Chapter 12

Memory reconsolidation, emotional arousal and the process of change in psychoanalysis

Richard D. Lane

Introduction

It is an honor and privilege to contribute to this volume on outcome research and the future of psychoanalysis. For many years, and for understandable reasons, the field of psychoanalysis advanced primarily by linking careful clinical observations with sophisticated clinical theorizing. Relative to other psychotherapy modalities there was a strong preference for viewing "experience distant" objective clinical research as unnecessary or even unhelpful and, as such, the field stood as an outlier relative to other modalities in mainstream clinical psychology (Bornstein, 2001). More recently the need for such research has become evident if it is to survive in this era in which third party payers rely on outcome data to make decisions about reimbursement for care. Several excellent contributions in this volume (e.g., Leichsenring & Rabung, 2008; Shedler, 2010) have demonstrated that psychodynamic psychotherapy and psychoanalysis (hereafter referred to as PDT) are indeed very effective. Within this context of competition and external scrutiny, it is important to be able to explain both how PDT fits into the wide range of modalities available and what PDT offers that distinguishes it from other approaches. To do so I will present a recent theory of change in psychotherapy based on advances in neuroscience that applies to all major psychotherapy modalities and will explain from that vantage point what PDT offers that may make it the treatment of choice under certain circumstances.

In a recent paper in Behavioral and Brain Sciences (BBS) (Lane et al., 2015a), my colleagues and I put forward the idea that enduring change in all psychotherapy modalities that bring about enduring change do so through reconsolidation of emotional memories. The fundamental advance that made this theory possible is the discovery that memories become labile or malleable whenever they are recalled and that information made available when the memories are in the labile state can be incorporated into the original memory in a process called memory reconsolidation (Nadel, Samsonovich, Ryan & Moscovitch, 2000; Elsey et al., 2018). We further proposed that emotion was the key ingredient in this updating process. As such, this theory was consistent

with Freud's concept that patients "suffered from reminiscences" (Freud, 1910) as well as the central role that affect has played in psychoanalytic models of the mind and treatment since its inception (Freud, 1895; Spezzano, 1993).

Emotion is a particularly potent way to update memories because synaptic plasticity, which is the molecular basis for encoding memories, is enhanced by the neurotransmitters and hormones (e.g., norepinephrine, cortisol) that are activated by emotional arousal (Schwabe et al., 2012). As such, emotion makes otherwise neutral events more likely to be remembered, and, to the extent that emotional experiences were activated at the time of an event, those experiences constitute critical information that is incorporated into the memory of that episode. Any given event is encoded in memory in multiple ways corresponding to the modalities activated at the time (e.g., sight, sound, movement) (Schacter, Wagner and Buckner, 2000) and emotion is one such modality that can be updated. Moreover, memories are stored and retrieved in a mood congruent fashion (Bower, 1981). For example, when in a happy mood, happy memories are more likely to be recalled; when in a depressed mood, memories related to sadness and loss are more likely to be recalled. This intimate relation between emotion and memory may lie at the heart of the utility of the free association method.

In the BBS paper (Lane et al., 2015a) we proposed that the three essential ingredients for enduring change in psychotherapy, which apply to PDT as well as other modalities, are: (1) reactivating old memories whether through explicit recall or reminders, as well as activating the "old" (usually painful) affect associated with those old memories; (2) engaging in new emotional experiences during treatment that are incorporated into those reactivated memories via the process of reconsolidation; and (3) reinforcing the updated memory by practicing new ways of behaving and experiencing the world in a variety of contexts. These three ingredients have come to be known as the "LRNG Model" of change based on this first initials of the last names of the paper's authors (Lane, Ryan, Nadel, and Greenberg). This acronym also captures the notion that enduring change in psychotherapy involves a particular type of "learning" that involves interactions between emotion and memory as well as between different types of memory.

In the BBS paper we also introduced the "integrated memory model," which states that whenever episodic memory, semantic memory, or emotion are activated, the other two are activated as well. Our theory of change holds that what distinguishes between different psychotherapy modalities is how access is gained to the "integrated memory model." Thus, PDT preferentially enters this interactive matrix through episodic memories, whereas cognitive-behavioral therapy, for example, preferentially enters it through semantic memories and associated thoughts. The idea here is that new emotional experiences in psychotherapy contribute to the episodic memory of that episode, which interact with and potentially modify semantic memory or generalizable knowledge corresponding to the recurrent pattern that is the focus of treatment.

