



Psychoanalytic treatment: a neurobiological view

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Abstract

We present a review of several hypotheses concerning the possible neurobiological correlates of the main processes involved in analytic therapy. Attachment theory may represent an interesting link between psychoanalysis and neurobiology. According to Bowlby's conception, interactions with parental figures during infancy lead to the formation of an "internal working model." This determines how the individual will relate with others and cope with stress throughout life. The patterns formed are in many cases pathological. The internal working model is stored as implicit memory, which is expressed independently of consciousness. Clinical improvement in analytic therapy ultimately depends on changes in the implicit memory system, which entails structural brain modifications. Implicit memory system changes may be related to alterations in explicit memory systems, which result from interpretative work. They may also occur directly as a result of the emotional experiences in the patient-analyst relationship.

Keywords: neurobiology; psychoanalysis; attachment theory; explicit memory; implicit memory; review

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Introduction

Freud began his career as a neuroanatomist and neurologist and published important neuroscientific works on infantile cerebral paralysis and aphasia (Sacks, 1998). Even after creating psychoanalysis, he held the belief that mental phenomena are related to cerebral activity (Gedo, 1997; Reiser, 1985; Schore, 1997a).

The manuscript *Project for a Scientific Psychology*, written by Freud in 1895, has gained the attention of both psychoanalysts and neuroscientists. Despite being considered a pre-psychoanalytic writing, this

work presented key aspects of the most important psychoanalytic concepts and theories (Pribram, 1998; Schore, 1997a). In this work, Freud conceived of the existence of "contact barriers" between neurons, corresponding exactly to what Sherrington would 2 years later describe as and name "synapses" (Pribram, 1998). Furthermore, Freud theorized about the possibility of representing memory at the synaptic level as "a permanent alteration following an event." In doing so, he anticipated several essential physiological properties of long-term potentiation of synaptic transmission, a phenomenon that would later be described in 1973 (Centonze, Siracusano, Calabresi, & Bernardi, 2004).

Freud never abandoned his mechanistic, neuroscientific model of *Project for a Scientific Psychology*. He simply transformed it with small modifications into his metapsychological concepts. Despite representing completely distinct models, metapsychology and psychology coexisted throughout all of Freud's psychoanalytic work (Brook, 1998). Therefore, Freud the neuroscientist has remained alive, although hidden, in Freud the psychoanalyst.

Recently, the debate about the feasibility and utility of an interaction between psychoanalysis and neurobiology has become increasingly intense. There are two main views on this issue. For some authors

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(Dayan & Olliac, 2010), the concepts and theories of the two areas are fundamentally different and cannot be articulated. Accordingly, only occurrences in the analytic setting are relevant for psychoanalysis (Wolff, 1996). It is also argued that neurobiological knowledge cannot contribute to the comprehension of meanings, which is the essence of psychoanalysis (Blass & Carmeli, 2007). However, according to other authors (Beutel, Stern, & Silbersweig, 2003; Cheniaux, 2006; Cooper, 1985; Gabbard, 2000; Gedo, 1997; Olds, & Cooper, 1997; Ouss-Ryngaert & Golse, 2010; Reiser, 1985; Rosenblatt, 2004; Sauvagnat, Wiss, & Clement, 2010), a dialogue between psychoanalysis and neurobiology may enrich both areas. Concerning psychoanalysis, an anchoring in neurobiology may lead to greater refinement of its theories.

Consistent with this last position, we present a review of several hypotheses about the possible neurobiological correlates for the main processes involved in analytic therapy. The clinical phenomena observed in analytic therapy (e.g., transference, resistance, insight, working-through) are examined in light of current neurobiological knowledge.

Cognitive science classification of memory systems

The discovery of the existence of multiple memory systems in the brain arose from the study of patients with bilateral hippocampal lesions such as the famous amnesic patient H.M. Following brain surgery, the patient lost the ability to form new memories about people, places, and objects. However, at the same time, he was fully capable of learning new perceptual and motor skills (Milner, 2005).

Cognitive science classifies memories into two main systems: explicit (i.e., declarative) and implicit (i.e., non-declarative; Knowlton, Mangels, & Squire, 1996). Explicit memories depend on conscious activity and are represented as either language or sensory images. They can be subdivided into episodic (i.e., related to experienced events) and semantic (i.e., related to non-autobiographical facts) memories (Tulving, 1972). The hippocampus, parahippocampal, perirhinal, and entorhinal cortices, and diencephalic structures are involved in explicit memory systems (Squire, 1992; Squire, & Zola-Morgan, 1991). Bidirectional projections between the hippocampus and neocortical areas may account for the conscious character of explicit memory (Mishkin, Suzuki, Gadian, & Vargha-Khadem, 1997).

