From Synapse To Psychotherapy: The Fascinating Evolution of Neuroscience

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This paper reviews neuroscientific advances across the therapeutic disciplines and outlines new potential insights into understanding the biology of the psychotherapeutic processes. In a quest to understand the modus operandi of psychotherapy, the author reviews the evolution of the biology of psychotherapy. The mechanisms involved in learning processes, such as memory and priming, attachment, and long-term consequences of early life trauma, demonstrate how brain structures can be affected by environmental changes. Finally, the author proposes that verbal and non-verbal aspects of the psychotherapeutic process mediate their therapeutic effects through biological changes as they work on primitive emotional reflexes and stimulate mentalization processes.

INTRODUCTION

My reflection regarding the relationship between biological and psychological variables in psychotherapy started years ago in clinical practice. A general practitioner referred a patient, Ms. F., to me for treatment. Ms. F. was a successful, intelligent, professional woman in her early fifties. When I met her for the first time she was deeply depressed, practically in a state of "psychological death"—helpless and hopeless, although not suicidal. Three months prior to starting psychotherapy, she made the heartbreaking decision to leave her husband. A few weeks after that decision, she was diagnosed with breast cancer, which was treated by mastectomy and chemotherapy. One week after chemotherapy was initiated, a business associate of 15 years informed Ms. F. that he could not continue his professional relationship with her.

My goal for the patient, with her cooperation, our collaboration, and long-term psychotherapy, was to bring her "back to life." Her strength was an incredible resilience, supplemented with a daily antidepressant (fluox-
etine), and a weekly (later biweekly) blend of supportive and psychodynamic approaches. From the very beginning of the treatment, Ms. F. expressed conscious apprehension and resistance regarding too “analytical” an approach (perceived by her as intrusive and almost dangerous). I respected her feelings by offering only sporadic and carefully weighed instances of confrontation and interpretation. She survived. She went back to life, to work, and to her relationships. As the patient improved, I tried to stop the antidepressant. But soon Ms. F. became more depressed and less able to process past and present life events. She would regress into an ominous withdrawal state. When the frequency in the sessions changed, the patient would complain of diverse somatic issues (abdominal pain, allergy symptoms). Clearly both drug therapy and psychotherapy were helping this patient. How exactly they worked together was not easily comprehensible, although such a synergy has been noted in a variety of psychiatric problems.

Since Sigmund Freud’s pioneering work in the late 19th century, differences in the efficacy of psychotherapy compared to placebo have been proven. However, researchers have repeatedly failed to find convincing evidence of significant differences in efficacy among mainstream psychotherapies. As early as 1936, Saul Rosenzweig suggested that common factors were responsible for the effectiveness of various kinds of psychotherapies, and he also proposed that all therapies were equally effective. He named this phenomenon “The Dodo Bird Effect” (Rosenzweig, 1936, pp. 412-415). In 1976 Lester Luborsky and Barton Singer reviewed the psychotherapy outcome literature and agreed with that conclusion. Further meta-analyses reported no differences in outcome among diverse types of therapies (Grissom, 1996; Wampold, Minami, Baskin, & Callen Tierney, 2002; Wampold, 1997). To make some sense of these findings, it is necessary to understand more thoroughly the operative mechanism behind therapeutic processes. The first question I considered was: What is encompassed in the term psychotherapy? In 1978, Hans Strupp described it as “an interpersonal process designed to bring about modification of feelings, cognitions, attitudes and behavior which have proved troublesome to the person seeking help from a trained professional.” (p.3) In other words, psychotherapy can be viewed as a psychosocial treatment, including a patient-therapist relationship in a specific, interpersonal context, which is based on a theoretical model underlying the therapist’s practice. Bringing about modification in the patient’s perceptions entails new learning, and learning involves numerous, complex neurobiological processes.
Attempts have been made to understand what exactly is learned in psychotherapy, what is transmitted, and through what medium. An answer may lie in recent theories of attachment, affect regulation, and mentalization (Champagne & Meaney, 2001; Fonagy, 2002; Schore, 2003a, 2003b). These studies show how social interactions are closely linked to modulation of physiological states: from the expressed affective response to the pruning of neuronal dendrites. These new insights deserve a brief examination in the context of exploring how psychotherapy works. With the explosion of knowledge in the field of neuroscience in the last decade, there also has been a resurgence of interest in psychotherapy. Neurologists, cognitive therapists, and psychoanalysts seem to find new inspiration and a greater willingness to talk and share when exposed to the incredible advances of the science of our nervous system. This paper will review the neuroscience evolution across disciplines and how it provides new potential insights in the psychotherapeutic processes.

