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The Neurobiology of Transference

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Understanding transference in terms of neurobiological mechanisms has been an area of interest throughout the last decade. The newly developed methods of neuroscience, such as neuroimaging and molecular neurobiology, help explain a neurobiological base for biological correlates of the mental process described in psychoanalytic theory. In this review, we present an hypothesis about neurobiology of transference, with the help of other previously proposed mechanisms such as neurobiology of attachment, pattern completion, memory systems, repetition compulsion, and neurobiology of psychotherapy.

Keywords: transference, neurobiology, neuropsychoanalysis

In basic terms, transference is defined as the redirection of feelings and desires and especially of those unconsciously retained from childhood toward a new object. These mostly include unresolved or conflictual feelings and desires. The new object in psychoanalysis is usually the analyst. Thus, in transference, the patient redirects his unresolved or conflictual desires and feelings to the analyst in order to resolve them.

In the case of any particular conflict around sexual or aggressive impulses, the conflict is embedded in an internalized object relation, i.e., in a repressed or dissociated representation of the self (self representation) linked with a particular representation of another who is a significant object of desire or avoidance (object representation). These internalized object relations are activated in the transference with an alternating role distribution. The patient enacts a self representation while projecting the corresponding object representation onto the

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analyst at times. At other times the patient projects his representation onto the analyst and identifies with the corresponding object representation (Kernberg, 2000).

During the past decade, an effort has been made both by psychoanalysts and neuroscientists to identify the underlying neuroanatomical, neurophysiological, and molecular underpinnings of psychoanalytical concepts under the name of neuropsychoanalysis. This effort has helped us to fill the gap between mind and brain, and to gain a better understanding of effects of every mental action on underlying neural systems, and vice versa. And this does not only apply for conscious mental actions, but also to unconscious mental acts, which form the very basics of psychoanalytic theory. Repression is one of these acts, and we have previously tried to explain repression in terms of neuroscience (Ceylan and Sayin, 2012). In this review, we aim to find a neurobiological explanation for transference. Toward this aim, we will first briefly summarize explanations proposed by others, such as neurobiology of attachment, pattern completion, memory systems, repetition compulsion, and neurobiology of psychotherapy. Then, we will briefly describe our hypothesis about externalization, libidinal gratification, and object relational gratification. In the final part of this article, we will present our interpretation of the neurobiology of transference.

Recollecting the Past in the Present: Involvement of Different Memory Systems in Transference

A discussion about neurobiology of transference would be inadequate without discussing the involvement of memory systems. Internalized object relations are encoded in memory and emerge in the mode of relatedness that the analysand brings to the analysis (Gabbard, 1997).

One of fundamental goals of psychoanalysis is to make the unconscious conscious. From a neuroscientific perspective, this can be described as rebuilding the brain; increasing the interconnection and integration of neural networks dedicated to unconscious and conscious memory. Thus, we need to look at different memory systems and how they relate to unconscious and conscious parts of the psychic apparatus.

Different Types of Memory Systems

Long-term memory systems are usually classified into two categories according to the type of information encoded, namely declarative and non-declarative memory (Squire and Zola, 1996). Declarative memory requires conscious recall; a conscious process must bring up the information. This is sometimes called explicit memory, since it consists of information that is explicitly stored and retrieved.

Declarative memory can be further sub-divided into things that we recall about our own lives (episodic memory) and general world knowledge (semantic memory) that does not relate to events in our lives. Examples of episodic memory include events in our personal history, such as our graduation party. Semantic memory reflects knowing general facts about the world, such as how to tell time (Gazzaniga, Ivry, and Mangun, 2002). The main brain areas involved in declarative memory are the medial temporal lobes (especially the hippocampus) and the diencephalon (McDonald and White, 1993).

In contrast, non-declarative memory (or implicit memory) is not based on the conscious recall of information, but on implicit learning. Implicit (unconscious) memory is observable in behavior but is not part of conscious awareness. Procedural memory is one form of implicit memory and involves the learning of a variety of motor (e.g., knowledge about how to drive) and cognitive skills (e.g., the acquisition of reading skills). A second form of implicit memory is associative memory, which is based on classical conditioning. Classical conditioning occurs when a conditioned stimulus (an otherwise neutral stimulus to the organism) is paired with an unconditioned stimulus (one that elicits some response from the organism). A person may instantly feel sad whenever he listens to a song by a particular singer. The sadness may, for instance, emerge based upon a past experience when he heard of the death of his mother while a song by the same singer was playing. This connection or association, however, is not available to conscious awareness. A third form of implicit memory is non-associative learning, which involves simple learning such as habituation (the decrease in the response with repeated presentations of the stimulus) and sensitization (the increase in response with repeated presentations of the stimulus) [Gazzaniga, Ivry, and Mangun, 2002]. The main brain areas that are involved in non-declarative memory are the basal ganglia, the striatum, and the cerebellum (McDonald and White, 1993).

Neurodevelopment of Different Memory Systems

Looking back at the evolutionary development of neomammalian brain can help us to find which structures are more related to these two different memory systems. In triune brain (Baars and Gage, 2010), each tier is involved with different aspects of memory functioning. The reptilian brain contains instinctual memories, the lessons of past generations (genetic memory) that control reflexes, and inner bodily functions. The paleomammalian brain (limbic system) contributes to emotional memory and conditioned learning — a mixture of primitive impulses and survival programs sculpted by experiences. These two systems are nonverbal and comprise aspects of the Freudian unconscious. The neomammalian brain, although largely unconscious in its processing, contains networks responsible for explicit verbal memory biased toward the left hemisphere (Cozolino, 2010).

As we all know, neurodevelopment of different brain structures happens at different times during intrauterine life and infancy. At birth, most parts of the so-called reptilian and paleomammalian brain are mostly developed. These structures, including brain stem, amygdala, thalamus, and middle portions of the frontal cortex, are responsible for formation of primitive reflexes which are basically used for survival. These kinds of learning through these more primitive structures form sensory, motor, and emotional networks of implicit memory.

The development of explicit memory parallels the maturation of hippocampus and higher cortical structures over the first years of life (Jacobs, van Praag, and Gage, 2000; McCarthy, 1995). This also explains the phenomena of childhood amnesia or the absence of explicit memory from early life; the maturational delay of these structures is responsible for this lack of explicit memory during first years of life. Neural networks in hippocampus and cortex provide for conscious, contextualized learning and memory that becomes more consistent and stable over time.