In the next sections I will review relevant advances in the neurosciences with regard to memory reconsolidation, the interaction between episodic and semantic memory, implicit emotion, emotion-memory interactions in the context emotional trauma and the process of change. Following this I will then discuss how this model applies to PDT and how it helps to explain what PDT uniquely offers.

Memory reconsolidation

Memory consolidation refers to the transformation of memory from short (temporary) to long term (enduring). The traditional 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, multiple trace theory (MTT), a relatively new innovation in memory research, 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, Samsonovich, Ryan, & Moscovitch, 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 (Hupbach, Gomez, Hardt & Nadel, 2007; Nadel, Campbell & Ryan, 2007; Wilson & McNaughton, 1994; Hardt, Einarsson & Nader, 2010). 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 as well as new relevant information pertaining to the original memory. 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, Schafe & Le Doux, 2000), even when that reactivation is nothing more than a reminder of the spatial context of the original event.

In discussing memory reconsolidation it is important to distinguish it from the behavioral phenomenon of extinction. Reconsolidation is assumed to actually change components of the reactivated memory, whereas extinction is assumed to merely create a new memory that over-rides the previously trained response (Milad & Quirk, 2002). Thus, an "extinguished" response is not really gone, since 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, Freudenthal & Romano, 2011; Inda, Muravieva & Alberini, 2011; Maren, 2011).

In humans, Hupbach and colleagues (2007; Hupbach, Hardt, Gomez & Nadel, 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, participants were either reminded of the first session or not and immediately afterward 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, while 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.

Episodic and semantic memory

Episodic and semantic memory seem, at least phenomenologically, quite different from one another. Episodic or autobiographical recollection involves thinking about a past event—it is personal, emotional, imbued with detail, 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. While

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 allows us to predict the outcomes of new situations using the generic knowledge gained from similar situations in the past. This formulation suggests that episodic and semantic memory are representational systems that together capture both the regularities and irregularities of the world, allowing one 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 (Ryan, Hoscheidt, & Nadel, 2008b).

It has long been assumed that these two types of memories are relatively independent of one another, both functionally and anatomically (Schacter & Tulving, 1994; Schacter et al., 2000; Tulving & Markowitsch, 1998; Aggleton & Brown, 1999). Recent research, however, has called this independence into question (see Ryan, Hoscheidt, & Nadel, 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, Cox, Hayes & Nadel, 2008a; Ryan, Lin, Ketcham, & Nadel, 2010; Hoscheidt, Dongoankar, Payne & Nadel, 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. This information can then be retrieved separately from a specific context if necessary.

Semantic memory is therefore 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 that 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.

Implicit emotion

In contrast to a model of the unconscious as a cauldron of forbidden sexual and aggressive impulses and wishes, the "adaptive unconscious" (Bargh & Morsella, 2008) 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).

The distinction between implicit and explicit processes, a cornerstone of modern cognitive neuroscience, has also been applied to emotion (Kihlstrom, Mulvaney, Tobias, & Tobias, 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 chapter 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 (Lambie and Marcel, 2002; Kihlstrom, Mulvaney, Tobias, & Tobias,

2000; 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 (Quirin et al., 2009; Winkielman & Berridge, 2004; Zajonc, 2000; Ledoux, 1996; Smith & Lane, 2016). 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).

The somatomotor component of implicit emotion refers to automatic motor expressions of emotion such as facial expressions and gestures but also involves more complex behavioral phenomena such as scripts, enactments and procedures. In 1991, Clyman wrote an important paper in a psychoanalytic journal on the procedural organization of emotion (Clyman, 1991). He put forward the idea that transference may be understood to be organized at the implicit, procedural level and that the processes of interaction in the transference reflect previously learned ways of enacting emotion. This is entirely consistent with what we now know about implicit emotion as the bodily expression of emotion at the visceromotor and somatomotor level that precedes the conscious *experience* of specific, differentiated emotion feeling that must be constructed, as opposed to uncovered (Lane et al., 2015b; Barrett, 2017). This procedural level can be thought of as "the doing of emotion"—rule-based schemas for how to express love, handle anger, get attention, joke around and obtain love and reassurance (Lane & Garfield, 2005). It is a key element of what the Boston Change Process Study Group (2007) meant by the "implicit level of relational knowing."