Implicit memories are essentially pre-linguistic and independent of conscious experience. They may be expressed through behavior or autonomic reactions, which result from a previous experience with a stimulus. Nevertheless, a conscious or deliberate recollection of the previous experience during which the information was acquired is unnecessary (Schacter, 1987). Implicit memories

cannot be remembered but only enacted (Clyman, 1991).

Procedural memory is the prototype of implicit memory. It is the memory system responsible for the performance of perceptive and motor abilities. Driving a car, walking, and completing a puzzle are examples of procedural knowledge. Procedural memory is related to the striatum. Other implicit memory systems include non-associative learning (e.g., habituation and sensitization), classical conditioning, operant conditioning, and priming (Kandel, 1999; Schacter, 1987). Emotional responses can be learned through classical conditioning and, in this case, are related to the amygdala (Kandel, 1999; LeDoux, 1993).

Claparède (1951) demonstrated that an emotional experience can be acquired, stored, and recalled in the absence of a conscious process. He evaluated a female patient with severe anterograde amnesia. Whenever introduced to Claparède, the patient shook his hand, repeated his name, and carried on a normal conversation. However, when he left the room for a few minutes and then returned, the patient behaved as if the previous interaction had not occurred. Claparède once pinpricked the patient's hand as she saluted him. As expected, she was not able to consciously recall the painful incident. However, she refused to shake his hand again, suggesting that she was able to store the aversive experience.

More recent studies found results consistent with those reported by Claparède. For example, Turnbull & Evans (2006) described a case of a patient with profound anterograde amnesia who presented normal performance on a complex emotion-based learning task (i.e., the Iowa Gambling Task). Furthermore, Feinstein, Duff, & Tranel (2010) subjected amnesic patients to a sadness induction procedure using affectively laden film clips and observed that their sadness persisted for much more time than the explicit memory for the inducing event. Similar results were obtained when happy film clips were used.

Constant repetition may transform explicit memory into implicit knowledge. For example, learning to drive a car is initially associated with conscious recall; however, driving eventually becomes an automatic and non-conscious motor skill (Kandel, 1999).

Kandel (1983), who studied associative and non-associative learning processes in the snail *Aplysia*, demonstrated that long-term learning affects gene expression and leads to anatomical changes in the brain. Initially, environmental stimuli produce a large release of neurotransmitters into synapses. With continuous activation of the neurotransmission system, new proteins are synthesized and, consequently, new synapses are formed.

Attachment theory and the formation of symptoms in early infancy

Psychoanalytic theory situates the origin of psychological problems in early infancy. Initially, Freud

(1905) stressed the importance of conflicts related to sexuality. However, other psychoanalysts were primarily interested in other aspects of infancy such as early object relationships. For example, Winnicott (1965) stated that failures in holding (i.e., the emotional and physical bond between mother and child) disturb emotional development. This failure in holding corresponds to Balint's (1979) concept of "basic fault." Furthermore, Kohut, Goldberg, & Stepansky (1984) proposed that having a non-empathic mother negatively affects a child's self-esteem.

Attachment theory, formulated by the British psychoanalyst Bowlby (1963), also considers the relevance of early object relationships in psychopathology and personality development. At first, most psychoanalysts strongly opposed attachment theory. However, many psychoanalysts recently observed several points of contact between Bowlby's theory and psychoanalysis and suggested that the two theories are compatible (Fonagy, 1999b; Fonagy, & Target, 2007; Ouss-Ryngaert, & Golse, 2010).

According to Bowlby (1963), the attachment relationship is characterized by the close liaison between the infant and mother or a substitute. The infant searches for proximity to the mother, displaying behaviors that call the mother's attention such as crying, smiling, and raising the arms, among others. The mother, in turn, presents an innate tendency to react to the infant's demands, expressing behaviors such as holding and rocking the child, making exaggerated facial expressions, and changing her speech pattern. Mother-infant attachment has been observed in other species such as primates (Harlow, 1971) and has high adaptive value for the offspring (Pally, 1998).