Psychotherapy often involves the retrieval of emotional memories. Formation of emotional memories is highly dependent on subcortical structures such as amygdala and hippocampus.

Emotional Memory: The Interaction between Amygdala and Hippocampus

Sensory inputs to the amygdala come from two different networks (LeDoux, 1994). The first one comes directly from the thalamus and serves rapid responses during survival decisions based on minimum information. Amygdala's output goes directly to the hypothalamus, limbic-motor circuits, and many brainstem nuclei and causes a rapid survival response. These are the kinds of circuits which cause us to run away quickly when we see a snake during our walk in the woods. Second sensory input first loops through the cortex and hippocampus before reaching the amygdala, and thus adds cortical processing (context and inhibition) to appraise ongoing perceptions and behaviors. When we see the same snake in a cage at the zoo, these circuits inhibit the fear response of the amygdala.

The emotional value to the object based on both instincts and learning history is connected by the amygdala, in association with medial areas of the frontal cortex (Davis, 1992; LeDoux, 1986). The amygdala associates conscious and unconscious indications of danger with preparation for a survival response (Ohman, Carlsson, Lundqvist, and Ingvar, 2007). The amygdala's major role related to psychotherapy is that it creates an emotional bias in conscious processing; that is what makes us see the glass as half empty or full (Kukolja et al., 2008).

The amygdala is one of the key components of affective memory (Chavez, McGaugh, and Weinberger, 2009). In an adult brain, the amygdala also enhances hippocampal processing of emotional memory by stimulating the release of norepinephrine and glucocorticoids via other brain structures (McGaugh, 2004).

Through these chemical messages, the hippocampus is alerted to the importance of remembering what is being experienced, a key component of learning. The activation of the sympathetic nervous system alters the chemical environment within and between neurons, enhancing long term potentiation and neural plasticity.

The hippocampus is the essential structure for the encoding and storage of explicit memory and learning (Zola–Morgan and Squire, 1990). It also participates in our ability to compare different autobiographical memories and make inferences from previous learning in new situations (Eichenbaum, 1992).

The reciprocal relationship between amygdala and hippocampus is an interesting area for understanding neuroscience of psychotherapy. The amygdala and hippocampus have different contributions to formation of memories. The amygdala is involved with generalization, while the hippocampus is involved with discrimination (Sherry and Schacter, 1987). The amygdala has a central role in the emotional and somatic organization of experience, while the hippocampus is vital for conscious, logical, and cooperative social functioning (Tsoory et al., 2008). Their relationship will impact affect regulation, reality testing, resting states of arousal and anxiety, and our ability to learn emotional and more neutral information (Cozolino, 2010).

Involvement of Different Types of Memory Systems in Transference

Both explicit and implicit memory may be involved in the transference process, and may influence each other. For instance, work on implicit memories can make it easier for fantasies and recollections to surface from explicit memory. At the same time reconstructions of events through autobiographic memory can help retrieve patients' early experiences, along with related fantasies and defenses. All these associations may emerge from implicit memory in transference and in dreams (Mancia, 2006). Gabbard (2006) suggested that both procedural and declarative memory systems can be assumed to be involved in the development of transference. He stated that both procedural and declarative memory have implicit and explicit aspects. Implicit procedural memory involves automatic stereotyped behavior tied up with long-standing characteristic patterns of unconscious defenses and unconscious internal object relations. Implicit declarative memory involves repressed and preconscious expectations, fantasies, and fears about how the analyst may react. Explicit declarative memory, especially autobiographical memory, can also be extraordinarily important, as the patient consciously recognizes symbols and problematic patterns along with their antecedents. Through the reconstruction of one's life narrative and working through problematic patterns in the present are recognized as present-day repetitions of early childhood patterns.

According to the connectionist model of cognitive neuroscience, transference reaction can be seen as a collaborative and a parallel activation of different neural networks in which different parts of the same representation are encoded (Westen and Gabbard, 2002). From this point of view transference reaction is formed by the activation of different neural networks at the same time: (1) the networks for the implicit declarative memories for that particular relational pattern, (2) the networks for the affective responses linked with that particular relational pattern, and (3) the networks for the implicit procedural memories which include defenses associated with the regulation of that particular affect that transference reaction activates. With the help of psychoanalysis, links between neural networks that have been activated together for years or decades are weakened and new associative linkages are created, or previously weak linkages can be strengthened.

Involvement of different memory systems in transference formation is shown in a case report of a male patient with a profound anterograde episodic memory loss caused by anoxic hippocampal damage. Despite his amnesia, he was able to develop a transference relationship with his analyst. The patient did not have an episodic memory recall of the analyst and the previous sessions, but as the therapy progressed, he reported to be "very much at ease at the moment, and he felt comfortable with the analyst, in that one-to-one relationship." The authors think that this report emphasizes the fact that the interpersonal properties of the transference relationship are mediated emotion-based nonepisodic memory systems, rather than conscious episodic recall (Turnbull, Zois, Kaplan–Solms, and Solms, 2006).

Memory as a Re-categorization

The old theory of memory was based on a static memory perspective (Aschraft, 1994; Baddeley, 1997). According to this theory, memory was perceived as a place in the brain where information was stored. In this sense, memory was a constant structure, resistant to change, and was retrieved exactly as it was stored.

A more recent view of memory is based on a dynamic memory perspective. According to this view, memory is not to be conceived of as stored structures (the computer metaphor) but as a function of the whole organism, as a complex, dynamic, recategorizing, and interactive process. In this sense, memory is a theoretical construct that connects the state of the individual in the past and the influence the event had on the individual to the behavior in the current situation (Leuzinger–Bohleber and Pfeifer, 2006). This new view of memory can explain how memory systems are involved in transference reaction: memory is always based on new and idiosyncratic narratives taking place in current interactional situations but at the same time contain traces of the historical truth.

According to Edelman (1987), memory is defined as the ability of the whole organism to re-categorize, a capacity which always stems from sensory-motor coordination processes and value systems. Categorization occurs by sampling of the environment by multiple sensory maps within the same modality and between different modalities, and which one of these patterns of correlations is chosen or selected in the categorization is modulated by a value system. Value systems are basic evolutionary adaptations that define broad behavioral goals of the organism. In this way the organism is capable of generating categories on its own as it interacts with the environment. Since there is no limit to the patterns of sensory stimulation, new perceptual categories can be formed if they have distinct behavioral consequences. Edelman speaks of a never-ending process of re-categorization, which allows the organism to adapt constantly to new situations by applying knowledge gained in past experiences.

