Academic/Research Article

An exploration of the role of neuroscience and neuroimaging in the psychodynamic approach

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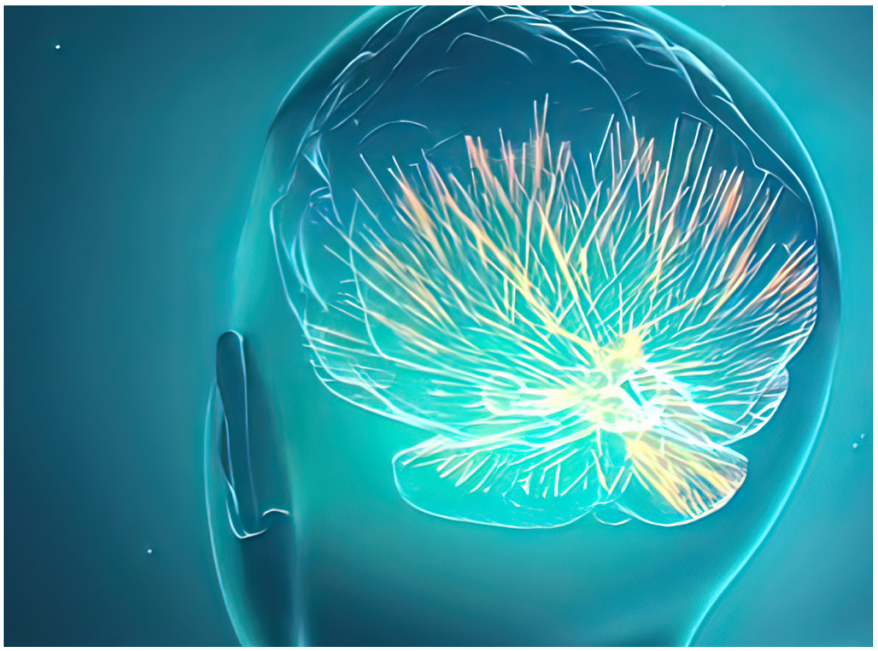

Psychodynamic psychotherapy assumes that much of human experience occurs unconsciously. Could memory reconsolidation provide a key to alleviate unconscious emotional learnings?

Introduction

The important neuroscientific discovery of brain plasticity – the ability of the brain to change with experience not only in childhood and adolescence but all through life – appears highly relevant to psychotherapeutic modelling and methods. Psychodynamic psychotherapy works under the assumptions that much of human experience happens in the unconscious mind and that childhood experiences have a strong impact on how the mind functions.

Therapeutic change focuses on engaging with unconscious processes and enabling the client to move towards change by becoming aware of them (Reeves, 2013). A number of questions present themselves: How can these assumptions be tested in an objective, scientific way?; how do unconscious emotional learnings from childhood experiences reflect in the memory system of the brain?; how does engaging with unconscious processes and helping the client to become aware of them move the client towards change?; what does the experience of a psychotherapeutic encounter involve in order to facilitate lasting change?; and can neuroscience validate any answers in an unbiased way?

This article explores if psychodynamic studies should consider the neuroscience of mind and the technology of neuroimaging and, hence, enrich psychodynamic theory and therapy with biological understanding. Neuroimaging studies may have the potential to become an unbiased and objective research tool for psychotherapeutic models of the mind. A stronger collaboration between neuroscience and psychodynamic psychotherapy could strengthen the relevance of psychodynamic models and methods in the clinical setting towards pharmacology and cognitive psychology. Secondly, underlying brain mechanisms of memory and fear will be examined and, finally, the exploration will concentrate on possible links between psychotherapeutic approaches and a certain suspected form of brain plasticity around memory, called memory reconsolidation.

