abstract:** We share the idea of Lane et al. that successful psychotherapy exerts its effects through memory reconsolidation. To support it, we add further evidence that a behavioral interference may trigger memory

update during reconsolidation. Furthermore, we propose that – in addition to replacing maladaptive emotions – new emotions experienced in the therapeutic process catalyze reconsolidation of the updated memory structure.

We applaud the authors for their Integrative Memory Model, which finally brings together what belongs together: Basic science on the dynamic nature of memory with clinical science on what makes people change. Lane et al. conceive of psychotherapeutic change as the result of memory change. In the process of memory change, maladaptive emotions are substituted with more adaptive emotions. In our commentary, we want to foster the Integrative Memory Model by (1) adding pertinent empirical evidence supporting its claim of memory updating through behavioral interference and (2) proposing a second function of aroused emotion during psychotherapy: Emotions catalyze the process of memory updating during reconsolidation.

Our first comment concerns additional reconsolidation literature that supports the Integrative Memory Model and thereby strengthens the laid-out bridge between basic memory research and clinical psychotherapy research. Following reactivation, old memory traces re-enter an active, fragile state, the so-called reconsolidation period. During reconsolidation, old memories may either be strengthened or, if confronted with interfering material, updated and hence altered. We still need to know more about the circumstances, under which a behavioral interference – the analogue to psychotherapy – is capable of updating memories during reconsolidation. Recent studies have shown that the presentation of interfering material after reactivation has the potential to alter memory traces for semantic (Forcato et al. 2007, 2010), episodic (Chan & LaPaglia 2013; Hupbach et al. 2007; 2008; Strange et al. 2010; Wichert et al. 2011; 2013), and autobiographical (Schwabe & Wolf 2009) memories. Three of these studies allow inferences about the role of emotional arousal during reconsolidation. Wichert et al. (2013) had their participants reactivate old picture memories shortly before they took three runs of new picture encoding. New as well as old pictures had either neutral or emotional content. When memory for old pictures was tested one week later, the decrease in memory accuracy was mainly a result of the incorporation of new emotional picture information in the old memory traces. Strange et al. (2010) had participants learn neutral words. One day later, reactivation of these word memories was triggered in a cued recall test where word stems served as cues. On a trial-by-trial basis, the presentation of a word stem cue was in 20% of the cases immediately followed by a picture of a face that displayed an emotional or neutral expression. The presentation of emotional but not neutral expressions impaired the recall of learned words at one day and at one week following the interference manipulation. These results suggest that during reconsolidation of nonpersonal, declarative memories, emotional items provide a stronger interference than neutral ones. In the study by Schwabe and Wolf (2009), old memories contained either neutral or emotional autobiographical information, whereas the interfering information given following reactivation of autobiographical memories consisted of a nonpersonal story. This nonpersonal interference reduced only the recall of memories that contained neutral but not

emotional autobiographical information. Studies investigating the impact of personalized, emotional interference on the reconsolidation of emotional autobiographic memories would provide for an experimental analogue to psychotherapy and are necessary to further elucidate the role of emotional arousal in this context.

That brings us to our second comment: We propose that new emotions not only replace old, maladaptive emotions, but also catalyze the fixation of the updated memory structure in the course of reconsolidation. When describing the psychotherapeutic effects of emotional arousal, Lane et al. state that an emotional reaction is needed because “the new and more positive emotional experience [is needed] to take place of former response” (sect. 9.2, para. 2). In this view, the emotional reaction is updated through the integration of new emotional responses much as the semantic structure is updated through the integration of new semantic information. We propose that aroused emotion has a second function in the therapeutic process: It boosts memory updating during reconsolidation. It is widely known that emotional arousal boosts initial consolidation (e.g., Anderson et al. 2006) – an effect that Lane et al. mention in their article – and that is neurally mediated by the interaction between amygdala and hippocampus (e.g., Cahill 2000; Canli et al. 2000; Phelps 2004). It is very likely that emotional arousal also boosts reconsolidation. Although differences do exist, consolidation and reconsolidation share neurotransmitters that trigger the process and intracellular signaling cascades that mediate it (Besnard et al. 2012; Johansen et al. 2011; Nader & Hardt 2009). Furthermore, consolidation and reconsolidation also share psychological components such as a susceptibility to interference that varies in strength depending on the intensity (e.g., number of repetitions) and the content (e.g., emotional vs. neutral) of the interfering information (e.g., Lustig & Hasher 2001; Wichert et al. 2013). It therefore seems intuitive that emotional arousal catalyzes both memory consolidation and reconsolidation, a possibility that has been discussed in animal studies (e.g., Akirav & Maroun 2013) and in studies with humans (e.g., Schwabe et al. 2013). As noted above, emotional interferences boosted the reconsolidation of episodic memories to a larger extent than neutral interferences (Strange et al. 2010; Wichert et al. 2013). Furthermore, when memory reactivation coincides with emotional arousal in the absence of interfering material, reconsolidation of the original memory trace is enhanced. This was shown in a study by Coccoz et al. (2011), where the reactivation of learned syllable-pairings was immediately followed by a cold pressor stress test that induced moderate levels of emotional arousal. Taken together, these findings indicate that emotional arousal influences the reconsolidation of episodic and/or semantic memories. Accordingly, aroused emotion during psychotherapy may boost the update of the integrated memory structure in the course of reconsolidation (Fig. 1). Such a mechanism is also in line with psychotherapy process research that emphasizes the importance of aroused emotion during effective psychotherapy sessions.

We conclude that aroused emotion during psychotherapy serves two functions, not just one: (1) replacing maladaptive by adaptive emotions and (2) boosting memory updating during reconsolidation of the therapeutically altered memory traces.