HISTORICAL REVIEW OF THE BIOLOGY OF PSYCHOTHERAPY

The debate about the nature of the body and mind interaction goes back far into history. As early as 400 B.C. Hippocrates (460-377 B.C.) was convinced that thoughts, feelings, perception and choices were activities of the brain. Patricia Churchland notes that Plato (427-347 B.C.), and later, Christian thinkers, such as St. Augustine (354-430) and St. Thomas Aquinas (1225-1274), hypothesized about and believed in a soul distinct from the body and divine in origin. (Churchland, 2002). René Descartes (1596-1650) reinforced and articulated this through the concept we call "Cartesian dualism," which assumes the mind’s operations of thought, language, memory retrieval, and reflection, as well as conscious awareness, proceed independently of the brain. Descartes confessed he was totally unable to imagine how the brain, a mechanical device, could be designed to reason and to use language appropriately and creatively. Some historians (Churchland, 2002) argue that Descartes' defense of a fundamental difference between mind and body was as much political as it was academic. Descartes, by reassuring the Church that the "soul" was its indisputable sphere of influence, not only avoided inquisition but also allowed the rest of science to develop. By the end of the nineteenth century, physics, chemistry and physiology were recognized as advanced scientific disciplines. The science of the nervous system, however, lagged behind. Santiago Ramón y Cajal and Camillo Golgi, through their remarkable anatomical work, were the first to open the door to understanding the brain. In 1887 Cajal started to apply the recently discovered technique of silver
impregnation ("Golgi" stain) to the cerebellum, retina and the spinal cord, and wrote an atlas that provided the foundation of modern anatomy. Cajal was convinced that the nervous system was made up of billions of separate nerve cells. At a neurology meeting in Rome in 1894, and later that year at his Croonian Lecture to the Royal Society of London, Cajal was asked where or how learned information was retained in the nervous system once acquired. In a brilliant intuitive moment, Cajal suggested that

... mental exercise facilitates a greater development of the protoplasmic apparatus and of the nervous collaterals in the part of the brain in use. In this way, pre-existing connections between groups of cells could be reinforced by multiplication of the terminal branches of protoplasmic appendices and nervous collaterals. (pp. 466-467)

In 1906 Cajal and Golgi received the Noble Prize in medicine "in recognition of their work on the structure of the nervous system."

In 1937 prominent pathologist, James W. Papez, published his well-known paper, "A Proposed Mechanism of Emotion," in which he theorized that emotion is a physiological process dependent on definite anatomical mechanisms. Papez suggested an association between the limbic pathway and emotions. On the anatomic level, the limbic system has connections with the endocrine system, brain stem, and autonomic nervous system. This circuit would have a role in the attribution of an affective valence to the learning and memorization processes (Davis, 1992; Davis & Whalen, 2001; LeDoux, 1996).

In 1949, the Canadian psychologist Donald Hebb proposed a hypothesis about what he called "neuroplasticity." In his influential book, The Organization of Behavior, Hebb suggested that the nervous system encoded information by strengthening activated neuronal connections (i.e. lowering their threshold of excitability for a given stimulus). For a long time the scientific community did not seriously consider this hypothesis. Nevertheless, Hebb's admirable intuition provided the preliminary insight into the possibility of synaptic plasticity.