Emotional trauma

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).

All too commonly, perhaps due to 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 them emotionally. This lack of awareness contributes to the tendency to experience traumatic threats in circumstances 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 (Stern, 1983; Lane & Garfield, 2005).

This 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, i.e., converting implicit emotional responses to explicit emotional responses. When the trauma is first recalled, the description of experience likely includes strong emotions such as fear that were experienced at the time and contributed to strong encoding of the event (McGaugh, 2003). As the therapy process unfolds, the events are recalled in the context of a supportive therapist who also helps the patient to attend to contextual information that may not have been available to the patient at the time of the trauma (in part because of temporary hippocampal dysfunction; Nadel & Jacobs, 1998). This new information in therapy contributes to a construction of the events in a new way that leads to emotions that had not been formulated or experienced before, e.g., experiencing anger at abuse that could not be either expressed or experienced at the time because the threat may have been 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 likely was not permissible at the time of the trauma to experience or express it. This helps create a coherent narrative account of what occurred. This is not the same as catharsis (uncovering what was previously known and releasing 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).

This suggests that distressing or traumatic event memories 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.

MTT provides a way of understanding how distressing emotional memories can be both strengthened over time and also the potential for being altered therapeutically. 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 context 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 sympathetic nervous system is reactivated via the amygdala. 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.

Process of change

MTT 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, which is step 1 in the LRNG model of change. 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, which is step 2 in the LRNG model. Next, the new way of construing and responding to familiar problematic situations must be implemented in a variety of circumstances, which is step 3 and the "working through process." It is conceivable that once this transformation has taken place the original memory including the associated emotional response can no longer be retrieved 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 interaction between memory and emotion and between different types of memory.

Applying these principles to relational psychoanalysis (Lane, 2018), the procedural or implicit aspects of emotion are in constant interchange between patient and analyst at the implicit level of relational knowing (Boston Change Process Study Group, 2007). A key phenomenon is that the analyst processes his or her own implicit (body based) and background (conscious but in the attentional background) feelings to make sense of the current interactive experience. This is accomplished by integrating an understanding of the patient's

recurrent patterns with the analyst's current interoceptive and introspective experience in the present moment.

A key element of the work of psychoanalysis is for the analyst to construct his or own experience to inform how these recurrent patterns are being manifested in the present moment of interaction and how these influence the experience of all those with whom the patient interacts (Eagle, 2000). If this conscious processing is not done, the implicit emotion may be enacted. Indeed, while enactments are inevitable, explicit reflection upon and discussion of such enactments may be extremely useful therapeutically (Safran, Muran & Eubanks-Carter, 2011).

Wachtel (2009) has described how the recurrent patterns of the patient are maintained by virtue of the fact that the patient's actions induce emotions in the other person that lead to behavioral responses that maintain the patterns. These "cyclical relational patterns" typically operate at the implicit level—one action leads to actions by others in response via the emotions induced in the transaction. The analyst's job is twofold: to consciously construct and experience the emotion so induced, to understand its origin and meaning, and then to use this information to promote a corrective emotional experience in the patient, as opposed to repeating the pattern unknowingly.

The second step in the change process is corrective emotional experience. This is not the hokey, artificial, and manipulated corrective emotional experience attributed to Franz Alexander by his critics at the time that the concept was introduced (Alexander & French, 1946; Wallerstein, 1990) but rather the process of making use of the authentic emotional responses generated by the interaction to provide the patient with what she needs. For example, providing the experience of being understood, cared for and even loved when criticism, judgement, and shame are expected. Or, to be taken seriously and to be protected from harm when earlier life trauma had been associated with being ignored and unprotected. If this corrective emotional experience occurs when the old memory and old painful feelings are activated, this may constitute the kind of critical moment that Daniel Stern (2004) describes and is the second step in the three-step process of change that we describe.

The third step in the LRNG model is the transition from episodic to semantic memory and the "working through" process. By providing new experiences in therapy that update prior event memories through reconsolidation, the semantic structures derived from experiences will also change. 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. As proposed in our integrated memory model, linkage to emotional responses is expected to translate into greater adaptive flexibility and success relative to the difficulties that led the patient to seek treatment.