Potential for joining forces

Pulver (2001) emphasised that neuroscience could not contribute anything to the "various ways in which the analyst attempts to optimise the atmosphere of the relationship to gain as much understanding as possible" (p. 7), but could be beneficial in choosing between competing psychodynamic theories by testing different hypotheses. This could have an impact on the development of psychodynamic theory in the future. Blass & Carmeli (2007) drew attention to a hidden conflict between the neurobiological science of mind and psychodynamic therapy in its essence, arising from the assumption that only biology was real; they feared psychodynamic therapy was about to lose the phenomenological view on subjective meanings. Conceding that mental phenomena had underlying mechanisms in biology, Blass & Carmeli (2007) questioned any benefit of understanding the associated biological processes for psychodynamic theory and practice.

On the contrary, Blass & Carmeli (2007) worried how neuroscientific findings could influence psychodynamic practice negatively – for example, if neuroscience was to find that conscious and unconscious memories were stored in different neural systems, and therefore concluded that unconscious traumatic memories could never become conscious – would psychodynamic therapists consequently give up on searching for traumatic memories?

Beutel & Huber (2008) explored the potential contributions of functional neuroimaging studies to a better understanding of what makes therapy effective. The task design in such neuroimaging studies is of particular importance, as those tasks need to arouse particular emotions or to allow for the examination of specific thought processes (Beutel & Huber, 2008). All of the published neuroimaging studies Beutel & Huber (2008) compiled in their review – except for one case study – had applied brief behavioural therapy and had focussed on a comparison with pharmacological treatment, showing that effective therapy also changed the functioning of the brain. Preliminary data from that one case study and a hitherto unpublished trial indicated tentatively that the same could be a valid assumption for psychodynamic therapy (Beutel & Huber, 2008).

Boeker et al. (2013) connected the individual meaning of a certain picture and the associated subjective affect with a corresponding brain state

However, Boeker & Richter (2008) expressed strong doubt that modelling neuroimaging studies in the same way as before – just by replacing brief behaviour therapy with psychodynamic psychotherapy – would bring any valuable insight for the development of the psychodynamic model. A mere comparison with the symptom reduction of pharmaceutics would not account for the fact that psychodynamic psychotherapy aimed for more than symptom reduction, namely for lasting therapeutic change of the deep underlying issues (Boeker & Richter, 2008).

Unbiased evaluation

Boeker et al. (2013) suggested a new way of modelling neuroimaging studies that would provide an unbiased evaluation of the psychodynamic encounter in its main characteristics, but would also account for the rich psychodynamic examination of subjective experience. According to Boeker et al. (2013), this would require two steps: 1) Systematic evaluation of a patient's subjective experience, leading to unbiased and quantified subjective data; and 2) Studying the neural mechanisms underlying those subjective data through neuroimaging.

To break the first ground, Boeker et al. (2013) developed a new model to examine a specific aspect in psychodynamic therapy for depression, that is, any shifts in the behaviour and feelings towards others. Boeker et al. (2013) transferred a validated self-evaluation questionnaire with 32 rating items around interpersonal behaviour patterns into validated pictures with abstract stick figures that symbolised certain behaviour patterns. During neuroimaging, test persons saw those pictures and had to evaluate on Likert scales how typical they found these illustrations with respect to their own behaviour, and also their level of emotional arousal while watching them (Boeker et al., 2013).

In this neuroimaging experiment, Boeker et al. (2013) connected the individual meaning of a certain picture and the associated subjective affect with a corresponding brain state. It was included in a one-year, large-scale study investigating the efficacy of psychodynamic psychotherapy for depressed patients. For Boeker et al. (2013), it was essential to acknowledge that psychodynamic psychotherapy deals with the person and not with the brain, and hence they warned against attempts "to map the psychodynamic concepts in a one-to-one way with neural activity in particular brain regions or networks and thus strive for what is described by the concept of 'neural correlates'" (p. 9).

Likewise, Beutel & Huber (2008) warned against the isolated use

of so-called brain correlates of mental disorders for diagnostic purposes because there was no evidence that certain brain states were the cause for certain mental phenomena. On the contrary, neuroimaging studies had already shown that voluntary changes of mental attitudes changed the functioning of the brain. "Patients do not seek treatment for changes in blood flow or brain metabolism, but for subjective difficulties, suffering and so forth" (Beutel & Huber, 2008, p. 13). Studies of learning gave some indication of psychotherapy even having the potential to change the structure of the brain (Beutel & Huber, 2008).