In 1966, Terje Lomo, then a doctoral student at the University of Oslo, observed a cellular event that appeared to have many of the properties necessary for a suitable long-term memory substrate. He named this event long-term potentiation (LTP). In 1973 Timothy Bliss and Terje Lomo published the first complete LTP study, in which they reported the first artificially induced modification of the strength of an intersynaptic connection. They reported that the stimulation of certain neuronal fibers by high frequency waves creates a significant and measurable increase in the
intersynaptic strength, insofar as it increases the ability to initiate postsynaptic potentials. They noted that the phenomenon, labeled LTP, might persist for weeks. It was probably the first experimental demonstration of long-lasting neuroplasticity. Later on, other studies (Andersen, Sundberg, Sveen, & Wigstrom, 1977; Morris, Halliwell, & Bowery, 1989; Morris et al., 2003) confirmed that different cellular and molecular mechanisms are at the origin of the different types of memorization and learning processes. These studies showed change in cortical thickness, size of synaptic connections, and variations (increase or trimming) in the number of dendrite prickles and ramifications in response to different kinds of interactions with the environment (Buonomano & Merzenich, 1998; Davis, 1992). But change in strength at an intersynaptic level (and the learning mechanism in general) may be mediated at a molecular or genetic level by various other means. Dennis Charney (2004) demonstrated how interaction with the environment influences alter response patterns (e.g. to severe stress) through long-term modulation in the production and release of multiple neurochemical, neuropeptide, and hormonal mediators. In his essay about the “Nature of Nurture,” Michael Meaney details how maternal licking and grooming in rats alters gene expression of glucocorticoid receptors in the neonate and how such alterations will influence later reactions to stress (Meaney, 2004). By demonstrating the cellular interface between environment and gene, Meaney introduces the fascinating and almost surrealistic “science of chromatin remodeling” (Meaney, 2004). New evidence in research makes obvious the plasticity of our brain structures and substantiates the environmental contribution to the continuous remodeling of our brain by strengthening, weakening or silencing its immensely complex synaptic circuitry.

Eric Kandel is another major figure in this “neurohistorical” journey. He entered medical school in 1951 with plans to become a psychoanalyst but in 1965 he decided not to apply for training at the Boston Psychoanalytical Institute as planned and to devote himself to research. Kandel wanted to think about problems in psychiatry and psychoanalysis in biological terms, hence, to explore the molecular mechanisms of learning and memory (Kandel 2005). But if he abandoned the couch for the laboratory, he would continue to have both in his heart and mind.

In 1979 he published a paper in The New England Journal of Medicine entitled, “Psychotherapy and the Single Synapse: The Impact of Psychiatric Thought on Neurobiological Research.” In this paper he deplored the partition he found in 1960 between what he called the “hard-nosed” and “soft-nosed” residents, and he expressed hope that the “deep seated
dualism that once caused psychiatry and neurobiology to split would prove to be a transient interlude in the history of psychiatry.” (p. 1037) But he did more than express hope; he offered his work. In his laboratory, Kandel studied a bizarre creature called *Aplysia Californica*. *Aplysia* is a marine snail suited for neurobiology study mainly because of its large neurons, which are among the largest in the animal kingdom. In addition, its entire nervous system contains only a few hundred neurons, making it less complex and, hopefully, easier to understand than that of higher animals. Habituation and sensitization—in other words primitive forms of learning and memory—may also be studied with *Aplysia*. Kandel in his experiments with *Aplysia*, demonstrated how the synaptic connection could be modified and reinforced in a permanent fashion through regulation of the learning processes (Kandel, 1989). This experience-dependent learning is transcribed/translated through short-term (change at the synapse level through existing proteins) or long-term (modulation of genome expression) structural modifications. Since then multiple research studies with animals, as well with human beings, refute our old models that represent the brain as a rigid structure. The neuronal patterns underlying our behaviors and emotions, our interpretation of reality and subjectivity, evolve, develop, and transform under diverse influences, including, for instance, a psychotherapeutic relationship in its verbal and non-verbal content.

NEUROLOGICAL BASIS OF PSYCHOTHERAPY

Memories

A crucial aspect of our life is “the capacity of the nervous system to benefit from experience” (Tulving, 2000, p. 727), i.e., the ability to learn and to remember (to have memory). In fact it would be more appropriate to speak of memories, as the complexity of memory far exceeds our imagination. It implies various mechanisms corresponding to, for instance, the reception, encoding, or retrieval of information. Many types of learning and memorization exist. They are expressed through behaviors and/or thoughts, and are modulated by emotional factors. A gross explanation of learning and memorization: The memories expressed in thought are referred to as “cognitive memory” or “explicit memory.” The behavioral kinds of memory are referred to collectively as “procedural memory” or “implicit memory.” Cognitive memory, which constitutes one of the major parts of research with human subjects, has been subdivided into four major categories, or systems:

(1) working memory, whose function is to keep memory “on line” over
a short interval of time while cognitive operations are performed on it;

(2) the perceptual representation system, the function of which is to mediate memory-based facilitation of perceptual identification of objects;

(3) semantic memory, which functions to mediate the acquisition and use of individuals' general knowledge of the world; and

(4) episodic memory, which functions to mediate conscious access to the personally experienced past (Tulving, 2000).