Discussion

It is fascinating to consider how the present model of change resonates with concepts put forward at the inception of the modern era of psychotherapy with the publication of Breuer and Freud's (1895/1955) "Studies on Hysteria." These authors held that memories and their associated affects were the problem (the source of the symptoms or dysfunction), the analyst's job was to facilitate overcoming the patient's resistance to enable recall of the memory and affect, and the curative aspect was to experience and express the affect that had been pent up (assuming that catharsis was the mechanism of cure). If recall could be accompanied by the experience and expression of the affect associated with the trauma, the memory would go through a process of what Freud called "retranscription." This process of retranscription would change and update the memory and the symptoms would be resolved (Freud, 1896/1966). It is therefore remarkable to note that, to our knowledge, Freud's concept of "retranscription" was the first reference to what has now come to be known as memory reconsolidation.

Freud's early thinking has also contributed in a major way to the conceptualization of affect as described in our model. It is customary in PDT to view affect as always pressing for discharge or expression while being kept out of awareness by virtue of defensive processes (Brenner, 1973). According to this view, the essential therapeutic task is to uncover the affect or emotion that had been previously formulated and known in order to allow its conscious registration. Although such phenomena are well established in PDT, the current model places particular emphasis on a developmental process whereby emotion is transformed from a purely bodily state to one that is mentally represented, i.e., from implicit to explicit. In that regard, my colleagues and I have proposed the concept of "affective agnosia" to highlight how deficits in the ability to mentally represent emotional states at the conceptual level (Lane et al., 2015b), such as that often seen in the context of trauma, provide a complementary perspective to the concept of defense. Indeed the two are not mutually exclusive in that deficits may help to explain why certain conflicts are not resolved and defenses become entrenched (Summers, 2013). It is therefore notable that the term "agnosia" was coined by Freud in 1891 while practicing as a neurologist before he created the field of psychoanalysis (Freud, 1953). This concept is not one that Freud pursued once psychoanalysis was established (Levine, 2012) but its relevance in the current context provides an opportunity to extend Freud's legacy.

An important way that PDT differs from other major modalities is its unique and time-honored focus on the etiology of current dysfunction. Traditionally this focus has been associated with the assumption that *understanding* the (presumed) etiology of a problem, as well as its manifestations through the years up to the present, will be a major contributor to resolving it (Brenner, 1973). This stands in contrast to the focus by other major modalities

on the factors that *maintain* current dysfunction. In some ways the concept of memory reconsolidation addresses this point directly. If one accepts the foundational premise of this model, namely that memories are not veridical records of the past (which Freud asserted; Schimek, 1975) but instead accepts that memories of the past may have been updated through the years (which Freud also claimed; Freud, 1896), one may view recollections of the past as the current version of memories that maintain the ongoing difficulties. This is not to discount the value of recall of past experiences as informative about earlier development. The current version of the recurrent pattern began at an early age and evolved over time. An adult's description of the early childhood environment, whether it is objectively accurate or not, can assist the clinician in identifying the specific nature of the current difficulties in relationships. What this amounts to is a developmental perspective on the factors that maintain the current difficulty. As such, this reframing of the concept of etiology in light of the phenomenon of memory reconsolidation allows for some convergence and potential overlap between psychodynamic theory and the theories underpinning other modalities.

The LRNG model emphasizes corrective emotional experiences as a necessary ingredient of the change process. In general, these are understood to be conscious emotional experiences that are counter to expectation and typically involve more positive emotions than anticipated. In the case of PDT these corrective experiences happen most importantly in the transference relationship with the therapist. As described by Daniel Stern (2004), progress in therapy may involve unusual critical moments that could not be planned or anticipated and are particularly memorable. In the context of PDT, it is also important to consider that the implicit process of relational knowing may involve interactions that induce more subtle feelings in the patient that may not be particularly memorable but over time may alter expectations and create hope that a new type of interpersonal experience may be possible. Indeed, Fonagy (1999) stated that "Psychoanalysis is more than the creation of a narrative; it is the active construction of a new way of experiencing self with other" (p. 218). Perhaps corrective emotional experiences that may or may not be noticed may be happening frequently and contribute an altered ability to relate to others in more trusting and less defensive ways. Perhaps the frequency of sessions and the intensity of the relationship with the therapist may provide a learning context for the transformation of recurrent patterns through reconsolidation that may differentiate PDT from other modalities and provide unique advantages.