Mental training study

In this context, the study of Valk et al. (2017) is worth noting. Valk et al. (2017) conducted a neuroimaging study with 332 healthy adults between 20 and 55 years of age. The participants engaged in nine months' mental training with three different learning modules related to presence, affect and perspective and measured the change in thickness of the outer layer of the brain (cortex) in different areas after each of the three learning modules.

Presence training focussed on mindfulness-based attention towards inner and outer present experience; affect training focussed on compassion, handling of difficult emotions and positive social attitude; and perspective training focussed on meta-cognitive skills and the capacity to observe one's own mental states and the mental states of others, partly based on the psychotherapeutic model of internal family systems therapy (IFST) (Valk et al., 2017).

Three months' presence training resulted in an increased thickness of the most frontal part of the brain in the forehead (anterior prefrontal cortex), correlated with improvement in attention (Valk et al., 2017). Three months' affect training increased the structure in different regions related to regulation of emotion and empathy, correlated with an increase in compassion (Valk et al, 2017). And three months' perspective training increased thickness in lower frontal and in lateral regions, correlated with an enhanced ability to understand others (Valk et al., 2017). In sum, it appears that effective psychotherapy changes both brain functioning and brain structure.

Short-term memory required a change in the strength of the synapse – the communication between two neurons through their communication terminals

(Kandel, 2006)

Brain mechanisms underlying memory and fear

Kandel (2006) discovered the two learning processes of fear-reducing habituation and fear-increasing sensitisation as being fundamental – habituation weakened effective communication between neurons and sensitisation strengthened it. Genetics determined the possible connections between nerve cells, but experience determined the effectiveness of the communication between them (Kandel, 2006).

Kandel (2006) found that short-term memory required a change in the strength of the synapse – the communication between two neurons through their communication terminals. However, long-term memory required structural change, that is the growth of new communication terminals and new synapses and possibly deactivation of some existing terminals. Structural change in long-term memory depended on the production of a certain new protein in the cell – long-term learning through practice or through intensely emotional events 'switched on' certain genes in the cell nucleus that are responsible for the production of proteins that build new synapses (Kandel, 2006). "The fact that a gene must be switched on to form certain long-term memory shows clearly that genes are not simply determinants of behaviour but also responsive to environmental stimulation, such as learning" (Kandel, 2006, p. 276).

The hypothalamus regulates the autonomic nervous system – the automatic control system of vital body functions and their adaption to emotion (Kandel, 2006). The hypothalamus and the autonomic nervous system play a role in unconscious aspects of emotions. The cortex evaluates the conscious aspects and the amygdala has a crucial function in both conscious and unconscious parts of emotions, particularly in fear (Kandel, 2006). The amygdala can store an unconscious long-term memory of a single threat, whereas conscious memory requires the involvement of the hippocampus (Kandel, 2006).

In case of threat, the amygdala may use a slow neural pathway to the cortex for evaluation and modulation, but may also bypass the cortex and directly activate a fast pathway to the autonomic nervous system (Kandel, 2006). Kandel (2006) found a way to diagnose baseline anxiety through functional neuroimaging. After measuring the background anxiety of a group of volunteers through a questionnaire, Kandel (2006) showed them pictures with fearful faces while scanning their brains, so that in one case they could perceive the faces consciously and reflect on them, and in the other

case he presented the faces too rapidly for conscious perception but still as unconsciously perceivable. Kandel (2006) found that unconscious fear lit up a different area of the amygdala than conscious fear; unconscious fear activated the basolateral nucleus and conscious fear the dorsal region.

Another finding was that the lighting up of the basolateral nucleus was directly correlated to the background anxiety of the volunteers, hence, this test could serve as a diagnostic tool and as an outcome measure after therapy (Kandel, 2006).

The questions arise how therapeutic interventions can modify unhelpful and unconscious emotional learnings of the past, and if neuroscience can provide a better understanding of the associated mechanisms.