Procedural memory has been called habit memory, non-declarative memory, and even implicit memory. Some compare it to an "unconscious" memory\(^1\). Procedural or "implicit" memory—recording facts without the awareness of the subject—evoke, in some aspect, the unconscious described by Freud. Interestingly, during studies of implicit memory done by neuroscientists and cognitive scientists, the instructions given to the subjects are virtually the same as those of "free association" (where the subject is asked to respond by the first word that comes to his/her mind).

**Implicit and Explicit Memory**

Implicit (procedural) and explicit (cognitive) memories differ at various levels. In their gross anatomic foundation, they activate different neuronal circuits: explicit memory involves the hippocampus; implicit memory involves the amygdala. The memory types vary in their temporality. Implicit memory seems to be functional at birth, whereas explicit memory becomes functional after three or four years of life. They also have dissimilar responses to biochemical substances, for example, alcohol and benzodiazepines prevent explicit recording, but not implicit recording.

Moderate stress seems to facilitate explicit memory, but if the stressing stimulus lasts too long or is too severe, it overwhelms the hippocampus' ability to regulate and prevents a correct encoding of explicit memory. However, at the same moment, the amygdala, anatomic location of implicit memory and coordination center for emotional memory, becomes more active. Depending on the activation of the amygdala or the hippocampho-hypothalamic tract, stress consequences are very different. Stress affects memory not only quantitatively but also qualitatively. Extreme situations of intense stress (rape, assault) can disturb spatial memory and interfere with long-term memory. Hans Selye pointed out, as early as 1946, that

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\(^1\)Ledoux (1996). Until a certain point the psychodynamic unconscious may be assimilated to the unconscious in a cognitive definition but the opposite is not true: cognitive unconscious does not imply psychodynamic process.
humans and experimental animals respond to stressful experiences by activating their hypothalamic-pituitary-adrenal (HPA) axis. The end product of the HPA axis is the release of glucocorticoid hormones by the adrenal gland. These hormones serve as major regulators of homeostasis—intermediary metabolism, muscle tone, and cardiovascular function. Together with catecholamines released by the autonomic nervous system and by the adrenal medulla, the secretion of glucocorticoids is essential for survival in the face of stress. Bruce McEwen and Robert Sapolsky discovered that the increases in glucocorticoids following prolonged separation, e.g., youngster from the mother, have adverse effects on the hippocampus (McEwen & Sapolsky, 1995). Exposure to elevated glucocorticoids across a number of weeks causes neurons in the hippocampus to atrophy, a condition that is reversible when the stress or glucocorticoids exposure is discontinued. However, when stress or when exposure to elevated glucocorticoids is prolonged over many months or even years, permanent damage occurs, and there is a loss of hippocampal neurons (Sapolsky, 2003). As we might predict from the key role of the hippocampus in explicit memory, both reversible atrophy and permanent damage result in significant impairment of memory. Similar reports are presented by others (Kandel & Pittenger, 1999). A recent review of the biological impact of trauma and its potential consequences for the development of posttraumatic stress disorder substantiates the data found in previous studies (Kimble & Kaufman, 2004).

**Priming: The Irresistible Mark of the “First Time”**

In “Remembering, Repeating, Working Through,” Freud stressed that what the patient does not remember e.g., from previous relational encounters, will be repeated in the relationship between patient and analyst (Freud 1914/1958). Memory research helps us to translate Freud’s concept of what emerges during the transference relationship into neuroscientific language. Among the discoveries and scientific experiments of the mechanism of implicit memory, a phenomenon called “priming” has been described. Historically, the term “priming” has been used in several areas of psychology to refer to conditions or stimuli that change an organism or system into a state of increased readiness or preparedness for action or response. Within cognitive psychology and cognitive neuroscience, priming refers to instances in which an earlier encounter with a given stimulus (word, face, object) modifies (“primes”) later responses to that same stimulus by increasing the speed of responding, or biasing the nature of the response (LeDoux, 1996). In 1911, the Swiss psychiatrist Rene-Edouard
Claparede reported this clinical observation (LeDoux, 1996). He had a female patient who, as a result of a brain damage, had seemingly lost all ability to create new memories. Consequently, Claparede had to reintroduce himself to her at each new visit as the patient had no recollection of having seen him before. One day he entered the room and as usual, held out his hand to greet her. This time he concealed a tack in his palm and when the patient greeted him, the tack pricked the patient’s hand. When he returned to the room the following day, the patient still was unable to recognize him, but she refused to shake his hand, although she could not tell him why but she wouldn’t do it. This is an example of the effect of priming.