There are diverse forms of reciprocal imitation in the mother-infant interaction such as rhythms, facial expressions, and sounds. It is possible that this imitation represents a process of bidirectional non-verbal communication between the mother and infant. Furthermore, expressions of their respective emotional states mutually, although not symmetrically, influence the mother and infant (Stern et al., 1998). For example, positive emotions may be associated with an acceleration of heart rate in both the mother and infant because of increased activity of the sympathetic nervous system. Additionally, when mother or infant smiles the other exhibits a decrease in heart rate attributable to parasympathetic activity (Basch, 1976). This type of interaction has also been observed in other mammals. For example, being licked by the mother regulates young rats' body temperature, heart rate, and level of motor activity (Hofer, 1995).

According to attachment theory, the mother acts as a secure base. If afraid during exploratory behavior, the infant is able to return to the mother. In what Bowlby called secure attachment, the mother provides safety

for the infant, who gradually acquires confidence and autonomy (Ainsworth, Blehar, Waters, & Wall, 1978). In this context, the mother acts as an external regulator of the baby's emotions. For example, the mother amplifies or reinforces the infant's positive emotional states, expressing her satisfaction in response to the baby's independence. She also attenuates the infant's negative emotional states in threatening situations (Spangler, Schieche, Ilg, Maier, & Ackermann, 1994). The experience of a secure attachment in infancy allows the individual to develop emotional self-regulation, which is a main feature of resilience to stressful life events (Schore, 2002). Consistent with this view, animal studies revealed that cubs who experienced greater licking by the mother exhibited less fear in adulthood (Caldji, Tannenbaum, Sharma, Francis, Plotsky, & Meaney, 1998). Insecure attachment may occur when the mother is negligent or excessively concerned with her child. In this case, the infant may not acquire the capacity to regulate its emotions and may have difficulty facing stressful situations as an adult (Schore, 2002).

Secure attachment likely acts as a protective factor against psychopathology in adulthood. In some studies, secure attachment has been associated with less anxiety (Collins, & Read, 1990), less hostility, greater ego resilience (Kobak & Sceery, 1988), and a greater ability to control emotions in personal relationships (Vaillant, 1988). In contrast, insecure attachment has been associated with depression (Armsden, McCauley, Greenberg, Burke, & Mitchell, 1990), anxiety, hostility, psychosomatic disorder (Hazan & Shaver, 1987), and decreased ego resilience (Kobak & Sceery, 1988). Moreover, a history of separation from the mother, abuse, or negligence during infancy appears to predispose individuals to depression (Kendler, Kessler, Neale, Heath, & Eaves, 1993), panic attacks (Silove, Manicavasagar, Curtis, & Blaszczyński, 1996), and shyness (Gunnar, Brodersen, Nachmias, Buss, & Rigatuso, 1996).

Bowlby (1963) suggested that the infant internalizes the attachment relationship, forming what he called the "internal working model." This model represents an unconscious system of schemas, beliefs, or guides of interpersonal relationships that are shaped through interactions with parental figures. The internal working model consists of expectations regarding behaviors of others and strategies for facing stress, and it determines the typical pattern of interpersonal relationships. This pattern basically consists of a repetition of early object relationships although, generally, there is no conscious recall of these relationships (Olds & Cooper, 1997).

According to Clyman (1991), the internal working model is stored as implicit memory. Emotional procedures and behavior patterns acquired during infancy, likely through the attachment relationship, are expressed automatically and repeatedly in adulthood, independent of the conscious recall of the events

that produced such learning. Likewise, some authors (Mancia, 2006; Yovell, 2000) suggested that traumatic experiences in the mother–infant relationship that occur during a preverbal phase of psychological development are stored only as implicit memories without ever being recalled as explicit memories. By blending the attachment and psychoanalytical theories, we can relate the internal working model to an unconscious, but not repressed, portion of the ego. Implicit memories cannot suffer repression because they are, by nature, unconscious (Kandel, 1999; Olds & Cooper, 1997). Furthermore, relating the internal working model and implicit memory to the fundamental clinical Freudian concept of repetition compulsion is possible (Clyman, 1991). This refers to the constant repetition of behaviors that originated in previous experiences in the absence of a conscious recall of these experiences (Freud, 1914).