Processes of change

Ecker et al. (2012) claimed that core processes of change in psychotherapy can be linked to the neurobiological process of memory reconsolidation. The discovery of memory reconsolidation, a hitherto unacknowledged form of brain plasticity, has challenged the traditional view of a century that memories of past experiences always stay original and permanent (Alberini & LeDoux, 2013). However, according to various post-millennial research studies, memory storage is dynamic and established memories can be modified (Alberini & LeDoux, 2013). An animal study with rats showed that the retrieval of fear memories destabilised the memories, and a pharmacologically induced disruption of the subsequent re-stabilisation, called reconsolidation, suspended the learned fear response (Nader et al., 2000).

Schiller et al. (2010) provided evidence in a trial with humans that certain psychological interventions interfered with the reconsolidation of a retrieved fear memory and lastingly updated this memory with fear-eliminating information, if the interventions took place while the retrieved memory was unstable, that is, within the reconsolidation window of about six hours.

Gorman & Roose (2011) drew an analogy between the reconsolidation window and the claim in psychoanalysis that timing is important for effective interpretation

Högberg et al. (2011) suggested a new reconsolidation-informed protocol for trauma psychotherapy – evoking positive emotions first to ensure that the updated memory includes safety, then reactivating the traumatic memory as a sensorimotor experience, and finally imagining a positive modification of the memory. Further, Ecker et al. (2012) promoted imaginary work as effective because for neural networks engaged in emotions, imagined or physical experiences would be largely the same, referring to the observations of Kreiman et al. (2000). Kreiman et al. (2000) had found that 88 per cent of the neurons in the human brain that responded to both vision and imagination did not differentiate between vision and imagination in their responses.

Gorman & Roose (2011) came to the conclusion that contemporary animal studies and neuroimaging studies with humans reflected two core hypotheses of psychodynamic psychotherapy: "1) That early life experiences can have a profound and lifelong influence on human emotion and behaviour; and 2) That unconscious mental processes strongly impact conscious mental processes and awareness" (p. 1201-1202). Hence, Gorman & Roose (2011) found interest in exploring possible links between the neuroscientific discoveries about manipulating the reconsolidation of fear memories on the one hand and some core processes in psychoanalysis on the other hand.

According to Gorman & Roose (2011), psychodynamic psychotherapy was about recovering and rewriting a client's narrative by bringing unconscious self-deceptions into awareness. They suggested to regard this psychoanalytic process as the 'reconsolidation' of an updated narrative. Gorman & Roose (2011) hypothesised similarities: 1) Between the conversion of childhood trauma into unconscious mental processes, and fear-conditioning in a laboratory animal; 2) Between the impact of repressed traumatic memories on behaviour and emotions, and the 'freezing' response of the animal towards the fear stimulus; 3) Between the processes of recovering a client's narrative, and reactivating a fear memory; and 4) Between the process of rewriting a client's narrative, and the updating of former fear memories through memory reconsolidation.

Regarding the seemingly crucial timing requirement for the updating of fear memories, Gorman & Roose (2011) drew an analogy between the reconsolidation window and the claim in psychoanalysis that timing is important for effective interpretation.

A certain unpredictability

Sevenster et al. (2012) discovered that memory retrieval on its own was not sufficient to destabilise fear memory and consequently initiate the reconsolidation process in humans. In fact, it

was necessary for the retrieval situation in their trial to connect a certain unpredictability regarding the outcome with the stimulus of the fear memory, to create a real possibility of the unexpected to happen – a new learning opportunity. Another important finding was that fear-reducing manipulations during memory reconsolidation alleviated the unconscious, automatic fear response of the memory without affecting the conscious, cognitive content of the memory (Sevenster et al., 2012).

In a functional neuroimaging study, Agren et al. (2012) localised a fear memory trace in the basolateral nucleus of the human amygdala and showed that disrupting the reconsolidation of the retrieved fear memory by updating the memory with new unfearful information 10 minutes after memory reactivation completely eliminated the fear component of the memory in the amygdala. Björkstrand et al. (2015) followed up on this study and confirmed that the erasure was still valid after 18 months.