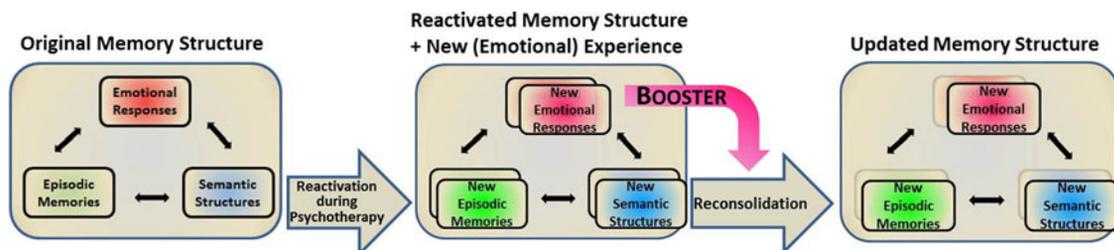


Figure 1 (Stein et al.). Illustration of the proposed mechanism: After reactivation, updating of the integrated memory structure is boosted by emotion.

## Mental model construction, not just memory, is a central component of cognitive change in psychotherapy

doi:10.1017/S0140525X14000326, e28

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**Abstract:** We challenge the idea that a cognitive perspective on therapeutic change concerns only memory processes. We argue that inclusion of impairments in more generative cognitive processes is necessary for complete understanding of cases such as depression. In such cases what is identified in the target article as an “integrative memory structure” is crucially supported by processes of mental model construction.

We support the approach of Lane et al. in focusing on cognitive processes in understanding psychopathology and how to treat it. However, we believe a broader range of processes is necessary to address in particular cases. In our papers (McIntosh et al. 2005; Sedek & von Hecker 2004; Sedek et al. 2010; von Hecker & Sedek 1999; von Hecker et al. 2013) and edited monographs (Engle et al. 2005; von Hecker et al. 2000) we stress the specific role of limitations in mental model construction in cognitive psychopathology, especially in subclinical depression.

There are close parallels between aspects of cognitive functioning in depression and the state resulting from pre-exposure to uncontrollability. In line with the cognitive exhaustion model (Sedek & Kofta 1990; von Hecker & Sedek 1999), we assume that some of the cognitive impairments observed in depression can be explained by experiences of unsolvable situations that lead to uncertainty. Such experiences may stem from past, irreversible life events, from subsequent rumination, or from counterfactual thinking. We hypothesize that uncontrollability and, in particular, ruminating thoughts about uncontrollable conditions, can lead to a depletion of those cognitive resources that support flexible, constructive thinking. Extended rumination by a victim of trauma, for example, may lead to cognitive states that impair building new cognitive models necessary for optimal functioning. Although constructive thinking may be initiated by depressive individuals, this cognitive limitation will impair the quality of new, integrative constructions or mental models related to a particular episode, a class of situations, or in more severe cases, about numerous aspects of life. Further, this may cause broader deficits given the central role of mental model construction for cognition in general (see Brewer 1987; Garnham 1997; Greeno 1989; Holland et al. 1986; Johnson-Laird 1996).

Considering only memory processes provides an incomplete picture of cognitive targets for therapeutic change; there is compelling evidence for cognitive limitations in depression that go beyond just memory performance (Sedek et al. 2010; von Hecker & Sedek 1999; von Hecker et al. 2013). Indeed, depressed participants demonstrate these limitations across various paradigms tapping mental model construction: (a) mental models of interpersonal sentiment relations (social cliques models); (b) linear order reasoning (mental arrays); (c) evaluation of categorical syllogisms (mental models of logical relations); (d) situation models (inferences about the meaning of written text). Of these, we shall discuss (a) and (b) in greater detail.

Regarding (a), depressed individuals often exhibit compromised interpersonal behavior (e.g., Gotlib & Hammen 1992). Thus, we (von Hecker & Sedek 1999) studied how mental models of sentiment patterns are constructed, a crucial component of understanding one’s social environment that might be affected by depression. (Participants were presented with series of pairwise sentiment relations (e.g., “Tom and Bill like each other,” “Tom and Joe dislike each other”) such that

the complete set of relations formed subsets of people who like each other within cliques whilst disliking people in other cliques. Amongst all relations, a few diagnostic ones would always determine the actual number of cliques. Although depressed individuals did notice the diagnostic value of these particular relations, they were less accurate than non-depressed individuals in determining the number of cliques involved. We interpret this as a demonstration of the difficulties depressed people have with the construction of adequate social mental models (von Hecker & Sedek 1999, Experiments 2 and 3). They remembered the key elements, but they could not generate a mental model based on that information.

Regarding (b), we studied the *symbolic distance effect* (SDE; see Leth-Steenen & Marley 2000), the phenomenon that if people learn bits of information such as “Tom is older than Harry,” “Harry is older than Jack,” and “Jack is older than Bill,” they respond quicker and more accurately when later asked about the older one in pairs of persons wider apart in the ordered sequence (e.g., Tom and Bill) as compared with narrower pairs (e.g., Tom and Harry). We (Sedek & von Hecker 2004) found this effect reversed in depressed participants. Given that the SDE follows on the basis of discriminability assumptions (Holyoak & Patterson 1981) when people construct an integrated linear model of the order information (e.g., Tom>Harry>Jack>Bill), we think that depressed individuals may not readily construct such models but rather rely on the original piecemeal information when responding. Overall, mental models are a prime vehicle for individuals to determine their perspective in the world and in social contexts (Garnham 1997; Holland et al. 1986; Johnson-Laird 1996; von Hecker et al. 1996) such that therapeutic intervention at this point seems essential.

Based on the above perspective and findings, we suggest that a crucial aspect of therapeutic change when dealing with depression (related to traumatic stress and other forms of emotional disturbances) may be to re-strengthen the ability to construct mental models, especially in the social domain. Concerning the therapeutic approaches to the above disturbances we also think that Lane et al.’s term “integrative memory structure” should be complemented by “construction of mental models.” Focusing on the creation of new mental models, especially for disorders such as depression, may be more consistent with the benefits seen from approaches, such as cognitive behavioral therapy, that deal with developing functional understandings and responses to current events in contrast to adjusting or understanding prior events.

Finally, we concur with Lane et al. on the importance of looking at cognitive processes as leverage points for therapeutic intervention. Cognitive processes are critical to how the internal and external world interact. We believe that as much as Lane et al. are right to stress the importance of interactions between emotion and memory content as a vantage point for therapeutic intervention, considering interactions between emotions and cognitive procedures is another useful vantage point. Moreover, our specific findings in depression underscore the importance of considering how there may be different foci for different disorders. This broader cognitive approach may have major relevance for future directions in developing therapeutic strategies.