As stated by Freud (1915), the aim of defense mechanisms is to avoid displeasure. Some authors (Clyman, 1991; Gabbard, 2000; Westen & Gabbard, 2002) view them as strategies formed through early object relationships in order to regulate emotions. If this is the case, then defense mechanisms are components of the internal working model and stored in an implicit memory system. Similar to operant conditioning processes (i.e., a form of implicit memory), if a defense has efficiently reduced anxiety or avoided painful feelings in infancy, then it tends to be maintained indefinitely and reappears in future situations similar to those in which it was generated. In this case, the reduction in anxiety acts as reinforcement of defense (Westen & Gabbard, 2002). Having been successful, a defense mechanism formed during infancy tends to be crystallized even if it leads to formation of symptoms and, consequently, becomes maladaptive (Clyman, 1991). In our opinion, this view is consistent with Freud's (1920) notion of the primacy of repetition compulsion over the pleasure principle.

Social phobia can be used to illustrate how the internal working model is stored as implicit memory. The results of a study (Hermann, Ziegler, Birbaumer, & Flor, 2002) support the hypothesis of aversive conditioning (i.e., a form of implicit learning) as an important etiologic mechanism in this mental disorder. Fourteen men with social phobia and 19 healthy control subjects participated in aversive conditioning paradigms that consisted of two neutral faces as conditioned stimuli and an aversive odor as the unconditioned stimulus. Only the social phobia group showed enhanced unconditioned stimulus expectancy and delayed extinction of the conditioned physiological responses. Clinical psychoanalytical work has revealed that patients with social phobia have internalized representations of parents who shame, criticize, ridicule, humiliate, abandon, and embarrass. These internalizations are established in early infancy and then repeatedly projected onto other persons, who are consequently avoided (Gabbard, 1992). In this case

we can speculate that repeated pairing occurs between social exposition (i.e., the conditioned stimulus) and parental disapproval (i.e., the unconditioned stimulus) in childhood. Therefore, interpersonal contacts cause anxiety in adulthood.

Assuming that the internal working model is stored as an implicit memory, its influence on behavior is enduring because long-term learning entails anatomical changes in the brain (Kandel, 1983). Likewise, Diamond, Krech, & Rosenzweig (1964) demonstrated that brain structures are not only subjected to genetic control, but also shaped by experiences throughout life. In their study, infant rats exposed to environmental enrichment exhibited an increased number of cortical neurons, dendritic connections, and glial support cells and increased cortex thickness.

Schore (1997b) postulated that dyadic attachment experiences occur during the same period as the maturation of the right orbitofrontal cortex, which occurs during the first year and a half of life. The right orbitofrontal cortex is the seat of emotional regulation, which is related to its projections to subcortical limbic structures. According to Schore (1997b), the development of neural circuits in the right orbitofrontal cortex is dependent on emotion-laden interactions between the infant and the infants' caretakers. Therefore, a traumatic attachment experience could retard this process of maturation, predisposing the individual to mental disorders.

Recovery of infancy memories in analytic therapy

The concept of repression is fundamental in psychoanalysis. Repression is the defense mechanism that actively blocks undesirable or unacceptable mental representations from consciousness (Freud, 1915). In *Studies on Hysteria*, Breuer, & Freud (1895) stated that memories of traumatic events could be removed from consciousness and become pathogenic. As discussed, considering the present classification of mnemonic systems, only explicit memories can be repressed because implicit memories are, by definition, unconscious (Clyman, 1991; Mancia, 2006).

Several neurophysiological hypotheses have been formulated to explain repression. One hypothesis suggests an inhibition of the communication between the cerebral hemispheres. Accordingly, painful memories do not reach the left hemisphere (i.e., the hemisphere related to language function) and, consequently, they do not become conscious (Joseph, 1996). Based on several neuroimaging studies, Carhart-Harris, Mayberg, Malizia, & Nutt (2008) proposed that the subgenual cingulate, orbitofrontal, and ventromedial prefrontal cortices, because of their ability to inhibit visceromotor centers, are responsible for repression. According to this hypothesis, these regions restrain untempered

drives and flurries of unconscious material from discharging into the cortices and being consciously registered. Anderson et al. (2004) studied suppression, a mechanism of defense in which the person actively prevents awareness of an unwanted past experience. Using functional magnetic resonance imaging, they observed an association between suppression and increased dorsolateral prefrontal activation and also reduced hippocampal activation.

Most of the experiences that occur during early infancy cannot be consciously recalled in adulthood. Freud (1905) believed that infantile amnesia is caused by the repression of child sexuality. Accordingly, interpretative work in analytic therapy would remove repression and consequently lead to the recovery of early memories. This recovery of repressed memories to consciousness was essential for curing symptoms in analytic therapy (Breuer & Freud, 1895).