Similar to Edelman's theory about memory as a re-categorization, Modell (1990) defines memory as a re-transcription. According to Modell, the memories of affective experiences are organized into categories (affective categories) as an attempt to find a perceptual unity between the past and the present. Affect categories concerning the self, or the self in relation to objects, can be observed most clearly in the process of projective identification. The refinding and redefining of archaic affect categories in present time through projective identification and transference reaction is seen as re-transcription of memory.

We think that these ideas of dynamic memory can offer us a neurobiological base to understand how working through of transference relationship in psychoanalytic therapy forms new memories. Memories of relationship patterns of an early childhood with significant others become activated in the psychoanalytic setting. Sensory-motor perceptions are categorized according to past value systems of the analysand and transference occurs. By the working through of this transference and with the help of corrective emotional experience in relationship with the analyst during therapy, new value systems are formed by these new inputs to the memory and re-categorization or re-transcription occur.

The Intrusion of Early Implicit Memory into Adult Consciousness

Early memories mainly include emotions and our attachment schema (a key form of implicit memory, which we will describe more broadly in the following section), which are in the form of preverbal, sensory, motor, and affective information. These early emotional memories include two closely related concepts to transference and therapeutic change, namely, emotional awareness and emotional change.

Emotional awareness is described as an individual's ability to recognize and describe emotion in oneself and others (Lane and Schwartz, 1987). Five levels of emotional awareness in ascending order are: (1) awareness of physical sensations, (2) action tendencies, (3) single emotions, (4) blends of emotions, and (5) blends of blends of emotional experience (the capacity to appreciate complexity in the experience of self and other). The first two levels are implicit aspects of emotional awareness, which are developed first chronologically, and their neural substrates are more the reflexive and primitive parts of the brain, such as brainstem and diencephalon, respectively. Experience, as well as realities and demands of the outside world add to and modulate these levels and the later three levels of emotional awareness develop. These higher levels work explicitly and their neuroanatomical correlates are limbic and paralimbic areas, and prefrontal cortex, respectively. Lane and Garfield (2005) have proposed that transition from implicit to explicit processing of emotion is the core process associated with clinical change in psychotherapy.

Emotional procedures organize how we interpret situations and how we react to them across the life span. Infants and young children can decipher the rules by which families operate and develop strategies for meeting their needs within their families. These emotional procedures are guided by procedurally encoded heuristics which are initially adaptive but later lead to systematic distortions in the processing of information and experience. Transference is the enactment of the emotional procedures learned in childhood (Clyman, 1991).

Transition from implicit emotional procedures and emotional awareness levels into explicit processing of emotions by working through transference reaction in psychoanalysis is the core process associated with change. By transference reaction, the networks of these implicit social memories are activated and this preverbal implicit memory is verbally and behaviorally brought into the consulting room. Psychoanalytic psychotherapy allows long silences between the therapist and analysand and this silence also activates these preverbal implicit memories. Revisiting and evaluating these memories from an adult perspective by interpretation of transference reaction during psychotherapy often lead to rewriting the history in a creative and positive way. The introduction of new information or scenarios to past experiences can alter the nature of memories and modify affective reactions by formation of new synapses. The construction and reconstruction of autobiographical narratives require that the semantic processing of the left hemisphere integrates with the emotional networks in the right.

Cozolino (2010) gives a very good example of how we may grow and move on to new lives, yet our implicit memory systems retain old fears. He tells us a story in the early 1960s. During World War II, the Japanese navy left soldiers on many islands throughout Pacific but never retrieved them at the end of the war. Decades later, some tourists would innocently land on these islands and they were attacked by soldiers who thought the war was still being fought. They had dutifully kept guns oiled and remained vigilant for decades in anticipation of an American attack. They had spent years fighting a war that no longer existed. Cozolino (2010, p. 92) says: "While remaining vigilant for signs of attack for early attachment pain, approaching intimacy can set off all the danger signals. Therapists are trained to be amygdala whisperers who land on these beaches, attempting to convince the loyal soldiers with implicit systems of memory that the war is over."

Development of the Social Brain: Formation of Attachment Schemas

The term attachment is used to describe early caretaker–infant relationships as well as the psychological proximity that binds interpersonal relationships. Bowlby (1969) suggested that early interactions create attachment schemas that predict subsequent reactions to others. Schemas are implicit memories that organize within networks of the social brain, and are based on experiences of safety and danger with caretakers during early sensitive periods. A secure attachment schema enhances the formation of a biochemical environment in the brain which facilitates regulation, growth, and optimal immunological functioning. Insecure and disorganized attachment schemas have the opposite effect, and correlate with higher frequencies of physical and emotional illness. These schemas are a summation of thousands of experiences with caretakers that become unconscious, reflexive predictions of the behaviors of others. They become activated in subsequent relationships and lead us to either seek or avoid proximity. They also determine whether we can utilize intimate relationships for physiological and emotional homeostasis. These implicit memories are obligatory; that is, they are automatically activated even before we become conscious of the people with whom we are about to interact. They shape our first impressions, our reaction to physical intimacy, and whether we feel relationships are worth having. They trigger rapid and unconscious moment-to-moment approach–avoid decisions in interpersonal situations. Attachment schemas are especially apparent under stress because of their central role in affect regulation. Attachment is mediated by the regulation of the autonomic nervous system by the social brain, and a cascade of biochemical processes that create approach and avoid reactions and create positive and negative emotions. Schemas shape our conscious experience of others by activating rapid and autonomic evaluations hundreds of milliseconds before our perceptions of others reach consciousness.

It has been postulated that the social motivational system is modulated by many neurochemicals (Nelson and Panksepp, 1998). Some of these neurochemicals are oxytocins, vasopressin, peptides, androgens, and estrogens. The social motivational system extends into the amygdala, anterior cingulated, and orbitomedial prefrontal cortex. These circuits and neurochemicals are thought to regulate attachment, pain bonding, empathy, and altruistic behavior (Decety and Lamm, 2006; Seitz, Nickel, and Azari, 2006). In addition, the dopamine reward system of the brain, namely the circuits between ventral striatum and nucleus accumbens, is thought to be involved with more complex analysis of reward and social motivation (Kampe, Frith, Dolan, and Frith, 2001; Pagnoni, Zink, Montague, and Berns, 2002).