### ACKNOWLEDGMENT

The preparation of this paper was supported by the Mistrz Programme (Grzegorz Sedek, Foundation for Polish Science).

## Memory reconsolidation and self-reorganization

doi:10.1017/S0140525X14000338, e29

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**Abstract:** Lane et al. propose that memory reconsolidation through new emotional experiences is an integrative pathway to change in psychotherapy. My commentary suggests that memory reconsolidation is an element within self-reorganization. Given the focal nature of the self to every aspect of psychotherapy, it is a more useful construct on which to build integrative models than memory reconsolidation.

The virtues of Lane et al. are many: I will name three that seem especially compelling. First, the authors offer a serious integrative framework through which to study common mechanisms of change across a range of psychotherapies. Second, the authors place emotional processing front and center in their conceptualization of change in therapy. The third virtue is the foundation of the first two: A neuropsychological explanation that illuminates both the basis for psychological difficulties and the process by which these difficulties can be changed in therapy.

What an elementary neuropsychological account offers is a sort of machete with which to cut away some of the tangled underbrush of competing theories that have proliferated in psychotherapy. Clearly, similar processes underlie all therapies at a neuropsychological level. We have known for some time that theoretically different approaches to therapy have roughly equivalent effects (Wampold 2001), and Lane et al. help to illuminate why that is the case.

The authors posit as the core mechanism of change in psychotherapy the reconsolidation of prior emotional memories through new emotional experience. I would suggest that as memories change in therapy what is ultimately changing is the self, and that the self rather than memory is a more helpful and fruitful construct around which to build psychotherapy integration. I will clarify this idea briefly in this commentary. In order to achieve a clear model, the authors have at times been overly schematic. It is true that many therapies view emotion as important to the process of change. However, Lane et al. downplay substantial differences in the functions accorded to emotion in each of these therapies. Some therapies (e.g., emotion-focused) view emotion generally as a very healthy and essential source of motivation, value, and meaning. Other therapies (e.g., cognitive) view emotion primarily as a signal of distress requiring a cognitive solution. One of the contributions of recent advances in neuropsychology (e.g., Damasio 1999; Lane & Garfield 2005; Ozier & Westbury 2013) has been to represent cognition as fully embodied and to convey the relation between emotion and cognition in some of its enormous complexity.

A disadvantage of trying to present emotion and memory as explanatory mechanisms at such a level of abstraction is that we are left with a limited sense of what is most basic in psychotherapy: a complex, healing encounter between two people. To paraphrase Rollo May in a different context, whose memory and emotions are we talking about? That is a slight misnomer because the self does not exist over and against memory and emotions but rather, to a degree, is constituted by memory and emotions. The reconsolidation of memory traces and resulting changes in behavior can be construed as necessary elements in the reorganization of the self. It seems to me that the construct of the self is a more promising foundation for psychotherapy integration. The self allows for a better understanding of autobiographical memory, a place for agency in the integration of changes to memory, and an appreciation of why a positive therapeutic relationship is crucial for change. Let us look at each in turn.

It is difficult to make much sense of autobiographical memory without reference to the self. Some leading researchers on autobiographical memory view it as inextricably linked to the self. In Conway's (2005) model, memory is understood to be highly motivated in relation to enduring goals and the maintenance of a coherent self. The working self plays a crucial function in organizing goals, creating and organizing memories, and controlling their accessibility. Another recent model (Prebble et al. 2013) also provides a framework for tracking the relation between memory

and self, underlining subjective versus objective and present versus time-extended representations. Two conclusions can be drawn: the complexity of memory is best analyzed in the framework of its relation to self; and much of the self, like memory, is implicit.

One of the core ideas of Lane et al. is that emotion and memory processes are very often implicit, they require no conscious awareness of feeling anything, and they are based on an unconscious "conceptualized as an extensive set of processing resources that execute complex computations, evaluations, and responses without requiring intention or effort" (sect. 2, para. 2). The self can also be viewed as a self-organizing system, and it is best conceptualized as constructed dialectically from the interaction of many subsystems, some of which are unconscious, including many aspects of memory (Pascual-Leone 1987). With his concept of the proto-self, Damasio (1999) strengthened the idea that the conscious self is built up from the synthesis of implicit processes. Agency and intention are integral to every aspect of the therapy context; even unconscious change will need to be absorbed and integrated into a concomitantly changing conscious self. There is engagement, motivation, and agency involved in the integration into memory and self of new emotional experiences.

The self is born in relationship and is inherently relational (Bowlby 1988; Schore 1994). Human flourishing is ultimately about the capacity for a loving relationship with others and with oneself. Difficulties in the interpersonal domain provoke much of the pain, conflict, and loneliness that lead people to engage in psychotherapy. The emotional memories that need changing almost always involve others and new emotional experiences stem at least initially from the safety, understanding, and care proffered by the therapist, which compose a key piece of the corrective emotional experience. Important recent work on psychotherapy process underlines the ways in which implicit process can rupture the alliance, and how the articulation and repair of what is happening in the therapeutic relationship can be profoundly healing (Safran & Muran 2000). As even implicit memories change, the self adapts and reorganizes as it integrates the change. The self as agent in therapy is both being changed by internal and interpersonal processes, and seeking to understand and integrate this change experience. The self is the construct at the crossroads of all these processes and is the best focus for psychotherapy integration.

## Authors' Response

### The integrated memory model: A new framework for understanding the mechanisms of change in psychotherapy

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**Abstract:** In this response to commentaries on our target article, we highlight and clarify a variety of issues and respond to several comments, challenges, and misconceptions. Topics covered include the mechanisms of enduring change, the nature of memory, the conditions in which memories are updated, the

role of emotional arousal in change, and current limitations in our understanding of the neural basis of change in psychotherapy. It is our hope that through research stimulated by this exchange the latter may be advanced.

We would like to begin by thanking the authors of the 28 commentaries for their interest in our paper. It is clear that many readers perceived considerable value in it, but there are also many questions and some criticisms. Our general approach for our response will be to address the commentaries by theme in an integrated manner in the sections below.