Neurobiology, however, explains infantile amnesia based on the fact that the hippocampus is still immature and non-functional during early infancy (Nadel & Zola-Morgan, 1984). In the first years of life, only neural structures related to the implicit systems of memory, such as the amygdala, are active. The hippocampus, which is related to explicit memory, develops later (Anooshian, 1998; Joseph, 1996).

According to Fonagy (1999a), analysts know that patients cannot remember the events responsible for their mental problems, even with long-term analytic treatment. In *Constructions in Analysis*, Freud (1937) acknowledged the extreme difficulty in helping a patient recover a repressed memory and state that what is “constructed” from residues of memory would have the same therapeutic effect of complete and reliable recall. In fact, Freud (1933) redefined the aim of analytic treatment. The aim became strengthening the ego and enlarging its domain over the id, rather than removing repression and allowing the memories to reach consciousness. Because most of the ego is unconscious (Freud, 1940), we can consider that strengthening this psychic structure does not necessarily implicate broader memory recovery.

Interpretative work that leads to insight

In an analytic setting, there is a regression to primitive phases of mental development that permits the reproduction of the dyadic relationship with the mother (Winnicott, 1965). Because of repetition compulsion, transference occurs during an analytic session. According to Freud (1914), transference represents a repetition of the patient’s original relationship with parental figures that is experienced with the analyst. The patient is not conscious of this repetition and shows transference not through recollection, but rather through behaviors (i.e., acting-out). These behaviors,

feelings, or thoughts express a stereotyped, automatic, and typical pattern of interpersonal relationships. Such characteristics clearly indicate that they were stored as implicit memories (Brakel, & Snodgrass, 1998; Clyman, 1991; Gabbard, 2000; Lewis, 1995; Olds, & Cooper, 1997) and were reactivated by the similarities between the roles played by the parents and the analyst as authority figures, caregivers, and so on (Levin, 1997; Westen & Gabbard, 2002).

During the sessions, the analyst acts as a detector of the patient’s maladaptive pattern, which represents a specific internal working model. Through interpretative work, the analyst communicates this pathological pattern to the patient, who is generally unaware of this problem. The patient gradually acquires insight and can acknowledge that interpersonal relationships throughout his/her life are basically a repetition of experiences during infancy (Fonagy, 1999a; Gabbard & Westen, 2003; Lane & Garfield, 2005; Rosenblatt, 2004). Although these early experiences cannot be recalled, consciously dealing with this information may be helpful. The patient reappraises his/her defenses and perceives that although they were useful during infancy, they are inadequate in adulthood and cause suffering or restraints (Clyman, 1991; Rosenblatt, 2004; Schwartz, 1987). Additionally, unconscious dysfunctional beliefs acquired during infancy (e.g., a negative self-image leading to low self-esteem) are evaluated to determine if they are consistent with reality (Fonagy, 1999a; Schwartz, 1987). At the same time, through interpretative work, the internal working model is translated into words, thereby becoming symbolized. Automatic and repetitive behaviors associated with implicit memory are transformed into explicit knowledge. Consequently, patients gain the ability to control automatic behaviors. At this time, the patient is able to consciously choose more satisfying and healthier forms of relationships with others (Clyman, 1991; Lane & Garfield, 2005; Rosenblatt, 2004).

From a neurobiological perspective, symbolizing may result from a strengthening of the connections to Wernicke’s area, which is essential for language function (Damásio & Geschwind, 1984). A recent functional magnetic resonance imaging study (Lieberman, Eisenberger, Crockett, Tom, Pfeifer, & Way, 2007) addressed the brain mechanisms related to transforming feelings into words (i.e., affect labeling). They found that affect labeling was associated with decreased activity in the amygdala and increased activity in the right ventrolateral prefrontal cortex.

Working-through

Several analysts (Gabbard & Westen, 2003; Gedo, 1997; Rosenblatt, 2004) believe that although the achievement of insight is essential in analytic therapy, it

is not sufficient. Further accomplishments are necessary for successful treatment. Several authors (Clyman, 1991; Fonagy, 1999a; Gabbard & Westen, 2003; Lane & Garfield, 2005; Rosenblatt, 2004) believe that the therapeutic action of psychoanalysis depends on changes not only in the patient's explicit knowledge, but also (and ultimately) in implicit memories. Freud (1926a) stated that after the elimination of repression the target for working-through should be resistance to abandoning the typical forms of instinctual satisfaction. This type of resistance is related to repetition compulsion (Freud, 1926b) which, as discussed, is expressed as an implicit memory (Clyman, 1991).