Although the integrated memory model and the LRNG model focused on episodic memories, semantic memories, and their interaction, procedural memories were also described above in relation to transference, recurrent maladaptive patterns and the process of making behaviors more automatic through practice. In this regard, it is notable that the ability to change or update memories through reconsolidation is easiest for episodic memories,

more difficult for semantic memories and harder still for procedural memories (Schacter, Wagner, & Buckner, 2000). Much less is known about the latter two compared to the former. This means that by virtue of corrective experiences and the updating of episodic and semantic memories patients will be better able to construe familiar problematic situations differently and will have the ability to respond emotionally in different and potentially more flexible ways. It will take considerable practice, however, to overcome the old automatic behavioral tendencies. In this context, conscious understanding of the recurrent patterns and their manifestations through insight can assist in interpersonal navigation and problem-solving when encountering new ambiguous circumstances.

To the extent that the process of change involves the three step LRNG process that applies to other modalities as well as PDT, questions arise about the necessity of certain time-honored traditions in PDT. For example, is it possible to bring about enduring change in PDT without working in the transference relationship with the PDT therapist? Or, if the interpersonal emotional field is the context in which change occurs, to what extent (and in what contexts) is it advisable to use the couch with the analyst out of view (Goldberger, 1995), potentially depriving the patient of emotional feedback in the form of facial expressions and body movements that often go beyond what words and vocal tone can convey? To the extent that the LRNG model is considered applicable to PDT, it provides a different vantage point for reconsideration of these questions.

One of the advantages of a specific theory of change is that it can help to explain what may have gone wrong in treatments that were not successful as well as provide guidance when progress is stagnant. 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 only serves to reinforce and further ingrain the patient's original version of the traumatic or adverse memories, and is insufficient to bring about clinical change. The LRNG model may be useful in thinking about how to alter the trajectory of the treatment.

In conclusion, the integrated memory model and the LRNG model of change provide a unifying framework across psychotherapy modalities that includes but is by no means limited to PDT. In some ways this basic mechanistic framework is analogous to the automobile; they all work in fundamentally the same way, and yet there are hundreds of different makes and models. Many factors determine which one a person might select. It makes a big difference what a person's starting point is and where she wants to go, and factors such as comfort, speed, and expense are important. It is also true that certain vehicles can do things that others can't. In the case of psychotherapy, problems vary in

terms how deeply ingrained they are, the types of corrective emotional experiences that are needed to overcome previous learning and the number of repetitions needed to bring about the desired changes. For certain kinds of problems PDT works as well as other modalities; for certain others it may work better; and no doubt in many contexts other forms of therapy are to be preferred. An important goal for the future is to define what these contexts are.

Acknowledgment

I thank my co-authors Lee Ryan, Lynn Nadel, and Les Greenberg for their contributions to the model described here as originally published in *Behavioral and Brain Sciences* 2015; 38:1–19.

References

Aggleton, J.P., & Brown, M.W. (1999). Episodic memory, amnesia, and the hippocampal-anterior thalamic axis. *Behavioral and Brain Sciences*, 22, 425–489.

Alexander, F., & French, T.M. (1946). The corrective emotional experience. In *Psychoanalytic therapy: Principles and application*. New York: Ronald Press.

Bargh, J.A., & Morsella, E. (2008). The unconscious mind. *Perspectives on psychological science*, 3(1), 73–79.

Barrett, L.F. (2017). *How emotions are made: The secret life of the brain*. Boston: Houghton Mifflin Harcourt.

Barsalou, L.W. (1988). The content and organization of autobiographical memories. In: U. Neisser & E. Winograd (Eds.), *Remembering reconsidered: Ecological and traditional approaches to the study of memory* (pp. 193–243). New York: Cambridge University Press.

Bartlett, F.C. (1932). *Remembering: a study in experimental and social psychology*. New York: Cambridge University Press.

Bergman, E.T., & Roediger, H.L. (1999). Can Bartlett's repeated reproduction experiments be replicated? *Memory & Cognition*, 27, 937–47.