Supposedly based on the neurobiological memory reconsolidation process, Ecker et al. (2012) defined a four-step protocol to create lasting change in psychotherapy for a client's problematic emotional learnings: 1) Trigger the targeted learning; 2) Create an experience that significantly differs from the client's expectations from the learning; 3) Create a new learning within five hours from evoking the old learning that contradicts or modifies the old; and 4) Verify the erasure of the old emotional learning. According to Ecker et al. (2012), erasure entails that former triggers do not reactivate the specific emotional reaction and the connected symptoms have permanently disappeared without requiring any further measures.

However, the existing body of neuroscientific research has not provided undisputed evidence for the existence of the memory reconsolidation update mechanism in humans

Ecker et al. (2012) mentioned some psychotherapy modalities to be inherently coherent with the therapeutic reconsolidation process: accelerated experiential dynamic psychotherapy, coherence therapy, eye movement desensitisation and reprocessing (EMDR), emotion-focused therapy, focussing-oriented psychotherapy, Gestalt therapy, Hakomi therapy, IFST, interpersonal neurobiology, neuro-linguistic programming and traumatic incident reduction.

However, in a more recent study, Klucken et al. (2016) were not able to replicate the previous results of Schiller et al. (2010) and Agren et al. (2012), and found no evidence for fear erasure through updated memory reconsolidation. Elsey et al. (2018) compiled a wide meta-analysis of the existing research around the memory reconsolidation update mechanism. This multitude of studies showed consistent results with the reconsolidation model, but not all of them. The limitations of various studies, the lack of clear criteria and the inconsistent findings that could lead to different explanations prompted Elsey et al. (2018) to suggest clear conditions for all future research around memory reconsolidation, given the importance this research has also for therapeutic approaches.

According to Elsey et al. (2018), the existing body of research has not yet provided clear and consistent evidence for the hypothesised memory reconsolidation update mechanism in humans. However, they also emphasised that this would not deny the clinical usefulness of therapeutic approaches that are based on the hypothesised reconsolidation, because here the only question is if the approaches are effective for patients.

As with any promising new therapeutic intervention, ethical considerations should play a role from the beginning when entering experimental research or clinical practice – especially in connection with the use of pharmacological agents that interrupt memory reconsolidation – to avoid unintended or undesirable collateral changes and to prevent misuse and abuse of memory modifying techniques (Elsey & Kindt, 2016; Hui & Fisher, 2015). Furthermore, therapists that work with memories should be aware of the risks in possibly creating false memories through suggestions or imagination, as explored by Loftus (1997).

Conclusion

The dynamic development in the neuroscience of mind around memory and learning provoked a stronger involvement of psychotherapy in general, fuelled by the discovery that neural circuits can unlearn what they learned before. However, psychodynamic therapists have mixed feelings. Openness for studying the brain mechanisms underlying psychodynamic psychotherapy also faces fears – that neuroscience could restrict psychodynamic practice in its richness; subjective experience could lose its relevance; 'brain correlates' replace the view on the person; and the focus could move from deeper underlying issues to a mere symptom reduction. Neuroimaging studies have already provided evidence that effective

psychotherapy changes the functioning and the structure of the brain.

In general, genetics limit the possible connections between nerve cells, but experience determines the intensity of communication between them. New long-term memory brings along structural change – the growth of new communication terminals in the nerve cells linked to gene activation. The hippocampus is essential for long-term memory; whereas the amygdala stores unconscious memories, in particular those connected to fear. The amygdala can bypass the conscious thinking parts of the brain and communicate directly with the body in a case of threat.

The discovery of the molecular process of memory reconsolidation – although not unequivocally confirmed – was particularly exciting for psychotherapy and some theorists of therapy pushed ahead the implementation of congruent protocols into practice. The idea of having found an evidenced way for eliminating fear in unconscious trauma memories by updating them with non-fearful information a short while after reactivation is captivating.

However, the existing body of neuroscientific research has not provided undisputed evidence for the existence of the memory reconsolidation update mechanism in humans. Nevertheless, psychotherapy does not need to wait and can – with all due caution relating to ethics and risks – focus on clinical evidence for now.

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