Expansion of the cortex in primates correlates with increasingly large social groups. Experience-dependent plasticity has been found in many areas of the brain, predominantly the prefrontal cortex and hippocampus (Kolb and Whishaw 1998; Maletic–Savatic, Malinow, and Svoboda, 1999). These structures are central to learning and memory, and they are also keys in shaping our attachment schemas. We know that our social environment has a major impact on neuro-development of our brain. The changes in our attachment schemas may also change our brain. Research has shown that in the transition from dating to marriage, there is a broad tendency to move from insecure and disorganized attachment schemas to increasingly secure patterns (Crowell, Treboux, and Waters, 2002). On the other hand, we also know that social support, compassion, and kindness result in positive neural growth, while social stress inhibits cell proliferation and neural plasticity (Czeh et al., 2007; Davidson, Jackson, and Kalin, 2000).

Psychotherapy can be seen as a kind of re-parenting. The therapist's attention, care, and nurturance may change the structure of the brain by promoting neuro-plasticity. We will point out how psychotherapy affects the brain, in the following sections. But at this point, we may say that parts of the brain which are closely connected to formation of attachment schemas would be the best candidates to change, if we are talking about transference-based psychotherapies, such as psychoanalysis. It has been proposed that cortical areas such as the orbitomedial prefrontal cortex, insula, cingulate cortex, and somatosensory cortex, as well as subcortical structures such as the amygdala, hippocampus, and hypothalamus are the major areas in the human social brain (Cozolino, 2010). It has been shown that the orbitomedial prefrontal cortex inhibits the amygdala, based on conscious awareness and feedback from the environment (Beer, Heerey, Keltner, Scabini, and Knight, 2003). Reciprocally, the amygdala inhibits the orbitomedial pre-frontal cortex when we are frightened and this is why we have a difficult time being rational, logical, and in control of our thoughts when we are frightened. Since the networks connecting our orbitomedial prefrontal cortex and the amygdala are shaped by experience, our learning history of what is safe and dangerous, including our attachment schema, is thought to be encoded within this system.

Transference in Terms of Affective and Conceptual Pattern Completion

Pattern completion is a neurological function involved in memory retrieval. It facilitates the retrieval of a complete pattern from a perceived, incomplete pattern (Samurai and Hattori, 2005). When the mind encounters a vague and incomplete visual or auditory stimulus, it refers to its previously memorized visual or auditory patterns to match the new stimulus with the complete pattern most closely correlated with it. Then that pattern is locked, and the person will perceive the vague pattern as the originally locked complete pattern (Javanbakht and Ragan, 2008). In the terms of object relations theory, objects and their patterns of relatedness already exist in our memory systems, and we use this information for pattern completion of ambiguous perceptions and situations. For example, the image of an unknown angry man with a cigarette may trigger a childhood memory of one's father, who also smoked and who used to get angry very quickly and behave badly. Through pattern completion, a person may unconsciously perceive the unknown man as his father and feel anxiety when he sees him (transference). Thus, pattern completion in transference occurs not only in terms of object recognition, but also in terms of one's relationship with that object.

A relationship with an analyst provides a perfect opportunity for ambiguity. The analyst–analysand relationship is not simply neutral; in fact an analyst strives to be free of emotional expression. The ambiguity of the environment is also intensified during the free association process. Furthermore, an analyst naturally represents a parental figure during the process of psychodynamic therapy, since he is the "authority" in this relationship. Thus, unknown aspects of the analyst's character and behavior can easily be substituted with the qualities of the analysand's parents. These patterns have been strongly encoded in the auto-associative networks in the analysand's memory systems. Pattern completion occurs both in psychodynamic and neurobiological terms, and transference occurs.

Pattern Completion, Repetition Compulsion and Projective/Introjective Identification

Freud, in his work "Beyond the Pleasure Principle" (1920, p. 18), explains repetition compulsion this way ". . . the patient is obliged to repeat the repressed material as contemporary experience instead of remembering it as something belonging to the past." Researchers have tried to give different psychological and biological explanations for repetition compulsion. Javanbakht and Ragan (2008) have proposed pattern completion as the underlying neurobiological mechanism of repetition compulsion and projective/introjective identification. They argue that projective and introjective identification form the primitive, or trauma-based, maturing psychological imprints or templates for the phenomena of transference and counter transference.

In every significant relationship, many aspects of the other person are vague to the perceiver. Subsequently, the mind, through the neuropsychological mechanism of pattern completion, attempts to relate these vague aspects to an archaic template. The perceiver will complete related patterns, such as behaviors, emotions, facial expressions, tone of voice, based on her reservoir of templates from past experiences, especially those with the most similar and significant emotional relevance. When a trained auto-associative network receives ambiguous inputs, it not only completes the incomplete or vague parts of those inputs, but it also eliminates those parts it perceives as irrelevant. In transference, this explains the way that patients appear to "ignore" realistic differences between their relationship with the analyst and some significant other. Thus, the patient begins to repeat patterns of behavior from the past with the analyst, and expects a familiar response from the analyst as remembered from relating to a significant other.

The reaction of the therapist to this transference reaction may also depend on the therapist's own pattern completion. Depending on his own encoded patterns, he does or does not become "hooked." If the projected behavioral pattern is not encoded in his neural networks, he may easily realize that this is a transference reaction from the patient. These recognized patterns can be used as information for the sake of the patient's psychological growth. But if the analysand's maladaptive pattern has a counterpart in the therapist's pattern reservoir, through pattern completion, the analyst may begin to react the way that the patient expects him to behave.

Projective identification can also be seen as an involuntary "mirroring action," in which the therapist's associations about the patient are creating an approximation of his feelings and thoughts. In projective identification, spontaneous matching of emotional states between the patient and therapist can occur via activation of mirror neurons (Greatrex, 2002). Discovery of mirror neurons have provided us neuropsychological and neuroanatomical evidence that the other can direct the thoughts and feelings we create at unconscious levels within ourselves.

Thus, from a "pattern completion" point of view, repetition compulsion can be seen as mastery over the unknown in the present, instead of mastery over the past. The patient escapes the unknown through completing unknown patterns with imprinted patterns from relationships to significant others. Although this process may cause a patient to suffer familiar pain, a feeling of mastery over the unknown can override his desire for pleasure (Javanbakht and Ragan, 2008).