The power of positive transference is crucial for the patient's acceptance of the interpretations and constructions offered by the analyst (Andrade, 2005; Rosenblatt, 2004). Transference also plays a fundamental role in the process of changing the patient's behavior. The option of abandoning old defenses and adopting a healthier pattern of behavior is strongly influenced by the encouragement received by the patient from the analyst (Andrade, 2005; Rosenblatt, 2004). Because of transference, the desire to please the analyst is likely to be one of the patient's main motivations in analytic treatment. Each time the patient adopts a healthier behavior, the analyst expresses his/her approval in some way, even without the conscious intention of proceeding in this way. The feeling of approval then motivates the patient to repeat the healthier behavior. Therefore, operant conditioning may increase the frequency of healthier behaviors (Olds, 2006).

A process of gradually weakening and extinguishing inappropriate defenses then occurs. At first, analytic sessions provide security for the patient as he/she tries to abandon his/her defenses and mentally face the feared situations. Consequently, a reduction in anxiety occurs. Supported by the analyst's encouragement and approval, the patient then faces the feared situations in reality. Each time this happens, anxiety becomes progressively less intense until it disappears completely (Gabbard & Westen, 2003; Schwartz, 1987). According to the principles of operant conditioning, the new behavioral pattern will be reinforced not only by the reduction in anxiety, but also by the improvement in the patient's quality of life (Rosenblatt, 2004). The analyst's behaviors in the therapy sessions resemble those of the mother in a secure attachment situation.

Changes in implicit memory systems require regular practice. After the conscious choice of a healthier behavioral pattern is yielded through interpretative work, continuous repetition of the new behavioral pattern is necessary for its incorporation into implicit memory systems; thus, it becomes enduring, automatic, and independent of consciousness (Clyman, 1991; Rosenblatt, 2004).

The patient-analyst relationship

In psychoanalysis, the mechanism of therapeutic action has long been debated. Several analysts stress the relevance of interpretative work, whereas others believe that clinical improvement essentially depends on the patient-analyst relationship (Cooper, 1988; Greenberg, 2007). Alexander & French (1946), Winnicott (1965), and Kohut et al. (1984) indicated that this relationship may represent an opportunity to repair parental faults, providing the patient with a corrective emotional experience, holding, or empathy, respectively. Different psychoanalytic schools yield similar therapeutic results, although they present different interpretative models. So, aspects beyond interpretation are fundamental for successful analytic treatment (Andrade, 2005; Gedo, 1997). Several authors (Andrade, 2005; Pally, 1998) stated that the affective components of analytic therapy are more important than the cognitive aspects and, consequently, the analyst-patient relationship is crucial for treatment.

New emotional experiences with the analyst may directly change the patient's implicit memory. Because of transference, the patient's typical pattern of interpersonal relationships formed during early infancy tends to be repeated with the analyst. However, the analyst behaves differently from the parental figures, which leads to the development of a new pattern and weakens the previous one. This change that occurs during analytic sessions may likely occur in the absence of consciousness and voluntary control (Andrade, 2005; Clyman, 1991; Gabbard & Westen, 2003; Jones, 1997; Lane & Garfield, 2005; Stern et al., 1998; Westen & Gabbard, 2002). A case report offers support for this view. During psychoanalytic therapy, an amnesic patient presented changes in the content of his emotion-related associations and was able to learn from the dynamic interaction with the analyst, although the patient could not consciously remember what had happened during the sessions and could not recognize the analyst (Turnbull, Zois, Kaplan-Solms, & Solms, 2006).

It is a common assertion that "unconscious-to-unconscious communication" occurs between analyst and patient. Pally (1998) suggested that the unconscious processing of nonverbal expressions of emotion (e.g., gestures, facial expressions, and prosody) could modulate the analyst-patient interaction, reciprocally influencing bodily sensations, thoughts, and behaviors. This interaction partially reproduces the mother-infant relationship. The analyst literally feels what the patient feels and vice versa. Accordingly, Cimino & Correale (2005) proposed that projective identification, a type of influence exerted by the patient over the analyst's mind, has pre-symbolic content and represents the communication of early traumatic experiences that emerge from implicit memory.