Conscious experiences and interactions grossly modulate, or shape, the architecture of our neurons and their connections. It has now been proven that experiences, of which we are not conscious, may have a similar impact. Implicit experiences, acquired without the individual’s knowledge, influence the response of the individual during a similar subsequent experience. This phenomenon influences the system of representation as well as the system of emotional responses. Therefore, a person initially confronted with a certain situation will have the tendency—later on and in similar circumstances—to replicate rules and reactions (in a broad sense) implicitly and explicitly associated with the initial situation. Moreover, when a person is exposed to an ambiguous stimulus, the relative neutrality of the stimulus will reinforce the subject’s tendency to apply the rules that he/she learned implicitly. Finally, it seems that priming built on abstract or general representations does not depend on the same mechanism as that of priming determined by specific sensorial stimulation. As such, we would have to distinguish among the learning experiences according to their abstract or concrete foundation/source.

The Ambiguous Construction of Memories

Daniel Schacter and his team have studied and discovered that our memories are frighteningly fallible: We remember things that never happened, and we forget completely things that did happen (Schacter, 2001). They also studied the nonconscious influence of past experience to situations in which people consciously recollect experiences that never occurred. Using positron emission tomography scans and magnetic resonance imaging, Schacter’s team studied brain activity as participants recalled true and false memories. The researchers observed that the patterns of cerebral activation are similar for both true and false recollection (Schacter & Buckner, 1998) They discovered that it is possible to
induce the construction of ‘real’ “false recollections” at the synaptic level. One way to induce creation of “false memories” is a process in which an individual thinks repetitively of a past event. In a study designed to test the conditions under which false memory reports are likely to be elicited, Nicholas Spanos demonstrated how false memories could be created (Spanos, Burgess, Burgess, Samuels, & Blois, 1999). The study revealed that complex, vivid, and detailed false memories could be elicited by first structuring individuals’ expectations and then motivating them to gain access to “memories” that were congruent with their expectations. The researchers found these results in participants who were hypnotized and those who were not.

ATTACHMENT AND SEPARATION

Attachment disorders have been described and studied in the psychological and psychiatric literature for approximately 50 years. Rene Spitz (1965) John Bowlby (1982), Harry Harlow and Stephen Suomi (1971, 1974) have demonstrated the importance of attachment and bonding for normal development. Recently Peter Fonagy (2002) reformulated and reinterpreted our understanding of the development of relationships and attachment. Harry Harlow and Stephen Suomi (1971,1974) concluded that in monkeys, separation of a youngster from the mother during the first few months of life negatively impacted the young monkey’s psychic organization, and that separation from a mother figure causes separation anxiety. The development of attachment theory itself is attributed to Bowlby (1982), who incorporated Harlow’s research on rhesus monkeys into his study of the human child’s ties to mother. In his movie A Two Year Old Goes to Hospital, Bowlby shows that an infant goes through several phases in reaction to separation. The infant goes from protest to crying to a sad state and, finally, to a more desolate state of resignation regarding the loss. Later Bowlby proposed that attachment of the human infant to the mother was biologically based, promoting security of the infant by the formation of a bond with his/her mother (Bowlby, 1982). This process occurred during the first year. From this secure base the child explores the world. Without this base, the child becomes distressed. Additional studies explored the diversity of attachment modalities of social animals and the physiological and behavioral consequence of separation (D. G. Amaral, 2002; Amini et al., 1996; Suomi, 1991; Suomi, Collins, Harlow, & Ruppenthal, 1976). Those studies enhanced, deepened, and reinforced Bowlby’s observations. In brief, soon after separation, a response-type “protest” occurs; it includes an increase in motor activity, prospecting behaviors,
repeated vocalizations, etc. Physiologically, heart rate, body temperature, cortisol, and catecholamines "synthetases" levels increase. If the length of the separation extends, a "despair" response occurs: The animal presents a decrease in motor activity and vocalization. It has less interaction with others, crouches, looks sad, and eats and drinks less. An increased level of self-huddling behavior and rocking has been noted. Heart rate, temperature, and oxygen consumption are reduced. In cases of extreme deprivation, "isolation syndrome" is described (Kraemer, 1992, 1997). Cognitive deficits and physiological and behavioral manifestations, such as self-mutilation, head banging, self-clasping, eye gouging, poor control of aggressive impulse, and eating disorders occur. The animal becomes socially incompetent, incapable of using social cues, such as facial expressions, to guide behavior, and becomes unable to initiate and engage in ordinary social interaction. Some of these problems can be treated, although incompletely. For instance if after the time of isolation, monkeys are put in contact with younger and more socially developed "therapist monkeys," (Suomi, Harlow, & McKinney, 1972) some of the profound cognitive and "relational" deficits may be partially reversed.