Psychotherapy as a Neurobiological Treatment

We have previously stated that psychotherapy is a kind of re-parenting and being so, is also a kind of learning: the individual re-categorizes or re-transcripts the memory and discovers and hopefully changes the old maladaptive attachment schemas with the newly learned information about him and other people. We already know that learning, in neurobiological terms, means formation of new synapses (Kandel, 1999). There are many researchers who have shown that psychotherapy changes metabolism, activation, and neuroplasticity of many brain areas (see Liggan and Kay, 1999 for a review). Different types of psychotherapies may affect different parts of the brain. To give an example, cognitive behavioral psychotherapy which focuses on specific patterns of thinking and predicts the kinds of thinking patterns may cause changes in brain areas mostly related to information processing, such as prefrontal cortex. But what about psychoanalysis? In psychoanalysis, transference-based interventions are one of the main tools of healing. Thus, brain areas mostly involved with transference formation would be the best candidate for change during psychoanalysis. As discussed above, those areas would include the ones related to emotion, memory, and attachment schemas formation. We have already discussed that those areas include cortical structures such as the orbitomedial prefrontal cortex, cingulated cortex, somatosensory cortex, and insula, as well as subcortical structures such as the amygdala, hippocampus, hypothalamus, thalamus, some other areas of limbic system and brainstem. Pattern completion may happen in networks related to the rapid survival response between amygdala and hypothalamus, limbic-motor circuits, and brainstem nuclei. Learning processes during psychotherapy can enhance the top–down inhibitory synapses between cortex–hippocampus and amygdala; thus emotional bias caused by the amygdala via pattern completion does not occur. Think of a patient with borderline personality disorder, with early childhood trauma related to abandonment. The amygdaloid memory system will react to the perception of abandonment as a transference reaction, when little or none exists in reality. Therapy with such a patient would utilize the higher brain systems, such as hippocampus and cortex to test the reality of these amygdala-produced cues for abandonment and inhibit inappropriate reactions. This reality testing provided by the hippocampus and cortex will help to distinguish real abandonment from innocent triggers.

Libidinal Gratification/Object Relational Gratification

In his well-known drive theory, Freud describes the libido or the sexual drive as having an origin in the erotogenic nature of the bodily zones; an impulse expressing the quantitative intensity of the drive; an aim reflected in the particular act of concrete gratification of the drive; and an object consisting of the displacements from the dominant parental objects of desire. Under the dominance of the drives and guided by the primary process, the id exerts an ongoing pressure towards gratification, operating in accordance with the pleasure principle. Freud regarded all libidinous drives as fundamentally sexual and suggested that ego libido (libido directed inwards to the self) cannot always be clearly distinguished from object libido (libido directed to persons or objects outside oneself) [Freud, 1920].

One of the authors of this article has previously proposed a concept he calls externalization (Ceylan, 2010). Externalization basically means releasing yourself to the outside in parts, during which an internal part is reserved for yourself to return to, like a rear front at any time. This internal part is used as a safe harbor (regression) in case of any failure by the individual to compete with object frustrations (like psychosis). The externalization process includes establishing a relationship with an object in order to take pleasure from and possession of that object. In this manner, externalization is closely linked to Freud's concepts of primary and secondary narcissism. We are born with a source of psychic energy (the id). This energy-loaded aspect of our internal structure (the material carried and revealed by our phylogenetic and species past in order to establish the ego) has to externalize in order to reduce its load.

Externalizing is in fact the sum of any actions undertaken by the "self" in order to achieve a stable balanced position in the world of objects. During the first months of life, the new-born sees the world and objects around himself as belonging to or as a part of his self. His psychic energy seeks pleasure through libido cathexis (libidinal gratification). As he grows, he begins to differentiate between self and objects. By object cathexis the child learns to use his psychic energy to get pleasure from these objects (object relational gratification). Freud implies that the psychic energy objectifies specific aspects prepared by the psychic apparatus of the organism (delay of transformation, deposition, and discharge) by using them (taking the cathexis from the ego, transferring it to objects, and thus making the objects, which provide energy for, a part of the ego).

We can say that externalization is actually the process of using energy to acquire information about an object, and maintaining homeostasis through this information. A human being naturally experiences the danger of losing homeostasis after being born into a foreign world. A baby has great energy and a weak body structure that cannot manage all this energy. So, he unwillingly distributes this energy onto objects, and by acquiring information on how to use those objects makes them carry his energy. He then uses his energy through those objects. Incomplete externalization on a group of objects is the most common cause of an inadequate sense of self. This triggers a pathological presentation leading to feelings of inadequacy as expressed for example in personality disorders.

By libidinal gratification, we refer to the most immature and infantile type of gratification. In this kind of gratification, libidinal drives still need gratification from the sources of early-stage psychosexual development. In this case, there are no adequately internalized object representations to fulfill the needs of libidinal drives. If a person has achieved an optimum level of mature and healthy internal object representations, his libidinal drives will seek gratification through object relations, and this is what we will refer to as object relational gratification. If libidinal drives cannot be directed into object relations, if libidinal gratification is so intense that it creates dependence, or if object relational gratification is not enough to give pleasure, a person will continue to seek libidinal gratification. Thus, he will try to get libidinal gratification from every situation and/or object that has the potential to fulfill that need. A relationship with an analyst is not an exception; the analysand forms a transference relationship based on libido gratification that is more intense and immature than a transference relationship based on object relational gratification.

Neuroscientific Base for Libidinal/Object Relational Gratification: Development of Self

We believe that Panksepp's core-self (Panksepp and Biven, 2012) and Damasio's (2010) three-staged self concepts provide a neuroscientific base for Freud's drive theory, as well as externalization. As discussed above, externalization process parallels the development of self in stages. Panksepp (Panksepp and Biven, 2012) and Damasio (2010) also describe a hierarchical development of self, as we will try to summarize below, before we move on to our interpretation concerning neurobiology of transference.

Panksepp describes SELF (Simple Ego-type Life Form) as "a coherent center of gravity for international organismic visceral-affective and external sensory-motor representations" (Panksepp and Biven, 2012, p. 390). He proposed that different kinds of SELF develop at different stages. The more primitive one is called the core-SELF, which is a primordial representation of the body, especially the visceral body, within the brain, which is foundational for affective being and the emergence of the higher mental apparatus. Core-SELF is related to primary-process emotional and other affective processes, and includes the most primitive emotions, such as seeking, rage, fear, lust, care, grief, and play (Panksepp, 1998). These emotions are universal, quite similar for all mammals, closely related to survival functions, such as the need to keep homeostatic balance and avoid bodily destructions. Thus, we may assume that core-SELF is more related to libidinal gratification.