Bornstein, R.F. (2001). The impending death of psychoanalysis. *Psychoanalytic Psychology*, 18(1), 3–20.

Boston Change Process Study Group (2007). The foundational level of psychodynamic meaning—implicit process in relation to conflict, defense and the dynamic unconscious. *Int J Psychoanalysis*, 88, 843–860.

Bower, G.H. (1981). Mood and memory. *American Psychologist*, 36(2), 129.

Brenner, C. (1973). *An elementary textbook of psychoanalysis*. Madison, CT: International Universities Press.

Breuer, J., & Freud, S. (1955; Original work published 1895). Studies on hysteria. In: J. Strachey (Ed.), *Standard edition of the complete psychological works of Sigmund Freud*. London, UK: Hogarth Press.

Clore, G.L., & Ortony, A. (2000). Cognition in emotion: always, sometimes or never? In: R. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 24–61). New York: Oxford University Press.

Clyman, R.B. (1991). The procedural organization of emotions: A contribution from cognitive science to the psychoanalytic theory of therapeutic action. *Journal of the American Psychoanalytic Association*, 39, 349–382.

Darwin, C. (1872). *The expression of the emotions in man and animals*. London, UK: John Murray.

de la Fuente, V., Freudenthal, R., & Romano, A. (2011). Reconsolidation or extinction: transcription factor switch in the determination of memory course after retrieval. *Journal of Neuroscience*, 31, 5562–5573.

Eagle, M.N. (2000). A Critical evaluation of current conceptions of transference and countertransference. *Psychoanalytic Psychology*, 17(1), 24–37.

Edelman, G.M. (1989). *The remembered present: A biological theory of consciousness*. New York: Basic Books.

Elsey, J.W., Van Ast, V.A., & Kindt, M. (2018). Human memory reconsolidation: A guiding framework and critical review of the evidence. *Psychological bulletin*, 144(8), 797–848. doi: 10.1037/bul0000152.

Freud, S. (1895/1950). Project for a scientific psychology (1950 [1895]). In *The standard edition of the complete psychological works of Sigmund Freud, Volume I (1886–1899): pre-psycho-analytic publications and unpublished drafts* (pp. 281–391).

Freud, S. (1910). The origin and development of psychoanalysis. *The American Journal of Psychology*, 21(2), 181–218.

Freud, S. (1966). Letter 52 from extracts from the Fliess papers. In: *The standard edition of the complete psychological works of Sigmund Freud, Volume I (1886–1899): pre-psycho-analytic publications and unpublished drafts* (pp. 233–239).

Freud, S. (1953). *On aphasia: A critical study* (Originally published 1891). New York: International Universities Press.

Friston, K. (2010). The free-energy principle: a unified brain theory? *Nature Reviews Neuroscience*, 11, 127–138.

Fonagy, P. (1999). Memory and therapeutic action. *International Journal of Psycho-analysis*, 80(2), 215–224.

Gazzaniga, M. (1998). *The mind's past*. Berkeley, CA: University of California Press.

Goldberger, M. (1995). The couch as defense and as potential for enactment. *The Psychoanalytic Quarterly*, 64, 23–42.

Greenberg, L.S. (2010). *Emotion-focused therapy: Theory and practice*. Washington, DC: DCAPA Press.

Hardt, O., Einarsson, E.O., & Nader, K. (2010). A bridge over troubled water: Reconsolidation as a link between cognitive and neuroscientific memory research traditions. *Annual Review of Psychology*, 61, 141–167.

Hoscheidt, S., Dongaonkar, B., Payne, J., & Nadel, L. (2013). Emotion, stress, and memory. In: D. Reisberg (Ed.), *Oxford handbook of cognitive psychology* (pp. 557–570). New York: Oxford University Press.

Hupbach, A., Gomez, R., Hardt, O., & Nadel, L. (2007). Reconsolidation of episodic memories: A subtle reminder triggers integration of new information. *Learning & Memory*, 14, 47–53.

Hupbach, A., Hardt, O., Gomez, R., & Nadel, L. (2008). The dynamics of memory: Context-dependent updating. *Learning & Memory*, 15, 574–579.

Inda, M.C., Muravieva, E.V., & Alberini, C.M. (2011). Memory retrieval and the passage of time: From reconsolidation and strengthening to extinction. *Journal of Neuroscience*, 31, 1635–1643.