## R1. Enduring change in psychotherapy

A major question raised by some of the commentaries is about the scope of what we intended to address with our model. Collectively, commentators wondered whether we were aiming to address all possible treatments for all mental disorders. The answer is, yes and no. The IMM serves as a starting point for understanding the common mechanisms of change among many psychotherapies, but it is not meant to apply to every kind of disorder or symptom. Our focus is on understanding how psychotherapies can result in *enduring* change, which requires learning. In the context of psychotherapy this learning involves the revision of previously acquired behaviors and emotional responses that became routine over time. This revision of previous learning can occur in several ways, including extinction and reconsolidation. Extinction and reconsolidation differ in that only *reconsolidation* involves updating and revising what was previously learned, whereas *extinction* involves new learning that overrides, rather than changes, the old. In our view, updating the memory structure through reconsolidation provides enduring change that establishes new and adaptive ways to respond to novel situations.

**Mancini & Gangemi** question how we can account for the diversity of psychopathology with a “single-process explanation.” Although we discussed four psychotherapeutic perspectives – behavioral, cognitive-behavioral, experiential, and psychodynamic – we expect the basic tenets of the IMM to apply to many interventions, including those discussed by **Kimbrel, Meyer, & Beckham (Kimbrel et al.)** – dialectical behavior therapy, acceptance and commitment therapy, and interpersonal psychotherapy – and by **Spanagel & Bohus**, such as general interventions including psycho-education and relaxation training, and disorder-specific interventions such as anti-craving skills in substance dependence, shifting of attention in social phobia, and imagery rehearsal in the treatment of nightmares. To the extent that these therapies have as their primary goal bringing about enduring changes in situational construals and responses that are more adaptive, and to the extent that each of these modalities facilitates the regulation of emotion through a supportive relationship with a therapist, the ingredients are in place to reactivate old memories, try out new ways of experiencing the self in interaction with the external world, and consolidate more adaptive emotional and behavioral responses into an integrated memory structure.

Psychodynamic psychotherapy appears especially well-suited to address the issue of maladaptive behaviors and their enduring modifications. We were therefore somewhat

surprised that **Levin** thought the processes we discussed were not relevant to the day-to-day activities of psychoanalysts. Rather than addressing the evidence we presented and the specific theoretical (sects. 2 and 3) and technical (sect. 9.4) implications for psychodynamic psychotherapy, Levin’s commentary almost resembled a psychoanalytic interpretation: that we, the authors, were not consciously aware of the pervasive influence of culture on our ideas and that, unbeknownst to us, we were repeating the same old explanations others had for the past century, however much we might think otherwise. As we stated in section 9.4,

For many years psychoanalysis as a field was averse to conducting objective research on its methods and outcomes for a variety of reasons, including concern that such research would irreparably alter the emotional milieu of the very therapy that was being studied. Furthermore, because of the challenges of formulating and testing hypotheses that could be falsified, the ability of psychoanalysis to survive in an era of evidence-based practice has been questioned (Bornstein 2001). A more recent recognition within the field of the necessity for research (Leichsenring & Rabung 2008; Shedler 2010) holds promise for its survival.

**Levin** states that we should move beyond the immediate need for methodological validation and bureaucratic credibility. This is not our view. It is important to appreciate that without empirical evidence supporting its efficacy and its mechanisms of action, psychoanalysis, like any other therapy, is in danger of stagnation and ultimate decline. We hope that in some small way this paper contributes not only to its survival but to its growth.

The notion of enduring change also addresses the suggestion of **Kimbrel et al.** that the common mechanism of change should be a biological one, because pharmacological interventions produce outcomes similar to psychotherapy. Our perspective is a bit different, in that we draw on considerable evidence that the combination of psychotherapy and pharmacotherapy is superior to either treatment alone for most major mental disorders (Cuijpers et al. 2014). This could be because the two classes of intervention target different brain mechanisms that together constitute a more comprehensive and synergistic package (Goldapple et al. 2004). Although pharmacotherapy is often an effective treatment for symptoms such as depression or anxiety, our emphasis has been on the role of psychotherapy in reducing vulnerability to recurrence by instilling enduring changes that are maintained after pharmacotherapy is discontinued. Supporting a biological mechanism, **Marks-Tarlow & Panksepp** point to the efficacy of deep brain stimulation treatments for depression that involve subcortical stimulation of positive affect as evidence that “bottom-up” (presumably, biologically based) treatments can be therapeutically effective. We would argue that the simple activation of positive affect alone addresses neither the importance of the context in which the positive experience emerges, nor the interpersonal meaning that the experience has for the client. In our view, updating memory structures through reconsolidation is both necessary and sufficient for enduring change to occur in psychotherapy.

Taking a cognitive perspective, **Moyal, Cohen, Henik, & Anholt (Moyal et al.)** suggest that acquisition of adaptive emotion regulation strategies is a more plausible mechanism of change in psychotherapy than reconsolidation of emotional memories. We agree that change in

psychotherapy involves changes in emotion regulation. We would argue that changing the way an individual *interprets* situations and the way she *responds* to situations represents the development of antecedent-focused and response-focused emotion regulation strategies, respectively (Gross 1998a). Therefore, our model for change in psychotherapy includes an important role for emotion-regulation strategies.

A related issue is whether our approach is relevant for disorders other than trauma-related disorders, a question raised by **Kimrel et al.** Indeed, **Moyal et al.** assume that post-traumatic stress disorder (PTSD) is the primary focus of our paper, and that we assume a traumatic etiology for all psychiatric disorders. This is a misconception of our model. Fundamentally, we are addressing how situations are construed and how one responds to them. Early-life trauma is certainly an important topic here because it can induce strong biases in the ways people construe and respond to situations. However, IMM describes a general process whereby emotionally charged situations induce cognitive and emotional adaptations that have enduring effects on patterns of behavior, thought, and feeling. **Moyal et al.** suggest that what we mean by therapeutic change is a reduction in clinical symptoms. On the contrary, in our view the goal of psychotherapy is, to put it simply, to promote a more adaptive situational response. This may result in not only a reduction in symptoms, but also an improvement in the ability to achieve one's goals in major life contexts such as work, interpersonal relationships, and leisure pursuits.