Schore (1997a) proposed that the interaction between analyst and patient represents communication between the right hemispheres of the brain because the right cerebral hemisphere is dominant for emotions. This author speculated that the ability to empathize is related to this hemisphere. The discovery of mirror neurons and several functional neuroimaging studies on emotions indicated that a cerebral correlate for empathy exists (Gallese, 2006). The observation of the actions of others activates premotor areas that are normally involved in the execution of the same actions. Mirror neurons are activated simultaneously in an individual who performs a motor action and in another individual who only observes the action (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). A human functional magnetic resonance imaging study showed that observing video clips of the emotional facial expression of disgust and experiencing the feeling of disgust activated the same sites in the anterior insula (Wicker, Keysers, Plailly, Royet, Gallese, & Rizzolatti, 2003). Keysers, Wicker, Gazzola, Anton, Fogassi, & Gallese (2004) found that both the observation and experience of touch activated the secondary, but not primary, somatosensory cortex. Finally, three studies (Botvinick, Jha, Bylsma, Fabian, Solomon, & Prkachin, 2005; Jackson, Meltzoff, & Decety, 2005; Singer, Seymour, O'Doherty, Kaube, Dolan, & Frith, 2004) showed that the same cerebral areas are activated when one feels pain and observes others with a facial expression of pain.

Some authors (Gallese, 2003; Iacoboni, 2009) believe that the discovery of mirror neurons contributed to our understanding of intersubjectivity and provided support for the intersubjective approach used in analytic therapy. Olds (2006) stated that these studies offer information about the biological mechanisms of imitation and the relationship between imitation and identification, which could contribute to a deeper psychoanalytic understanding of identification. The relevance of both imitation behaviors in the mother–infant relationship and the patient's identification with the analyst during therapy should be noted.

According to Kandel (1999), analytic treatment is successful only if it leads to adequate brain remodeling. Indeed, through environmental stimulation, synapses can be modified at any time in life (Diamond et al., 1964). Olds & Cooper (1997) stated that analytic therapy requires a long duration and high session frequency because changes in synaptic structure depend on continuous repetition. In our opinion, absence of these features in other forms of psychotherapy may be a limiting factor.

Anxiety disorders, especially phobic disorders, are hypothesized to be related to fear conditioning, which involves the amygdala and the structures with which it is connected (LeDoux, 1993). Morgan, Romanski, & LeDoux (1993) demonstrated that the medial prefrontal

cortex plays an important role in the regulation of fear extinction. LeDoux (1993) stated that all forms of psychotherapy would aid the cortex in acquiring control over the amygdala, thus inhibiting the expression of pathological emotional responses through an extinction process. However, extinction does not eliminate the implicit memories that underlie fear conditioning from the amygdala. Therefore, a spontaneous return of anxiety symptoms is possible (LeDoux, 1993). Considering this information, we suggest that a cognitive approach to emotional dysfunction (e.g., interpretative work in psychoanalysis) is important but does not lead to complete problem resolution. Therefore, a more subtle approach that directly affects the implicit memories stored in the amygdala without involving the conscious processes related to the cortex is necessary. We speculate that this approach could involve the analyst–patient relationship.

Final remarks

Any debate about the interaction between psychoanalysis and neurobiology should implicate the philosophy of the mind, a philosophical field that addresses the mind–body problem. Presently, substance dualism (i.e., the theory that the universe consists of two fundamentally different types of aspects, the mental and material) has little support from philosophers and scientists. Accordingly, most believe that psychological processes are in some way related to brain function (for a didactic review on the philosophy of the mind for non-philosophers, see Kendler, 2001).

Some materialist monism positions do not favor a dialogue between psychoanalysis and neurobiology. Eliminative materialism (i.e., the mind does not exist or is only an epiphenomenon) and reductive materialism (i.e., there is an identity relationship between mind and body) are among these philosophical positions. However, in our opinion, other philosophical positions such as psychophysical supervenience and emergentism are compatible with an interaction between psychoanalysis and neurobiology. According to psychophysical supervenience, psychological phenomena depend on physical and biological phenomena. Nevertheless, this does not imply that mental properties are reductive to physical or biological properties (Marras, 1993). Several philosophers view mental processes as emergent properties of brain function. At the level of psychology, new features emerge that cannot be predicted from biology (Kendler, 2001). Consistent with supervenience theory and emergentism, we assume that although psychoanalytic processes cannot be fully explained through neurobiological knowledge, psychoanalytic theory should not contradict biological laws.