Kihlstrom, J.F., Mulvaney, S., Tobias, B.A., & Tobis, I.P. (2000). The emotional unconscious. In: E. Eich, J.F. Kihlstrom, G.H. Bower, J.P. Forgas & P.M. Niedenthal (Eds.), *Cognition and emotion* (pp. 30–86). New York: Oxford University Press.

Lambie, J.A., & Marcel, A.J. (2002). Consciousness and the varieties of emotion experience: a theoretical framework. *Psychological Review*, 109(2), 219–259.

Landauer, T.K., & Dumais, S.T. (1997). A solution to Plato's problem: The latent semantic analysis theory of acquisition, induction, and representation of knowledge. *Psychological Review*, 104, 211–40.

Lane, R. (2000). Neural correlates of conscious emotional experience. In: R. Lane, & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 345–370). New York: Oxford University Press.

Lane, R.D., & Garfield, D.A. (2005). Becoming aware of feelings: Integration of cognitive-developmental, neuroscientific, and psychoanalytic perspectives. *Neuropsychoanalysis*, 7, 5–30.

Lane, R.D. (2008). Neural substrates of implicit and explicit emotional processes: A unifying framework for psychosomatic medicine. *Psychosomatic Medicine*, 70, 214–231.

Lane, R.D., Ryan, L., Nadel, L., & Greenberg, L. (2015a). Memory reconsolidation, emotional arousal and the process of change in psychotherapy: New insights from brain science. *Behavioral and Brain Sciences*, 38, 1–19.

Lane, R.D., Weihs, K.L., Herring, A., Hishaw, A., & Smith, R. (2015b). Affective agnosia: Expansion of the alexithymia construct and a new opportunity to integrate and extend Freud's legacy. *Neuroscience & Biobehavioral Reviews*, 55, 594–611.

Lane, R.D. (2018). From reconstruction to construction: The power of corrective emotional experiences in memory reconsolidation and enduring change. *Journal of the American Psychoanalytic Association*, 66(3), 507–516.

Leichsenring, F., & Rabung, S. (2008). Effectiveness of long-term psychodynamic psychotherapy – A meta-analysis. *JAMA*, 300(13), 1551–1565.

LeDoux, J.E. (1996). *The emotional brain*. New York: Simon and Shuster.

Levenson, R.W. (1994). Human emotion: A functional view. In: P. Elkman & R.J. Davidson (Eds.), The nature of emotion – fundamental questions (pp. 123–126). New York: Oxford University Press.

Levine, H.B. (2012). The colourless canvas: Representation, therapeutic action and the creation of mind. *The International Journal of Psychoanalysis*, 93, 607–629.

Liberzon, I., & Sripada, C.S. (2008). The functional neuroanatomy of PTSD: A critical review. In: E.R. de Kloet, M.S. Oitzel, & E. Vermetten (Eds.), *Progress in* Brain Research (pp. 151–169). Amsterdam, Netherlands: Elsevier Science Publishing.

Maren, S. (2011). Seeking a spotless mind: Extinction, deconsolidation, and erasure of fear memory. *Neuron*, 70, 830–845.

McGaugh, J.L. (2003). Memory and emotion: The making of lasting memories. New York: Columbia University Press.

Milad, M.R., & Quirk, G.J. (2002). Neurons in medial prefrontal cortex signal memory for fear extinction. *Nature*, 420, 70–74.

Modell, A.H. (2010). The unconscious as a knowledge processing center. In: J. Petrucelli (Ed.), *Knowing, not-knowing and sort-of-knowing: Psychoanalysis and the experience of uncertainty* (pp. 45–61). London: Karnac.

Nadel, L., & Jacobs, W.J. (1998). Traumatic memory is special. *Current Directions in Psychological Science*, 7, 154–157.

Nadel L, Samsonovich A, Ryan L, Moscovitch M (2000). Multiple trace theory of human memory: Computational, neuroimaging, and neuropsychological results. *Hippocampus*, 10(4), 352–368.

Nadel, L., Campbell, J., & Ryan, L. (2007). Autobiographical memory retrieval and hippocampal activation as a function of repetition and the passage of time. *Neural Plasticity*, 2007, 90472.