In conclusion, social mammals seem to share a type of physiological and behavioral response to the stress induced by short- or long-term separation from the primary care giver. The socialization mechanisms involve a complex system of loops open to the external world and to the caretaker's ability to respond "well enough" and at the appropriate time to the varied needs. This dynamic has a crucial function in the development of the neuro-physiological substrate. Very early in life, learning mechanisms (primarily nonconscious), intervene at a motor, cognitive, and neuropsychological level. Consequently, young subjects learn at a nonconscious level, the rules and patterns of interaction to which they have been exposed. This implicit recording of relational prototypes later influences the ways the subject considers, initiates, or interprets future relationships. This information is not directly accessible by a conscious thought process and could strongly determine the tendency to repeat original patterns, even those patterns that are pathological. So, early exposure to an inadequate attachment figure could predispose the individual—particularly if he/she has a limited number of models—to engage preferentially in relationships presenting similar deficiencies or inadequacies. Several studies have shown that early adverse life experiences result in increased gene expression for corticotropin-releasing factor (CRF) and may modulate the response to stress for the rest of the life (Heim &

TRAUMA

Neuroimaging and functional studies try to identify the spatial distribution of the cerebral activity during different types of emotions (Liggan & Kay, 1999). Multiple research studies indicate an increased level of activity in the amygdala during long-term encoding of memories are associated with intense emotional excitation (Cahill et al., 1996). This phenomenon is not observed during the recording of an event with neutral emotional valence. However, some studies have suggested that not everybody is alike in terms of amygdala activation during a supposedly moving stimulus. Research using functional magnetic resonance imaging studies shows that when criminals regarded as "psychopaths" were presented pictures/readings with high emotional valence, they did not exhibit the same responses as criminal "non-psychopaths" or healthy, non-criminal subjects (Kiehl et al., 2001). This may imply that some individuals, because of genetic or acquired neurological specificity of the amygdala, may not be able to learn through interpersonal processes involving identification and (at times) modification of feelings and emotions in the same way as other individuals. This may partly explain the very poor outcome of psychotherapeutic treatments provided to patients with high levels of psychopathology (Hare, 1999).

The research of Joseph LeDoux (J. E. LeDoux, 1996, 2002) is aimed at understanding the biological underpinnings of emotions, such as fear. He is particularly interested in how the brain learns and stores information about novel dangers. Using a task called "classical fear conditioning," his team mapped the neural pathways by which sensory stimuli enter and flow through the amygdala in the process of fear learning. Other studies (J. LeDoux, Romanski, & Xagoraris, 1989) showed that it is impossible to cancel some memories related to fear once those memories have been created or "written," processed through the amygdala. A trace of the trauma persists, "written" into the synaptic networks. The same researchers showed that the neocortex (whose inhibitory role is important) is not needed to acquire a fear-conditioned reflex. However, the neocortex is indispensable for the extinction of the fear-conditioned reflex once it has been created through conditioning (Amini et al., 1996; J. LeDoux et al., 1989). The extinction of the pathological reflex is far from being a passive phenomenon, it seems to be the outcome of an active process involving new learning (Bouton, 2000).