**Ainslie** is in agreement with **Moyal et al.**, as they state that the role of emotional trauma in psychopathology is limited and that putting traumatic memories at the core of pathogenesis overstates the case. **Ainslie** places less emphasis on how change occurs than on describing the cognitive mechanisms—specifically, the conflict between urges and self-control—that maintain and exacerbate mental symptoms such as phobias or addictions. But our paper is primarily about the mechanisms of change in psychotherapy, not the etiology of psychopathology. Our core assertion is that emotional arousal and memory reconsolidation are primary mechanisms by which enduring change occurs in psychotherapy. Adaptation to psychologically overwhelming experiences (trauma) is an important contributor to psychopathology, but not to all psychopathologies. Many other factors likely contribute to pathogenesis, including genetic and other biological factors, gene–environment interactions (**Caspi & Moffitt 2006**), and modeling and other contexts that are not traumatic in nature (**Kendler 2012**). The question of why one person becomes borderline whereas another becomes agoraphobic, for example, is unanswered at present, and is likely to remain so in the foreseeable future. As we said at the outset, it is not our intention to account for all psychopathology or to account for the pathogenesis of all mental disorders.

## R2. On the nature of memory

Given the central role that memory and memory processes play in our model of therapeutic change, it is not surprising that many commentaries raised issues regarding this core element. Some commentators (**Montemayor** and **Solms**) focused on the question of what memory is for, each in

his own way emphasizing the idea that memory provides the basis for predictions that guide future behavior, and that this gives prediction error, or *novelty*, a central role in learning (a point also emphasized by **Ecker, Hulley, & Ticic [Ecker et al.]**). We completely agree with this perspective and would even go beyond these comments to point out that all forms of memory, not just episodic memory, are used for predictive purposes; for example, semantic memory, too, plays a critical role in prediction.

As we discussed at length in our paper, and echoed by **Klein & Markowitsch**, the dividing line between episodic and semantic memory is getting harder and harder to see. Semantic knowledge can be conceptualized as probabilities, based on past experience, that the world works a certain way. We learn the statistics of the purely physical world of the sun, moon, and planets, and we also learn the statistics of the behavioral world, leading to predictions about the behavior of others, and to the knowledge, for example, that relationships at times do not end well. In our target article, we emphasized the interactive nature of semantic and episodic memories in interpreting the world around us and guiding our behavior. We note, as an historical aside, that **O'Keefe & Nadel (1978)**, in laying out their thoughts about the hippocampus and its critical role in learning and memory, emphasized exploration and novelty as the key to understanding this system.

Several commentators thought we should pay less attention to memory and more attention to the self (**Montemayor** and **Whelton**), or to auto-noetic consciousness (**Klein & Markowitsch**). We respectfully disagree. Both conscious and unconscious access to memories are important in understanding the impact of prior experiences on future behavior. In many forms of therapy, making the noetic become auto-noetic may be helpful, but it does not appear to be necessary for psychotherapeutic change. Although the noetic–auto-noetic distinction speaks to the level of subjective access to prior experiences, it does not undermine the basic distinction between semantic structures (knowledge) versus memory for unique past episodes, a dissociation well documented in patients with bilateral damage to the hippocampus (**Nadel & Moscovitch 1997**). Our focus is on the processes and mechanisms of *enduring* change, not on the content of the change or how that content is conceptualized. It is not unreasonable to think that the self is constituted, at least in part, of memory for prior events and emotions, and that revising memories and emotions will revise aspects of the self as well.

## R3. Updating memories: How, why, and when?

A number of commentators asked what is essentially the following core question: When a memory updating event occurs, is the original memory overwritten, or erased, or transformed (**Brewin, Montemayor, and Roache**)? In our view, each of those things can happen, depending on the circumstances and the kind of memory one is talking about. For the kind of autobiographical memories psychotherapy is most often concerned with, the most common outcome is transformation, which is exactly what the therapeutic process is intended to accomplish. Memories are not replaced; they are revised by incorporating new information into an integrated trace through the corrective experience. Transformation does not imply having “no

trace” of the original memory, as Brewin suggests. Although the core of the original memory may remain, the details of the event and their connection to emotional responses may change considerably. In this way, the old memory becomes unavailable in its earlier form. But that is not the same as the trace being lost or overwritten. (An interesting incidental comment by **Marks-Tarlow & Panksepp** referred to therapists who “explicitly wish to promote reconsolidation.” We should make clear that memory reconsolidation occurs automatically without intentional promotion by the therapist.)

There is a wealth of evidence supporting the reconstructive nature of memory (reviewed in our target article), although the degree to which our memories can be transformed is sometimes difficult for people to accept. **Montemayor** raises the issue of the need for balance between accuracy and malleability of memories, which we agree is an area of inquiry that should be encouraged. Neisser’s (1981) notion of “episodic memory” is relevant here. Neisser argued that though the details of an event may morph considerably over time, the core of a given memory remains intact.

The issue of “truth” in memory is often controversial. Is it ethical to “replace” a “true” memory with a transformed one that is clearly not the “truth”? Is it “adaptive” (**Montemayor**)? For example, **Patihis** suggests that memory reconsolidation is equivalent to memory distortion, essentially creating “false memories,” and questions whether it is ethical either to the client or to family members. That such processes can be mishandled and can be potentially damaging is certainly true, as demonstrated by numerous stories of falsely recovered childhood memories during psychotherapy, sometimes leading to terrible outcomes for the client and their families (Loftus & Ketcham 1996). This is a complex issue, but it is important to start from the appropriate point—there is no such thing as a “true” memory in the first place. Memory of a past life event is almost always a reconstruction, more or less correct and subject to significant distortion. Some memories, perhaps our most salient ones, are retained with apparently clear and truthful detail, but this is very much the exception. Some have speculated that these exceptional cases are retained in detail precisely because they are highly diagnostic (Klein et al. 2002), and these may or may not be the ones we care about in therapy. Transformation of memories happens all the time, like it or not, and the point of psychotherapy should be to harness this naturally occurring phenomenon for good purpose. Nevertheless, there is clearly a need for rigorous training in psychotherapy before one should be allowed to practice. The situation may be analogous to the potential benefits or harm that can result in general medicine or surgery depending upon the quality of the practitioner’s training and level of expertise.