According to Panksepp, a part of core-SELF begins to differentiate by experience, and emerges during the life span through the unique experiential landscape of each person or animal. This part of self is called the "idiographic SELF" (Panksepp and Biven, 2012). It develops as behaving under the control of primitive emotions causes a frustration because of the demands and rules of the social world. This development is parallel to the development of neocortex and cognitive capacities such as executive functions and memory. It is closely related to higher-order emotions, such as shame, guilt, jealousy, compassion and empathy (Panksepp, 1998). In this sense, the idiographic self is more related to object relational gratification.

Current evidence indicates that raw affective experiences, at their most primitive level, emanate from subcortical midline systems that are located in the upper brain stem and that connect heavily with more rostral higher cortical midline structures (Panksepp and Biven, 2012). Subcortical midline structures include peri-aquaductal gray, ascending reticular activating system, and mesencephalic locomotor region. Cortical midline structures include medial cinglate, insular cortex, frontal cortex, and orbitofrontal cortex. The primary-process emotional networks of the subcortical midline structures/cortical midline structures continuum form the neural substrate of the core-SELF. They are ancient, located in the ancestral medial regions of the brain, especially rich in visceral body representations, valuate the states of the body and world, and they become aroused during primary-process affective states. Functional MRI studies have shown that this system is more active when people are doing nothing (typically lying quietly with eyes closed or fixating on a cross), self-reflecting and/or ruminating; and becomes deactivated during goal-directed cognition (Raichle et al., 2001). These regions are called default mode network, and they include the medial prefrontal cortex, the posterior cingulate cortex, the inferior parietal lobule, the lateral and inferior temporal cortex, and the medial temporal lobes (Buckner, Andrews–Hanna, and Schacter, 2008; Fransson and Marrelec, 2008). As can be seen, the structures involved in neural substrates of the core-SELF and default mode network are similar, which means that the midline system of the brain mediates self-related processes, and subcortical/cortical midline structures become active only by internally generated materials. The inability of the neocortex to inhibit this network causes affect disregulation seen in severe personality disorders (Schore, 1994).

Development and functioning of consciousness is highly related to the reciprocal relationships between default mode network and the so-called task positive networks (since they tend to activate during cognitively demanding tasks and deactivate at rest), namely the salience network and central executive network (Allen and Williams, 2011). The central executive network refers to the top–down dorsal attention network associated with the online control of behavior, and includes dorsolateral prefrontal cortex, frontal eye fields, dorsomedial prefrontal cortex, infraparietal sulcus, and superior parietal lobule. The salience network refers to a more ventral network of regions involved in the automatic detection of error, somatosensory awareness, and the detection of salient nontarget stimulus and includes dorsal anterior cingulated cortex, frontoinsular cortices, amygdala, and ventral midbrain. This provides us neuroscientific evidence that areas related to core-SELF that seek libidinal gratification are epigenetically earlier-developed and exist in many mammalian species, and are inhibited by later-developed brain areas, which have higher-order cognitive functions and are more related to the idiographic SELF which seeks more object relational gratification.

Damasio's concept of self and the related neuroscientific base are similar to Panksepp's theory. According to Damasio (2010), self is built in stages. The simplest stage is called the protoself which consists of a neural description of relatively stable aspects of the organism and produces the spontaneous feelings of the living body (primordial feelings). This is closely related to the part of self which seeks libidinal gratification. The second stage of self is called the core self, which results from establishing a relationship between the protoself and an object. The images of objects are formed and modified in the brain and these images and the organism are linked in a coherent pattern. In our terms, the core self seeks object relational gratification. Damasio calls the third stage of self as autobiographical self, which allows multiple objects, previously recorded as lived experience or as anticipated future, to interact with the protoself and generate pulses of the core self. According to Damasio, the main neural components of the protoself include the brain areas responsible for interoceptive integration (such as nucleus tractus solitaries, peri-aquaductal gray, parabrachial nucleus, area postrema, and hypothalamus at brain stem level and insular cortex and anterior cingulated cortex at cerebral cortex level) and external sensory portals (frontal eye fields and somatosensory cortices). These brain stem nuclei are called homeostatic nuclei and they generate the feelings of the knowing component of the core self. They project to other brain stem nuclei (nuclei of reticular formation, the monoaminergic nuclei, and the cholinergic nuclei), and these projections generate the object saliency of the core self. In addition to these areas, the autobiographical self includes brain areas related to coordination of information (such as memory), and which Damasio calls convergence–divergence regions. These are the polar and medial temporal cortices, the medial prefrontal cortices, the temporoparietal junctions, and the posteromedial cortices. Most of these areas, especially the posteromedial cortices, are a part of default mode network.

Thus both Panksepp's core self and Damasio's autobiographic self are highly related to the so-called default mode network of the brain. When a person is not performing any kind of motor or cognitive task, he is engaged with self-reflective thoughts. These thoughts include placing oneself in past, present, and future as a physical, emotional, cognitive, and mental being. This may be the reason for activation of brain areas which are related to self.

Transference as a Need for Gratification

If we speak in terms of neuroscience, according to Hebbian theory, "any two cells or systems of cells that are repeatedly active at the same time will tend to become associated, so that activity in one facilitates activity in the other" (Hebb, 1949, p. 50). Thus, if libidinal gratification is sought very frequently, the synaptic connections representing this pattern will also be strengthened. To express this more simply, we can call the neural networks representing libidinal gratification *A*, and the strength of synaptic connections *cA*. As a newborn baby begins to grow, it forms new object relations and different object relational gratifications may also form. We will call the neural networks representing these object relational gratifications *B, C, D* . . . . . *N*, and the strength of these connections *cB, cC, cD . . . . . cN*. Using this notation, the amount of *cB, cC, cD . . . . . cN* can be expected to increase in an individual who forms healthy and mature object relations.

There will come a time when one, more than one, or all the connections *cB, cC, cD . . . . . cN* will be stronger than cA. Then, we can say that this individual prefers object relational gratification over libidinal gratification. Let us assume that for person Y, the amount of each of three connections (*cB, cC, cD*) equals more than *cA*, while for person *X*, only the amount *cB* is greater than *cA*. According to our formula, it can be expected that person *X* will seek more libidinal gratification and less object relational gratification, and thus will have a more neurotic personality than person *Y* throughout his life.

For every person, it is possible to calculate the mean strength of synaptic connections representing object relations:

$$c(\text{Mean}) = \frac{cB + cC + cD + \ldots\ldots cN}{N}$$

In this case, c(Mean) is a direct way of showing the amount of object relational gratification (objects other than mother or primary care giver, who can be a source of libidinal gratification), and an indirect way of indicating how much libidinal gratification has been given up. When for person *X*, c(Mean) – *cA* is low, the person is more prone to libidinal gratification, while for person Y, because c(Mean) – *cA* is high, he will tend toward more object relational gratification.

Let us assume that persons *X* and Y present for psychoanalysis one day. Person *X* will show a more intense and immature transference reaction because of low c(Mean) – *cA*, parallel to his need for libidinal gratification, while person *Y* will show a less intense and more mature transference reaction. We can say that where the c(Mean) is lower than *cA*, we can expect to find libidinal transference with strong pre-genital properties.

A Neurobiological Interpretation of the Relationship between Libidinal Gratification and Transference

If we try to locate the *A* network, symbolizing the synapses related to libidinal gratification, the best candidate would be the neural circuits between brain stem nuclei, limbic-paralimbic structures, thalamus, and hypothalamus (see Figure 1). We have some reasons to say this. First, as discussed above, those structures are involved in the human social brain, especially important for formation of attachment schemas and emotional memory (Cozolino, 2010). Second, when we look at the evolutionary development of the triune brain, these structures, being the parts of reptilian and paleomammalian brains, are the first ones to develop and already exist at birth (Baars and Gage, 2010). Besides, they contain nonverbal, instinctual memories, primitive impulses, and they control reflexes and inner bodily functions. Those mental events are closely related to libidinal gratification. Third, these neural circuits are part of the network responsible for rapid survival response (LeDoux, 1994). In this rapid survival response, the amygdala receives input directly from the thalamus (without reaching cortex), and sends outputs to the hypothalamus, limbic-motor circuits, and brainstem nuclei, in order to give a rapid response during survival decisions based on minimum information. Libidinal gratification is closely linked to survival: the mother's breast is the first object of libidinal gratification, and if the baby is not fed, it would die. Fourth, since we are talking about libidinal gratification, it is reasonable to think that the reward system of the brain is also involved. This system has its roots in the ventral tegmental area, which is also a part of the reticular activating system and rich with dopaminergic neurons. This system involves the synaptic connections with limbic structures, mainly with the nucleus accumbens. The reward system of

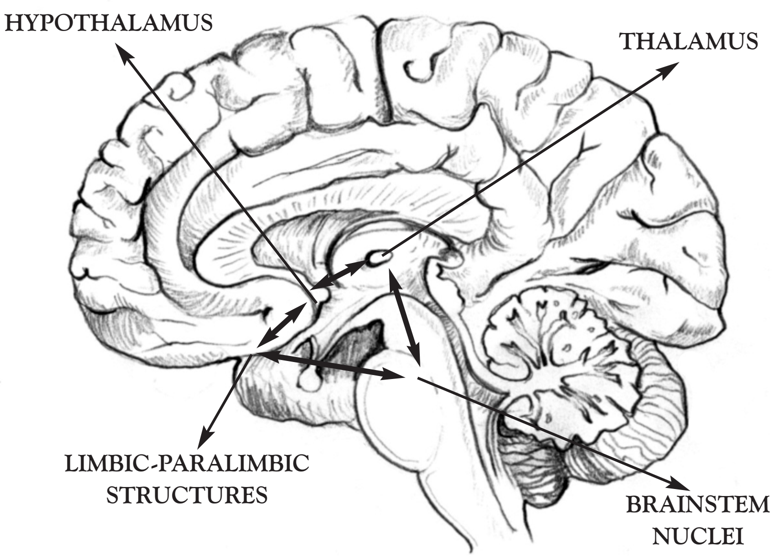

Figure 1: A schematic representation of A network, symbolizing the synapses related to libidinal gratification. A more "immature" transference occurs by pattern completion of attachment schemas coded in this network.[1]

[1]We thank Dicle Kaya for both figures.

the brain acts according to the pleasure principle, as in libidinal gratification, and seeks pleasure or removal of distress, without regard for any possible negative consequences (as we can see in individuals with substance abuse and dependence).

Our theory is in concordance with two theories which have tried to find neuroanatomical and neurobiological correlates of Freudian concepts. The first is Kaplan–Solms and Solms's (2002) theory about neuroanatomy of the Freudian mental apparatus. According to Kaplan–Solms and Solms, the ascending activating system, together with its limbic connections, are the anatomical and physiological correlates of the mental agency that in psychoanalysis is described as the id. Kaplan–Solms and Solms view the cortical arousal processes, which have their basis in the ascending activating system, as the physiological correlates of those mental processes that are conceptualized in psychoanalysis as psychical energy. Therefore, the ascending activating system can be seen as the great reservoir of libido. This psychic energy is the single driving force of the mental apparatus. The connections between these deep brain systems and the cortex provide the anatomical and physiological basis for primary process psychic functioning. The second is Carhart–Harris and Friston's (2010) theory about neuroanatomy of primary- and secondary-process thinking. According to these authors, primary-process thinking is governed by limbic and paralimbic structures, mainly by medial temporal lobes, as well as the hippocampus, amygdala, parahipocampal gyrus, and entorhinal cortex. They argue that Freud's description of the primary process is consistent with the phenomenology and neurophysiology of rapid eye movement sleep, the early and acute psychotic state, the aura of temporal lobe epilepsy, and hallucinogenic drug states.

So, we believe that these connections, summarized in Figure 1, represent the most likely equivalents for our neural network *A*, which is responsible for the libidinal gratification of person *X*. Recall that we hypothesized that person *X* would seek libidinal gratification using mechanisms such as the repetition compulsion all his life. By using pattern completion, person *X* might complete the part-objects of perceived others to a whole object which is suitable for libidinal gratification. In the transference relationship with an analyst, person *X* perceives the object (the analyst) as a source of libidinal gratification, and forms an infantile transference reaction. We hypothesize that pattern completion, in this case, would occur in the circuits between the amygdala, thalamus, hypothalamus, other limbic areas and brainstem nuclei.