Nader, K., Schafe, G.E., & Le Doux, J.E. (2000). Fear memories require protein synthesis in the amygdala for reconsolidation after retrieval. *Nature*, 406, 722–726.

Newman, K.M. (2013). A more usable Winnicott. *Psychoanalytic Inquiry*, 33, 59–63.

Quirin, M., Kazén, M., & Kuhl, J. (2009). When nonsense sounds happy or helpless: The implicit positive and negative affect test (IPANAT). *Journal of Personality and Social Psychology*, *97*(3), 500.

Ryan, L., Cox, C., Hayes, S.M., & Nadel, L. (2008a). Hippocampal activation during episodic and semantic memory retrieval: Comparing category production and category cued recall. *Neuropsychologia*, 46, 2109–2121.

Ryan, L., Hoscheidt, S., & Nadel, L. (2008b). Perspectives on episodic and semantic memory retrieval. In: E. Dere, A. Easton, J. Huston, & L. Nadel (Eds.), *Handbook of episodic memory/handbook of behavioral neuroscience* (pp. 5–18). Amsterdam, Netherlands: Elsevier.

Ryan, L., Lin, C.Y., Ketcham, K., & Nadel, L. (2010). The role of medial temporal lobe in retrieving spatial and nonspatial relations from episodic and semantic memory. *Hippocampus*, 20, 11–18.

Safran, J.D., Muran, J.C., & Eubanks-Carter, C. (2011). Repairing alliance ruptures. *Psychotherapy*, 48(1), 80.

Schacter, D.L., & Tulving, E. (1994). What are the memory systems of 1994? In D.L. Schacter & E. Tulving (Eds.), *Memory systems 1994* (pp. 1–38). Cambridge, MA: MIT Press.

Schacter, D.L., Wagner, A.D., & Buckner, R.L (2000). Memory systems of 1999. In E. Tulving, & F.I. Craik (Eds.), *The Oxford handbook of memory* (pp. 627–643). New York: Oxford University Press.

Schimek, J.G. (1975). A critical re-examination of Freud's concept of unconscious mental representation. *International Review of Psycho-Analysis*, 2, 171–187.

Schwabe, L., Joëls, M., Roozendaal, B., Wolf, O.T., & Oitzl, M.S. (2012). Stress effects on memory: An update and integration. *Neuroscience & Biobehavioral Reviews*, 36(7), 1740–1749.

Shedler, J. (2010). The efficacy of psychodynamic therapy. *American Psychologist*, 65(2), 98–109.

Smith, R., & Lane, R.D. (2016). Unconscious emotion: A cognitive neuroscientific perspective. *Neuroscience and Biobehavioral Reviews*, 69, 216–238.

Spezzano, C. (1993). *Affect in psychoanalysis: A clinical synthesis*. Hillsdale, NJ: Analytic Press, Inc.

Stern, D.B. (1983). Unformulated experience: From familiar chaos to creative disorder. *Contemporary Psychoanalysis*, 19, 71–99.

Stern, D.N. (2004). *The present moment in psychotherapy and everyday life*. New York: W.W. Norton & Company.

Summers, F. (2013). *The psychoanalytic vision*. New York: Routledge.

Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology*, 53, 1–25.

Tulving, E., & Markowitsch, H.J. (1998). Episodic and declarative memory: Role of the hippocampus. *Hippocampus*, 8, 198–204.

Wachtel, P.L. (2009). Knowing oneself from the inside out, knowing oneself from the outside in. The "inner" and "outer" worlds and their link through action. *Psychoanalytic Psychology*, 26(2), 158–170.

Wallerstein, R.S. (1990). The corrective emotional experience: is reconsideration due? *Psychoanalytic Inquiry*, 10(3), 288–324.

Wilson, M.A., & McNaughton, B.L. (1994). Reactivation of hippocampal ensemble memories during sleep. *Science*, 265, 676–679.

Winkielman, P., & Berridge, K. (2004). Unconscious emotion. *Current Directions in Psychological Science*, 13(3), 120–123.

Zajonc, R.B. (2000). Feeling and thinking: Closing the debate over the independence of affect. In: J.P. Forgas (Ed.), *Feeling and thinking: The role of affect in social cognition* (pp. 31–58). Cambridge, UK: Cambridge University Press.