**Ecker et al.**’s commentary addresses the need to better understand the circumstances required for reconsolidation to take place—that is, why a memory becomes unstable, or to use their word, *deconsolidated*, setting the stage for transformation through reconsolidation. They point out that emotional arousal per se is not required for inducing reconsolidation, and we would agree with that statement. Our model allows for multiple routes to change, including semantic structures (as would be emphasized in cognitive behavioral approaches) and the experience of new, contradictory, episodic events. However, in the context of

psychotherapy, where the focus is overwhelmingly on emotional experiences and emotional responses to the world, emotion becomes a key route for change. We marshal a great deal of evidence in support of the idea that emotional arousal is a key component of psychotherapy, and that the corrective emotional experience in therapy is a major part of what is reconsolidated.

Whether there are circumstances that optimally induce deconsolidation in other contexts is a very interesting research question that warrants investigation. **Ecker et al.** suggest it is only under circumstances of cognitive mismatch that memories are destabilized and available for transformation. Intuitively, it makes sense that memories are updated only when there is new information available to update them. Our view is that a corrective emotional experience represents a very salient kind of cognitive (and emotional) mismatch, such as when the therapist responds in a way that is clearly contrary to the expectations of the client. Levenson (1994) long ago emphasized that emotion is activated whenever there is a change in the interaction between the person and his or her current situation that has implications for that person’s needs, values, or goals. According to **Diekelmann & Forcato**, and **Stein, Rohde, & Henke (Stein et al.)** this is exactly the type of situation that facilitates memory reconsolidation. Physiological arousal may be an important attribute used by memory systems, not only to distinguish what is important to remember for survival or adaptation versus what is not, but also to determine what justifies revision of established memory. This certainly leaves open the possibility that purely cognitive mismatches contribute to memory reconsolidation, but it also suggests that emotional responses may provide a particularly potent type of mismatch that leads to memory revision.

In the end, the similarities between **Ecker et al.**’s formulation (Ecker et al. 2012) and ours are notable. They, like us, state that there are three essential steps to creating change. Their first step involves explicit recall of the problematic memory and its current expression and feeling it emotionally. Our first step involves activating the problematic memory but not necessarily explicitly recalling it. Their second step involves conscious recognition of mismatch or disconfirming information and feeling the experience of juxtaposing that information with the original memory in step one. Our second step involves activation of new emotional experiences (a critical step also emphasized by **Pascual-Leone & Pascual-Leone**) that allows the situation to be experienced and understood in a different way. Their third step involves repeated juxtapositions of the contradictory information in steps one and two. Our third step involves repeatedly experiencing and “working through” the emotional consequences of new learning in a variety of contexts. Further research that evaluates the similarities and differences in these models will likely be useful to the field.

Several other commentators discuss proposed mechanisms for memory change that have aspects in common with our IMM. We welcome the comparisons across models that may lead to a deeper understanding of this issue. For example, **Llewellyn** provides a nuanced discussion of the term *reconsolidation*, preferring instead *reassociation*, based on evidence derived from research on sleep and dreaming, and emphasizing the importance of both integration and segregation for understanding memory change. We do not disagree that reassociation, which

appears to involve transformation of semantic knowledge structures, can be an important source of enduring change. But it is not the only kind of transformation possible. Our use of the term *reconsolidation* is meant to encompass a number of ways in which memories and knowledge structures can be changed. In this sense, our model is in line with Llewellyn's ideas, and it will be strengthened by considering the details of the processes involved in memory transformation and the impact of the corrective experience.

Relatedly, **Reyna & Landa** emphasize the considerable overlap and specific areas of separation between fuzzy trace theory and our proposed framework. One area of convergence is that our focus on the transition from episodic to semantic memory involves extracting common or gist elements from personal experiences. Although Reyna & Landa emphasized the distorting aspects of emotion on memory, their commentary raises the question of whether corrective emotional experiences consisting of new primary emotion might recast the gist of past experiences in a way that would promote development of a healthier sense of self.

#### R4. The emotional arousal component of the IMM

Several of the commentaries seem to suggest that we were proposing emotion as the *only* avenue to therapeutic change (e.g., **Ecker et al.** and **Patihis**). That is not the case. Our model is interactive and integrated, such that memories, semantic structures, and emotions are engaged equally when any one component of the model is accessed. We go to great lengths to point out that there are multiple routes to change, all leading to updating of the entire model. Nevertheless, activating or modulating emotions likely increases the efficiency with which change comes about, regardless of the emphasis of any particular psychotherapeutic method. So, emotions do matter.

Counter to our position, **Patihis** points out that cognitive-behavior therapy (CBT) does not aim at high emotional arousal, nor does it always induce it, and yet CBT works well. We are aware that CBT, and more specifically cognitive therapy (Beck 1979), is the only one of the four modalities we discussed that often does not focus on emotional arousal as an ingredient of change. However, it is also true that the effectiveness of CBT treatment for anxiety and depressive disorders may not be enduring, at least in some cases. For example, Vittengl et al. (2007) reported that the mean proportion of patients who experience relapse or recurrence after receiving acute phase cognitive therapy was 29% in the first year and 54% in the second year. In section 9.2 of the target article we explain how changes in the way problematic situations are construed as a result of CBT could lead to reduction in emotional arousal associated with those situations. We suggest that these changes in arousal (and valence) might be incorporated into the memory structure through reconsolidation. Thus, we propose that a change in arousal might be a mechanism of change in CBT rather than an outcome. We appreciate that it is often not customary to view emotional arousal as playing a causal role in how CBT works. We present this perspective through the lens of the IMM as a testable hypothesis for future research.

**Marks-Tarlow & Panksepp** suggest that we advanced a "top-down" approach to emotion and memory reconsolidation, asserting that we failed to give adequate credence to the subcortical origin of emotions. This was a surprising characterization to us and does not fit the mechanisms that we describe. Their position is actually consistent with classic psychoanalytic concepts of emotion (Solms & Panksepp 2012), but it is one with which we take exception based both on the neuroscientific evidence that we reviewed in considerable detail in section 2 and for important clinical reasons. As we discussed in section 2, clients who have been abused may have emotional responses at the time of the trauma that are diffuse, undifferentiated, and high in arousal, and indeed, those clients are often unaware of how they felt at the time. It is often only in therapy that they can formulate for the first time, and experience for the first time, the full range of emotions related to the trauma (if one is covering in fear, one does not feel capable of angrily fighting back and does not experience anger, although it may be activated to some degree). Therefore, we agree that emotions originate subcortically and in fact often have a bottom-up trajectory, but we would argue that in many cases emotional experience is formulated and created for the first time in therapy (Levine 2012), not simply recovered by undoing defenses that conceal the presumably well-differentiated emotions.

We must point out that there is in fact very little difference between **Marks-Tarlow & Panksepp's** view of the subjective experience of emotion in animals and our view of implicit emotion in people. Our views on the nature of animal emotional experience are consistent with those of LeDoux (2012), who proposes that humans and other living beings share survival circuits (neural mechanisms mediating basic life functions such as feeding and reproducing), and that conscious emotional feelings occur when activation of these survival circuits interacts with the mechanisms for conscious processing. Panksepp's theory of what animals experience when subcortical affective circuits are activated (Panksepp & Biven 2012) is non-specific and consistent with the interoceptive awareness of bodily sensations that people can experience during the activation of implicit emotions. We would also point out that many of Panksepp's basic affective circuits include connections between subcortical nuclei and structures such as the anterior cingulate cortex (Panksepp & Biven 2012), raising questions about why the subcortical structures alone are thought to mediate conscious experience when they are in direct communication with phylogenetically newer paralimbic structures that in human studies correlate with subjective experience (Medford & Critchley 2010).

**Mancini & Gangemi** question the fundamental importance of the transition from implicit to explicit emotional responses, because subjective reports of anxiety often do not correlate with objective measures of physiological arousal. Certainly, the topic of the variable relationship between subjective emotional experience and physiological indices of arousal in normative or clinical contexts is one that is widely debated and for which no clear consensus has been achieved (Critchley & Harrison 2013). These authors also find it paradoxical that we espouse promoting emotional awareness when many clients, such as those with anxiety disorders, appear to suffer from an overawareness of their anxiety or related symptoms. We recognized this issue in the target article by pointing out the deleterious

effects of repeatedly rehearsing the same distressing experiences from the past. Instead, we emphasized the importance of accessing and becoming aware of new emotional information, such as experiencing a therapist's encouraging responses when criticisms and negative judgments were anticipated. In short, our goal was to emphasize the usefulness of "corrective emotional experiences," not emotional awareness of any and all kinds.

## R5. The neural bases of psychotherapeutic change

Our position is that enduring changes occur in psychotherapy that are manifested emotionally, cognitively, behaviorally, and physiologically in the brain. **Roache** appreciated the coherent, multilevel nature of our model of change in psychotherapy. Several authors, however, commented on the pressing need to further our understanding of the level of brain mechanisms mediating these changes, and we agree. In his commentary, **LaBar** points out the limitations of our current understanding of the interaction of the neural circuitry of emotions, centered on the amygdala, and those mediating episodic memories. In psychotherapy, we understand that this intersection is key to real behavioral change. We agree with **LaBar** that the field would benefit greatly from a broader neural systems approach that integrates emotional memory, emotion regulation, and reconsolidation. Similarly, **Ortu** brings our attention to the specific neuromodulatory mechanisms that underlie behavioral learning following an aversive event. This leads to the intriguing idea that the therapeutic session may be ideally suited to positive change because the therapist can directly manipulate specific learning contingencies, contingencies that are unlikely to be manifest in the real world.

The influence of sleep on memory mechanisms is another area of cognitive neuroscience with great potential. We pointed out that one of the implications of our model is that napping or sleeping after a therapy session could potentially enhance reconsolidation of memories and that new information added to the original memory could include emotional information from the therapy session. **Dielmann & Forcato** report evidence from exposure therapy treatment of spider phobia that sleep may specifically support the strengthening and updating of emotional memories. This point was further amplified by **Stein et al.**, who report on a series of experimental studies demonstrating that emotional content not only enhances memory consolidation but also has a stronger effect than emotionally neutral content on boosting memory reconsolidation.

Taking the contrary position, **Spanagel & Bohus** question the utility of memory reconsolidation. They argue that reconsolidation effects have been difficult to demonstrate consistently in the laboratory, and that clearly defined determining factors and experimental conditions that might inform therapy have yet to be identified. **Liberzon & Javanbakht** point out that memory reconsolidation was initially described in animal models and in relationship to relatively simple memory traces of fear conditioning. They suggest that more complex memory systems in humans, particularly for traumatic events, might work differently. **Patihis** points out that there is insufficient evidence that changing memories causes improvement in therapy (see also **Ainslie** and **Spanagel & Bohus** for similar comments). We discuss the evidence for

reconsolidation in humans in our article, including its relevance to PTSD. Although we recognize the challenges in studying reconsolidation, particularly as it applies to human memory, it is our opinion that further research on the neural mechanisms of reconsolidation and the relationship between reconsolidation and therapeutic improvement is important. One of the challenges in such research is that the usual short-term endpoints after treatment (e.g., three or six months) may not be sufficient to capture the enduring changes that we are seeking to explain.

## R6. Misconceptions about the IMM

**Moyal et al.** point out that CBT, emotion-focused therapy (EFT), and other modalities focus on the here and now and do not specifically endorse recollection of past events for the purpose of understanding the developmental origins of current difficulties. Here we must reiterate that it is not necessary to explicitly recall the memory to engage in revision through reconsolidation, but rather it is necessary to reactivate the memory trace through reminders that reference the original memory, regardless of awareness. Thus, having experiences with the therapist that are counter to expectations, in which the expectations are a product of the influence of an old memory, is sufficient to engage reconsolidation.