A Neurobiological Interpretation of the Relationship between Object Relational Gratification and Transference

If we try to locate *B, C, D . . . . . N* networks, representing the synapses related to object relational gratification, the best candidate would be the projections from the areas related to libidinal gratification to hippocampus and cortex (mainly prefrontal cortex, cingulate cortex, somatosensory cortex, and insula), as shown in Figure 2. This hypothesis is based on four reasons. First, the hippocampus and cortex are parts of neomammalian brain, which is the last developed part of the brain in terms of evolution (Baars and Gage, 2010). They are not fully developed at birth, and their maturational delay is responsible for the lack of explicit memory (childhood amnesia) during the first years of life (Jacobs, van Praag and Gage, 2000; McCarthy, 1995). In parallel to this neurodevelopment, libidinal gratification is present at birth but object relational gratification develops later, as the infant learns to differentiate between self and objects. Second, the discussed networks are parts of our social brain, responsible for shaping our attachment schemas with the help of learning and memory (Nelson and Panksepp, 1998). Libidinal gratification is not learned; it is primitive and reflexive. Object relational gratification is shaped by learning through the interaction with the environment (or the objects). Third, these cortical structures (mainly the prefrontal cortex) and hippocampus have an inhibitory effect over amygdala outputs (LeDoux, 1994). These circuits add cortical processing to sensory input, thus helping us to behave and to think more logically,

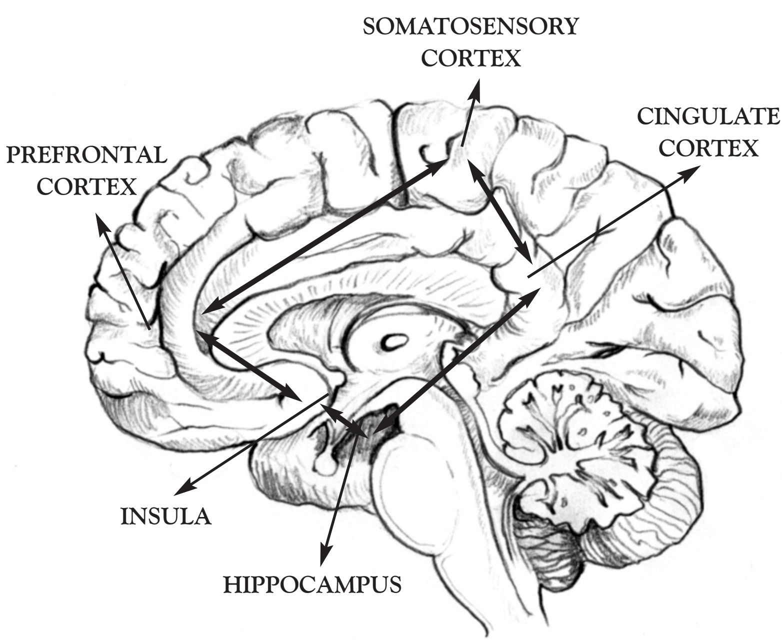

Figure 2: A schematic representation of *B, C, D . . . . . N* networks, symbolizing the synapses related to object relational gratification. A more "mature" transference occurs by pattern completion of attachment schemas coded in these networks.

rather than instinctively. A transference reaction based on object relational gratification is more mature (thus, reasonable) than a transference reaction based on libidinal gratification, which is rather immature (thus, instinctive). Fourth, as previously discussed as externalization, orienting toward objects while seeking satisfaction and pleasure is, of course, a task for affect, but decision making determines which objects will be the basis for externalization (Ceylan, 2010). The life-long process of externalization is based upon orienting to objects through affect, and then making selections of objects through decision making. It is well-known that the prefrontal cortex is involved in both affect regulation and decision making.

Kaplan–Solms and Solms (2002) have proposed that the frontal cortex, especially its prefrontal region responsible for the executive and inhibitory functions of the brain, is closely related to the ego of the Freudian mental apparatus. And we already know that one of the main functions of ego is object relations. Carhart–Harris and Friston (2010) have proposed that Freud's description of the ego is consistent with the functions of the default mode network and its reciprocal exchanges with the subordinate brain systems. Regions specifically implicated in the default mode network include the medial prefrontal cortex, the posterior cingulate cortex, the inferior parietal lobule, the lateral and inferior temporal cortex, and the medial temporal lobes (Buckner, Andrews–Hanna and Schacter, 2008; Fransson and Marrelec, 2008). Neural circuits in these areas are responsible for secondary process thinking, which is a function of ego. Besides, the default mode network, especially the medial prefrontal cortex, is responsible for suppression of activity in limbic–paralimbic areas, which are thought to be involved in primary process thinking (Carhart–Harris and Friston, 2010).

Based upon all of this, we hypothize that these neuroanatomical regions closely related to the concept of ego should play a role in object relational gratification. The synaptic connections representing object relational gratification (*B, C, D . . . . . N*) are probably located in the projections from the previously discussed areas to prefrontal cortex, hippocampus, somatosensory cortex, cingulated cortex, and insula (Figure 2), and pattern completion in transference relationships occurs in these circuits. If the mean strength of synaptic connections in these networks (*cB, cC, cD . . . . . cN*) is greater than *cA* in the mesolimbic region, object relational gratification will be preferred over libidinal gratification. Therefore, person *Y* will prefer a pattern of object relational gratification rather than libidinal gratification throughout his life. Pattern completion in the *B, C, D . . . . . N* neural networks will cause person *Y* to perceive part-objects as whole objects suitable for object relational gratification. In his transference relationship with his analyst, the object (analyst) will be perceived as an object for object relational gratification, so that person will develop a more mature/healthy transference relationship with his therapist than person *X* will.

Conclusion

In this review, we have summarized previously proposed neurobiological mechanisms for transference and connected some of these views with our own interpretation of the neurobiology of transference. While doing this, we reviewed parts of many theories, such as cognitive neuroscience, attachment theory, drive theory, neurobiology of psychotherapy, neurobiology of self, philosophy of mind etc. This multidisciplinary approach was needed, since we were trying to build a bridge between two remote disciplines, namely psychoanalysis and neuroscience.

When explaining the fundamentals of psychoanalytic theory with the findings of neuroscience, there is always a risk of over-simplification, over-generalization, and eliminative reductionism. Yet we took this risk, since we think that both psychoanalytic theory and neuroscientific view have things to learn from each other. The dialogue between psychoanalysis and neuroscience can be fascinating, innovative, fruitful, and interesting, but also challenging and complicated for both sides. These two fields often do not speak the same language, and apply different concepts even when they are using analogous terms. Thanks to an increasing number of fascinating empirical and experimental studies in the areas of psychotherapy research, developmental psychology, dream research, cognitive and affective neuroscience, there is an undeniable amount of neuroscientific evidence to support the basic psychoanalytic theory.

Freud lived in a time when existing technology could not explain the biological correlates of the mental processes he described in psychoanalytic theory. Advances in neuroscience made during the last decade help us to build a bridge between the mind and the brain. We believe that theoretical explanations in this area will encourage new neuroscience studies, which will provide a scientific proof for psychoanalytical concepts such as transference.

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