Integration of clinical neuroscience into psychotherapy: A narrative review of neuroscience-informed psychotherapy models for the treatment of depression and anxiety disorders

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Return to Articles

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More than a century has passed since Sigmund Freud (1856–1939) proposed a need to investigate the neurological basis of psychotherapy and mental disorders. Investigation of the neurological basis of psychotherapy and mental disorders has accelerated over the last decades, especially with the advancement in neuroimaging technologies. To date, findings concerning clinical, cognitive, and behavioural neuroscience have already delivered a range of insights useful for improving the biopsychosocial understanding of humans and the practice of psychotherapy. Neuroscience has reinforced the understanding among psychotherapists that all mental processes—even the most elaborate psychological processes, such as perception, memory, mood, emotion, thoughts, and behaviour—derive from operations of the brain, and that the brain plays a key role in mediating between body and mind (Goss & Parnell, 2017; Raichlen & Alexander, 2017). Research studies have also identified that the operations of the brain are determined by neural networks that are plastic. Through the phenomenon known as neural plasticity, these networks responsively adapt to the environment by changing the strength and forms of connectivity through experiences. Therefore, plasticity is considered a key underlying mechanism of learning and memory (Butler et al., 2018).

Contributions of Cognitive and Behavioural Neuroscience for Psychotherapists

The advancement in cognitive and behavioural neuroscience has helped psychotherapists to develop an understanding of the relationship between brain, body, and mind. Mind is a faculty that manifests in psychological processes, such as sensation, perception, thinking, reasoning, memory, belief, desire, emotion, and motivation (Berrios, 2018). The psychological processes of the mind do not operate independently but are synchronised and interrelated with each other and with the complex interactions of the endocrine system, nervous system, and immune system in the brain and body. The disruption of homeostasis in the nervous, endocrine, and immune systems contributes to the development of psychological disorders such as depression (Singh & Gotlib, 2014), anxiety disorders (Slavich & Irwin, 2014), schizophrenia (Frangou, 2014), autism spectrum disorders (Fatemi, 2015), and Alzheimer's disease (Lennart, 2009). A neurological mechanism that underlies many psychological disorders is disruption in the homeostasis of the autonomic nervous system triggered by excessive activation of the sympathetic nervous system resulting from psychological and physical stress. Such disruption

leads to abnormal activation of the immune system and inflammation reactions in the brain and body, dysregulation of the endocrine system, and cell degeneration, which in turn lead to the development of dysfunctional patterns of cognition, emotion, and behaviour (Singh & Gotlib, 2014). Hence, psychotherapists cannot ignore the neuroscientific process in the brain and body when providing psychological interventions and should aim to restore homeostasis of clients' nervous, endocrine, and immune systems to promote psychological wellbeing.

Neuroscientific Understanding of Psychotherapy

It is widely recognised that psychotherapy can produce neurobiological changes and promote homeostatic function of the nervous, endocrine, and immune systems, which lead to positive changes in cognition, emotion, and behaviour patterns (Grawe, 2007). Neuroscientifically, psychotherapy can be conceptualised as a professional activity that provides opportunities for unique learning experiences within a controlled environment aimed at producing lasting changes in gene expression (the process by which information from a gene affects human characteristics) and changing neural networks and their functioning in the brain to support clients to adapt better to their environment (Gonçalves & Perrone-McGovern, 2014).

The bottom-up and top-down regulations of the brain facilitated in the process of psychotherapy play an integral role in promoting the homeostatic function of the nervous, endocrine, and immune systems. