Special Report

Transprocessing: Neurobiologic Mechanisms of Change during Psychotherapy—A Proposal Based on a Case Report

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Abstract

This article proposes transprocessing (as in "transduction" and "processing") as a term to denote mechanisms by which the brain processes information in psychotherapy and develops solutions that have a lasting, curative effect. The case of a woman with a history of posttraumatic conversions, who recovered after long-term psychotherapy, is presented as the basis for a discussion on psychotherapeutic changes of the brain. Psychological healing and change, in general, is seen here as a result of a large variety of neurobiologic processes that reframe complex or multimodal memories. Through transprocessing, multimodal memories are deconstructed along the different axes of the brain tissue and restored through memory mechanisms at the synaptic, cellular level. Transprocessing requires a sustained interplay between the extended projections of the "language brain" and the repeated, alternating activation and deactivation of the midline structures associated with the self, to form pathways through long-term therapeutic experiences. We propose three separate stages of transprocessing by which new implicit and explicit memories of the therapeutic narrative are internalized into a first-person experience. Those stages are 1) evaluation, 2) acquisition, and 3) contextualization.

Introduction

Despite rapid advances in neurosciences, the neurologic basis for changes facilitated by psychotherapy remains unclear. The following case report introduces a discussion of newer findings regarding information processing and learning during psychotherapy.

Proposal

This article proposes transprocessing (as in transduction and processing) as a term to denote mechanisms by which the brain processes information in psychotherapy and the patient develops solutions that have a lasting, curative effect. Psychological healing and change, in general, are seen here as a result of a large variety of neurobiologic processes that reframe complex or multimodal memories. Through transprocessing, multimodal memories are deconstructed along the different axes of the brain tissue and restored through memory mechanisms at the synaptic, cellular level. Transprocessing requires a sustained interplay between the extended projections of the "language brain" and the repeated activation and deactivation of the midline structures associated with the self, to form pathways through long-term therapeutic experiences. We propose three separate stages of transprocessing by which new implicit and explicit memories of the therapeutic narrative are internalized as first-person experiences.

Case Report

A woman, age 44 years, was referred by a local internist after progressive speech problems and labile affect developed. Findings of the initial examination revealed a history of postpartum depression at age 34 years. At that time, with medication treatment and a 2-year course of psychoanalytic psychotherapy, the patient showed a full recovery.

On examination, the most striking finding was labile affect in the form of brief attacks of dysphoria, which were immediately relieved after changing the subject of conversation.

The patient's speech pattern was that of dysfluent aphasia. She was able to name objects and say nouns correctly. She was also alert and showed good nonverbal communication. Yet, she was unable to speak in full sentences. She was also speaking in a hoarse voice, which according to her husband, she had never before presented. At home she was irritable and would burst into brief crying spells. She had a recurrence of old nightmares, which we later learned were related to trauma. The rest of the neurologic findings and the results of the magnetic resonance image were normal. Further history revealed that she had been a flight attendant and had been assaulted and raped while walking to her hotel during a layover abroad 15 years previously. She had never received any treatment related to the rape.

She did well until she gave birth to her first daughter ten years before her referral to us, when she developed postpartum depression. During this episode she did not tolerate medications. Working diagnoses of conversion disorder and major depression with a history of posttraumatic stress disorder (PTSD) was made.

The patient was seen in dynamic psychotherapy 3 times per week. During interpretations that were rated as essential to autobiography, labile affect worsened temporarily by triggering a catastrophic reaction: a sudden attack of crying, lasting between 20 seconds and 1 minute. This was followed by a smile. The succession between states was dramatic. After about 12 weeks of treatment consisting of 36 sessions, the affect became more stable. She was able to focus on her emotional state, elaborating on it as her facial expressions became more congruent with her internal state. On numerous occasions, when the orbicularis oris

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muscles contracted and pulled her mouth downward into a sad expression, she would be able to connect to emotions of sadness.

During the following 50 sessions (approximately 3 months), the patient spent most of the time during her sessions talking at length about her deep feelings of loss and her belief that she had suffered a stroke. She was experiencing a sense of lack of control over the future. During the same time, she experienced nightmares and severe nocturnal anxiety. She reported nightmares 2 to 3 times per week and exhibited symptoms of PTSD. She had hyperarousal in the form of attacks of anxiety with palpitations and headaches, which were diagnosed as tension headaches. The nightmares were eventually interpreted by her and by her therapist as expressions of fear of failure in life, which was tied to the emphasis her immigrant parents placed on academic performance. "It is easy to fail in America," her mother used to say. "What if I fail?" had been part of her self-talk since adolescence. During psychotherapy new narratives of self-confidence developed, such as "I was actually privileged … ." It was later that she tied her sense of loss (eg, symptoms of stroke) to a perceived failure to foresee and prevent the rape. She saw herself as paralyzed in front of evil.

During the next six months, the nightmares gradually subsided. What was particular to this patient was a gradual improvement in her speech in parallel with the disappearance of nightmares. She returned to work full time after a year on sick leave.

Her depression lifted gradually, and she returned to old hobbies and interests. She became more involved with her two children and later decided to work half time so as to spend more time with her family. To date, four years since the episode, she has not shown any relapse of symptoms.

Discussion

On the basis of this case and the existing vast literature on psychological processing, we propose two areas for future exploration pertinent to the healing mechanisms in psychoanalytical psychotherapy: the neuroanatomical basis of processing and transprocessing and the uploading of implicit healing narratives.

Neuroanatomical Basis of Processing

The large amount of literature on the neuroanatomical basis of processing mechanisms (Figure 1) divides it into vertical processing systems, horizontal processing systems, and neuroplasticity and processing.

Vertical processing systems: The vertical processing systems include:

1. self-related processing and the subcortical-cortical midline system
2. reentry circuits
3. prefrontal-subcortical circuitry.

Panksepp and Northoff[1] have referred to self-related processing attributed to a set of midline structures that start in the brain stem, in the reticular activating system, and are interconnected with higher brain structures in the subcortical and cortical areas, referred to as the subcortical-cortical midline system. These structures accomplish the integrative bodily functions and the convergence of basic emotional systems to form the proposed "bodily self or proto-self"[2-10] (see Sidebar Self-Related Processing and Subcortical-Cortical Midline System, item 1).

Reentry, or the cortical-subcortical parallel reentrant circuits[11-13] provide the structural basis for an interactive system, between the cortex and the subcortical areas of the basal ganglia and striatum, substantia innominata, and the extended amygdala. This network allows for a bidirectional mirroring between subcortical implicit networks and cortical neural activity.

The prefrontal cortex includes the orbital medial prefrontal cortex and the lateral prefrontal cortex and their connections

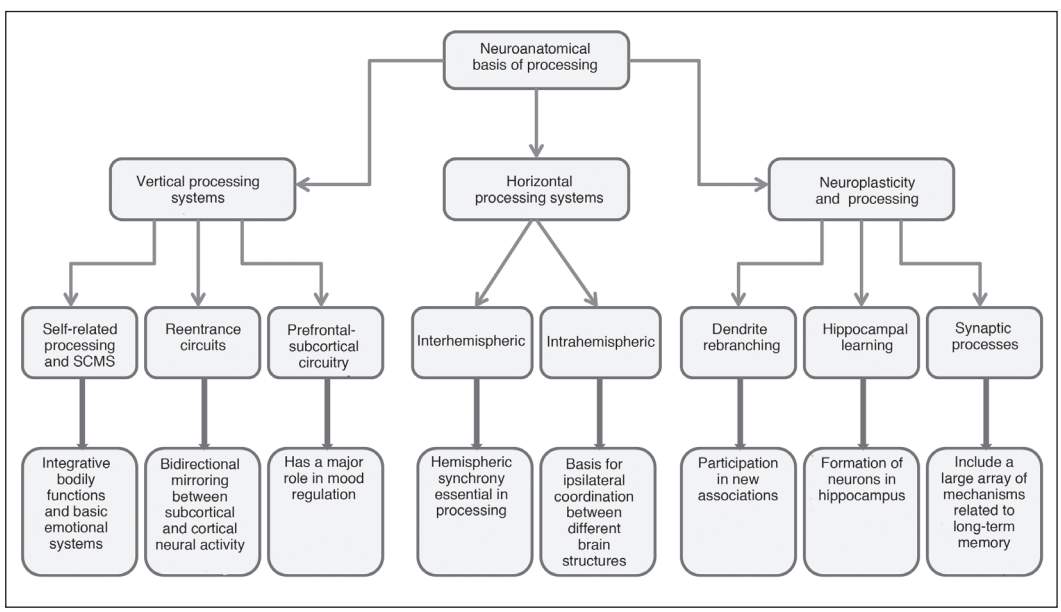

Figure 1. Neuroanatomical basis of processing.

SCMS = subcortical-cortical midline system.

to the striatum and to the thalamic nuclei. These very dense networks provide a major role in mood regulation (see Sidebar Self-Related Processing and Subcortical-Cortical Midline System, item 2).

Horizontal processing systems: These systems can be subclassified into the interhemispheric and intrahemispheric systems. The interhemispheric components include the corpus callosum and the anterior commissures. Routine conscious speech-driven activity maintains left-brain dominance. For psychotherapy and personal development, developing meaningful narratives about adverse life events have a healing quality.[14] A large body of literature has further demonstrated that speech, in an interactional context, involves extended bilateral areas,[15-26] which creates a "beltway of communication and awareness" around the entire brain (see Sidebar Self-Related Processing and Subcortical-Cortical Midline System, item 3).

Intrahemispheric processing occurs by means of the white matter tracts that are the structural basis for ipsilateral coordination between different brain structures. Such white matter structures are the inferior occipitofrontal fasciculus and the inferior longitudinal fasciculus.[27] The role of these structures has been grossly overlooked in the past.

Neuroplasticity systems: This is a very extensive subject that involves learning processes and human change. Experiential relearning after brain damage has been shown to result in remapping of brain projections.[28] Three major areas are of particular interest.

1. Dendrite rebranching, which includes the formation of new

Self-Related Processing and Subcortical-Cortical Midline System

1. *Self-Related Processing and Subcortical-Cortical Midline System*: The subcortical-cortical midline system includes the periaqueductal gray, an extremely rich connected brain structure,[1] and the superior colliculi, bed nucleus of the stria terminalis, ventral tegmental area, mesencephalic locomotor regions, preoptic areas, hypothalamus, and dorsomedial thalamus.[2-4] Vertical processing also creates an access pathway between cortex, the prefrontal cortex, and brain-stem areas that are believed to generate the basic affective states (Seeking, Fear, Rage, Panic, Nurture, Lust, and Play) that are necessary for survival.[2,5]
2. *Prefrontal Cortex:* A detailed review of these networks is beyond this presentation but can be found in Price and Drevets.[6] The subdivisions of the lateral and orbital medial prefrontal cortex (dorsal prefrontal, ventral prefrontal, caudal prefrontal, orbital and medial networks) cover, to different degrees, most aspects of human mental activity.
3. *Interhemispheric Components:* Clinical experience suggests it is the hemispheric synchrony that is created through the massive white-matter network essential in processing. A developmental right to left shift in hemispheric control and dominance in learning has been recognized.[7] In the learning process, a dynamic shift in time occurs from task-naive to task-experienced recognition.[8,9] Individuals with posttraumatic stress disorder activate predominantly the right hemisphere during remembering and reexperiencing of trauma. This is unlike people who do not have posttraumatic stress disorder, who have left-brain dominance on brain imaging and evoked potentials. The experience of eye movement desensitization and reprocessing has further suggested a particular healing quality of processing that involves bilateral but alternative speech and brain stimulation. Furthermore, patients with a history of chronic trauma and alexithymia are known to have limited awareness of and/or access to their emotional experiences, with a high prevalence of somatization. Alexithymia and a history of early trauma have been associated with functional and anatomical deficits of the interhemispheric white matter.[10-12] Traumatic memories and posttraumatic stress reconfigure a right-brain dominance due to catecholamine overconsolidation[13] of memories in right hemispheric tracts early,[14,15] before reaching the perceptive speech brain. Language is described as providing our subjective perception of being able to think.[16] By means of the interhemispherical (transcallosal) transfer, information reaches the speech center, which exerts its role in awareness formation. Speech, through words, designs meaning to objects. It decreases emotional charge by diminishing the "incomprehensible" and unpredictable aspects of the environment. Unlike the earlier understanding of speech assigned to left speech centers only, the large, bilaterally extended notion of the "speech brain"[17,18] refers to more global (evolutionary) networks of awareness and communication combined. ❖

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dendritic spines and their participation in new associations
2. Hippocampal learning and neurogenesis, referring to the formation of neurons in the hippocampus
3. Synaptic processes, which include a large array of long-term memory-related mechanisms, including protein synthesis, cytoskeletal reorganization, activation of brain-derived neurotrophic factor,[29-31] and possible epigenetic mechanisms. New multimodal memories are formed both by "new memory acquisition"[32] and by a reworking of old memories at the time of "remembering," a process referred to as "reconsolidation."[33]

Transprocessing and Uploading of Implicit Healing Contents

In the case presented herein, activation of language, in time, led to an end of her speech abnormalities. Although the speech abnormality was highly suggestive of a neurovascular abnormality, the possibility of a minor cardiovascular anomaly, the lack of any abnormal findings on imaging, the lack of previous cardiovascular risk factors and relevant family history, and the positive history of psychological trauma strongly suggest conversion.

Because of a lack of clear neurologic pathology, conversion disorder was presumed to be the result of an underlying psychological mechanism, with the Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition, Text Revision) classifying it as a somatoform disorder[34] and the International Classification of Diseases, Tenth Revision,[35] classifying it as a dissociative disorder. Psychiatric treatment[36] including psychotherapy[37,38] and pharmacotherapy,[39] hypnotherapy,[40] and transcranial magnetic stimulation[39] have all been proposed as methods of treatment for conversion disorder. Neuroanatomically, healing mechanisms involve complex changes in brain functioning. We propose the term transprocessing, a combination of two terms: transduction, meaning a reexpression and translation of a persistent functional brain activity into a new type of cellular activity (eg, transduction of stress in the function of the hypothalamopituitary axis), and processing, which is a function by which the brain makes sense of environmental inputs. The exact sequence of brain events in transprocessing during psychotherapy remains unclear at this time. However, several stages in the course of changes during long-term psychotherapy may take place: evaluation, acquisition, and contextualization.

In the acquisition stage … new views about oneself are being "uploaded" in the form of new narratives. … using the same mechanisms that are at play during rearing and early nurturing.

The first stage, evaluation for new information, occurs when a patient familiarizes him/herself with the therapeutic setting and the analyst. This requires numerous adjustments and an amount of adaptational stress with its catecholamine secretion and formation of new implicit memories. In this stage, new information, perceived through the five senses, is also confronted with the primary affective states (instincts), which originate in the brain stem—seeking, play, panic, grief, fear, lust, and so on[41]—and with elements of implicit and explicit autobiography.

In the acquisition stage or self-reference stage, new views about oneself are being "uploaded" in the form of new narratives.[1] Long-term memory and reconsolidation are necessary to be activated, as is the reference to one's older narratives. The alternation between reflection and verbal exchange during psychotherapy creates an alternation of activation of the language brain bilaterally, like a "beltway" of communication and awareness with the deactivation of the default mode of midline structures. Through repetition and alternation of activation of these, major regions (midline vs external frontal temporal occipital brain surface) may connect by new links. Repeated and alternative stimulations create new links through synaptic protein syntheses and long-term potentiation associated with learning. Some of the newly acquired information may become stored as implicit memories in a variety of subcortical areas, linked to the midline structures of the self. By doing so, an experience becomes a "first-person experience" of the self, hence self-reference processing. The uploading of a new narrative uses the same mechanisms that are at play during rearing and early nurturing. Caretakers do provide, through an interactive manner of uploading, an image of the world for the developing child.[42] During development such uploading is both verbal and nonverbal. In humans, speech itself has a privileged learning curve.[43] A large well of research data comes from attachment studies and rating of the coherence of a narrative. Coherent narratives in caretakers have been highly correlated with mature attachment in offspring.[44] By contrast, poorly coherent narratives, as rated on the Adult Attachment Interview, was highly correlated with immature type of attachment and personality pathology in offspring.[45] Hence, healing changes in psychotherapy use preformed long-practiced, developmental pathways, explaining their profound impact on personality.

A stage of contextualization and reconsolidation of one's autobiographic memory occurs through repetition and transference worked through in analysis. Reconsolidation as a memory mechanism has a particular role in reworking a person's identity. Long-term fundamental personality changes may involve epigenetics, but the relationship must be further demonstrated by future research.

Conclusions

Transprocessing is a proposed mechanism by which changes during psychotherapy are internalized and assimilated. The implications of such a multistage mechanism are consistent with long-term clinical experience:

1. All psychotherapies have a common denominator: the restructuring of memories of old dysfunctional patterns of response to the routine social environment.
2. To produce pervasive changes, psychotherapies must include repeated reexposure to newly formed multimodal memories, hence the need for long-term therapies.
3. The emergence of new research that validates a neural model of psychotherapy may also call for public provision to further the availability of psychotherapy as a large-scale preventive and curative intervention. This may lead to further humanization of mental health treatment and to a shift toward a more integrative treatment approach in psychiatry. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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