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These results can contribute to our reflections concerning psychotherapeutic treatments. Despite differing perspectives, psychodynamic as well as behavioral or cognitive-behavioral theories present similar hypotheses regarding the origin of some of these phenomena. In each of these therapeutic modes, the traumatic experiences have been learned, encoded, and may eventually generate an anxiety disorder. Both theories seem consistent with recent biological findings, but they offer different therapeutic approaches. Psychoanalytic and psychodynamic theories attempt to bring the origin of the internal conflict back to consciousness, while some behavioral therapists, such as Joseph Wolpe (Wolpe & Rowan, 1988), try to release patients’ anxiety through reconditioning methods. In both psychodynamic and cognitive/behavioral approaches, therapists help patients handle troubling situations “in a different way” or modify dysfunctional responses to problems. In neurobiological terms, we “train” the cortex to exert a form of control on the amygdala modalities of functioning and expression. The phenomenon of extinction promoted by behavioral therapies may consist mostly of implicit learning involving the amygdala and prefrontal areas. Psychoanalytic and psychodynamic work with conscious symbolic elements also may involve control of the amygdala’s activity through the temporal lobe and other neocortical areas. Last but not least, connections from the cortex to the amygdala are much “weaker” than connections from the amygdala to the cortex (D.G. Amaral, Price, Pitkanen, & Carmichael, 1992). This may explain the considerable amount of time required to build “new connections” from the cortex to the amygdala and account for (in part) the characteristic lengthy therapeutic process, such as psychoanalysis. Psychotherapy, besides its specific qualities as an interactional relationship, can be considered a process, including active intentional recollection related to explicit memory. It also may be looked upon as a facilitation of the remembrance of implicit memories through techniques such as free association. In psychodynamic psychotherapy, when we ask the patient to remember and free associate, the patient’s amygdala becomes activated. Depending on the personality, training, and theoretical background of the therapist, the patient takes part in an active process. In a sense the patient receives new emotional and intellectual instructions. Ideally, the new knowledge acquired with psychotherapy gives the patient innovative, new ways to treat the sensorial and cognitive associations linked to the original trauma. Therefore, erasing traumatic memories, or more precisely, removing some of their consequences, is not necessarily a passive archaic reflex, but an active process, implying new learning (Bouton, 2000).
CONCLUSION

Recording information without conscious awareness is a fundamental quality of our nervous system. A variety of genetic, biological, and relational factors underlie these “recordings.” Specific life events seem to have a decisive influence upon the type and quality of information encoding (Mohammed et al., 2002). Encoding particular events is based on physiological states associated with specific mental representations of the events. Depending upon the quality and maturity of the synaptic web, the characteristics of the stress and other variables, the subject may experience emotional states without explicit recollection of the events or the subject may recall only fragments of representation. Attachment studies show that some traumatic situations, particularly those linked to separation and neglect, may have profound short- and long-term consequences, consisting of hampered neurophysiological, cognitive, and/or behavioral adaptation and persistent alterations corticoid levels in response to stress (Heim & Nemeroff, 2002; Heim, Owens, Plotsky, & Nemeroff, 1997a, 1997b; Kaufman et al., 2000; McEwen & Sapolsky, 1995; Nemeroff, 2004). These long-term consequences may be related to irreversible recording of a particular response to initial stress in the amygdala. Psychotherapy may be considered a form of implicit and explicit learning through the development of a patient-therapist relationship. Primatologists have shown that affective and physiologic instability related to inadequacies in the early life environment may be partially restored through cultivation of stable, adequate relationships.

The neocortex, in addition to being an anatomic entity found only in humans and in a few higher mammals, is considered the center for complex symbolic representation and tasks (Fuster, 2000, 2002). When the psychotherapeutic process acts on primitive emotional reflexes, it activates neocortical structures. As we have seen in this review, the psychotherapeutic process involves multiple mechanisms, including verbal and non-verbal interactions. As a result, the therapist’s commitment and reliability are as important as intellectual and technical skills. The dependability and consistency of the therapist, and aptitude in being “good enough” may eventually lead to a revision of initial pathological patterns in patients. In other words, the therapist has to tune his or her instrument with the chief melody of the patient’s history. Step by step, the therapist has to find and take a place in the therapeutic “duet” so that the new relationship may evolve into healthier relationship for the patient than previous relationships. Despite the torments of the patient’s indelible past,
the resources and the plasticity of the synaptic brain, combined with the art and competency of a therapist, will, in due course, be revealed as the keys to a new balance.

REFERENCES


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