Despite the current lack of prestige of substance dualism within philosophy and science, we observe a clear antagonism between psychodynamic and biological

psychiatrists. The traditional and outdated etiological subdivision of mental disorders into psychological vs. organic still exists in daily clinical practice (Miresco & Kirmayer, 2006). According to this view, psychotherapy is the best treatment option for psychological disorders, whereas psychopharmacotherapy is more appropriate for organic disorders (Gabbard, 2000).

Neurobiological data have seriously challenged the dualistic perspective of mental disorders. Recent studies using functional neuroimaging techniques (e.g., positron emission tomography and single-photon emission computed tomography) found no differences in the effects on brain metabolism between patients who improved with psychotropic drugs and patients who responded to psychotherapy. Comparisons were performed between fluoxetine and behavioral therapy in patients with obsessive-compulsive disorder (Baxter et al., 1992), citalopram and cognitive-behavioral therapy in patients with social phobia (Furmark et al., 2002), and venlafaxine and interpersonal therapy (Martin, Martin, Rai, Richardson, & Royall, 2001), paroxetine and interpersonal therapy (Brody et al., 2001), and venlafaxine and cognitive-behavioral therapy (Kennedy et al., 2007) in patients with depression. Furthermore, three case studies (Saarinen et al., 2005; Tolmunen et al., 2004; Viinamaki, Kuikka, Tiihonen, & Lehtonen, 1998) and a case series (Lehto et al., 2008) reported an increase in serotonin transporter densities in response to 1 year of psychodynamic psychotherapy treatment. These studies followed up a patient with depression and borderline personality disorder (Viinamaki et al., 1998), a patient with depression (Saarinen et al., 2005), a patient with mixed mania (Tolmunen et al., 2004), and a sample of eight patients classified as having atypical depression (Lehto et al., 2008). Such results indicate that psychopharmacotherapy and psychotherapy both yield important and similar changes in neural activity, although likely through different mechanisms (Beutel et al., 2003).

Some psychoanalysts such as Fonagy (1999a) and Rosenblatt (2004) studied the role of memory in the mode of action of analytic therapy and the importance of the distinction between explicit and implicit memory mechanisms for psychoanalysis. Likewise, we believe that Freud (1914), in *Remembering, Repeating and Working-Through*, formulated a similar distinction. In analytic therapy, we consider “remembering” and “repeating” as forms of expression of explicit and implicit memory, respectively.

Indeed, linking psychoanalytical treatment to changes in memory systems and brain structures would reduce the distance between psychoanalysis and psychotherapy modalities that aim to incorporate neuroscientific knowledge into its theories, such as cognitive therapy. Although this approach is disapproved by most psychoanalysts, some authors (Kempke & Luyten, 2007) view contact points between psychodynamic and

cognitive therapies. Accordingly, Wallerstein (1986) proposed that the differences between psychoanalysis and other types of psychotherapy are more quantitative than qualitative and that psychoanalysis would be situated at an extreme of a continuum.

To summarize, we believe that clinical improvement in analytic therapy ultimately depends on changes in the implicit memory system, which entails structural brain changes. Implicit memory system changes may be related to changes in explicit memory systems yielded by interpretative work. They can also occur directly as a result of the emotional experiences in the patient-analyst relationship. As Rosenblatt (2004) stated, the patient must practice to improve. However, the patient must first know what and how to practice.

We view psychoanalysis and neurobiology as complementary rather than competing disciplines. In our opinion, a purely objective approach to mind where the vast contribution of psychoanalysis in the study of the subjective aspects and meanings of human behavior is ignored is incomplete. Likewise, neurobiological knowledge can provide psychoanalysts with a broader understanding of several important therapy issues. First, the fact that hippocampal immaturity in early infancy can account for much of infantile amnesia leads to the questioning of a more traditional psychoanalytic technique that is restricted to the interpretation of repressed material (Andrade, 2005; Fonagy, 1999a; Gabbard & Westen, 2003; Rosenblatt, 2004; Schore, 1997a). Furthermore, neurobiological findings provide support for the belief that both the insight that results from interpretative work and the patient-analyst relationship are essential for treatment (Gabbard & Westen, 2003; Jones, 1997; Rosenblatt, 2004; Watt, 2000). In this sense, both the cognitive and affective components of therapy are relevant, and their actions can be synergistic (Andrade, 2005; Watt, 2000).

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