An important question raised by **Liberzon & Javanbakht** is whether "contextualization" – that is, the process of updating old memories by adding novel contextual elements – is actually independent of reconsolidation, because it does not require that the old memories become unstable. We believe that recalling old memories with some details of the original context puts that memory into a labile state that allows new contextual elements to be added to the original memory through reconsolidation. The specific components or the extent of a retrieved context that is necessary to shift the memory into a labile state (referred to as deconsolidation by **Ecker et al.**) is an empirical question that has yet to be answered.

**von Hecker, McIntosh, & Sedek (von Hecker et al.)** note that depressed individuals show limitations in their ability to create and update mental models of their social world. They propose that mental model construction, not just memory, is a central feature of cognitive change in psychotherapy. Although they present no evidence to support their supposition, their approach is representative of cognitively based treatment modalities that focus exclusively on cognitive mechanisms as opposed to a reconsideration of the past. In our view, a mental model is a semantic memory structure. If it is to influence future behavior, a change in an integrated memory-emotion-semantic model must be retained so that it can affect construals of social situations in the future. Thus, we would take issue with the position of von Hecker et al. that a focus on memory excludes mental model construction. We would emphasize once again that memory structures can be activated and modified without explicit recall of the past.

## R7. Enhancing therapeutic change

Finally, a number of commentaries provided varied and interesting discussions of factors and methods that are

generally consistent with our formulation but may further enhance the therapeutic outcome. In this section, we briefly describe how these proposals mesh with the IMM model.

**Mann, Cone, & Ferguson (Mann et al.)** point out that implicit attitudes are highly relevant to the situational construals that are addressed in psychotherapy. Based on their experimental findings, they contend that implicit attitudes can be revised strongly, quickly, and durably if individuals believe that new information is true and predictive of what will likely happen in the future. In our model, we emphasize the need to expand these experiences to other contexts. One important way this expansion occurs is through the therapist's facilitation of the client's own experiences outside of therapy. The latter shifts the focus from the client's belief in the therapist to the client believing what her own newly articulated experience is telling her about herself. Of course, validation and support by the therapist is an important part of the process of the client coming to accept and integrate this new information, but the critical discovery and articulation of the new experiences often originate with the client, not the therapist.

The commentary by **De Brigard & Hanna** highlights the use of counterfactual thinking and the emotional changes that it induces, both in the context of CBT and in daily life; that is, the tendency to experience positive affect when repeatedly thinking about the implausibility of alternative outcomes of past personal experiences. This idea reinforces and extends our proposal that a critical ingredient of change in CBT is the emotional state that results from the alterations in thinking that are promoted by CBT. Thus, the phenomenon that we describe in relation to CBT may be a more general phenomenon linked to the post-processing of emotional events that helps healthy individuals stay healthy.

The concept that the IMM is relevant to normative functioning was expanded by **Benga, Neagota, & Benga (Benga et al.)**, who point out an intriguing connection between our view and anthropology. These authors raise the possibility that the processes we describe as essential ingredients for enduring change in psychotherapy also apply to cultural rites of passage, which constitute culturally created methods of facilitating developmental transitions across the life cycle. Consideration of whether IMM applies to a range of cultures is potentially important, particularly in light of the comments of **Levin**, who expressed concern that our model might reflect a particularly Judeo-Christian orientation to human experience.

Several promising suggestions are discussed by **Stanioloiu & Zaretsky** regarding alterations in retrieval operations, such as enhancing the capacity to retrieve positive emotional memories, and maintaining a first-person perspective during recollection of both positive and negative memories. Although our model focuses on the mechanisms of change (encoding), there is no doubt that considering both encoding and retrieval mechanisms will result in a more comprehensive understanding of how memory change occurs in psychotherapy, a point also emphasized by **Brewin**. Focused research that compares and contrasts the relative merits of competitive retrieval versus reconsolidation in a psychotherapy context would be very useful.

**Whelton's** commentary emphasizes the positive impact of interpersonal relationships, not only in real life but also in the client-therapist relationship (in contrast to

**Mancini & Gangemi's** discussion of the role of negative interpersonal relationships in maintaining dysfunction). This is an intriguing idea; these social interactions may play a crucial role in memory transformation when stories are repeatedly recollected and shared with others, as we have argued elsewhere (Ryan et al. 2008c). A more thorough understanding of the qualities of social interaction that lead to positive transformation of painful and distressing memories could be extremely important for understanding not only the therapeutic process but also the social circumstances that allow individuals to cope with adverse life events.

Individual differences in the clinical response to psychotherapy is one of the most important, and poorly understood, issues in the field today. **Kimbrel et al.** raised the critically important question of how the proposed model accounts for individual differences in treatment response. Here we would focus on individual differences in the capacity to process emotional information, as addressed by **Pascual-Leone & Pascual-Leone**. The ability of clients to experience differentiated emotions and describe their experiences in words is a predictor of successful treatment for panic disorder either with CBT or manualized psychodynamic psychotherapy (Beutel et al. 2013). In our target article we discussed the inverted-U shaped functional relationship between arousal and the ability to articulate one's own thoughts and feelings as well as those of others. Shifting arousal level so that the client is functioning at the peak of the inverted-U function may contribute to greater awareness and emotion processing that can contribute to the propensity for corrective emotional experiences. The same may apply to understanding individual differences in vulnerability to disorders, such as PTSD. Only about 20% of traumatized individuals develop PTSD (Admon et al. 2013). Consistent with the inverted-U relationship just mentioned, it has been proposed that complex childhood trauma is associated with a "window of tolerance" between sympathetic-dominant hyperarousal and parasympathetic-dominant hypoarousal (Corrigan et al. 2011). Functioning within this window may enable subjects to self-regulate more effectively than at the extremes on the arousal continuum and could conceivably play a preventative role. A more thorough understanding of the biological, psychological, and social factors that contribute to individual differences in resilience and vulnerability are needed for the field to make progress.

## R8. Conclusion

In summary, we welcome the opportunity to discuss the points, questions, and objections raised by our colleagues. It is our hope that our formulation will engender consideration, debate, and research on the mechanisms of change in psychotherapy. We firmly believe that applying the concepts and theories of cognitive neuroscience—from the fields of memory, emotion, decision making, and others—will inform this field and help propel it forward in the future.

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[The letters "a" and "r" before author's initials stand for target article and response references, respectively]

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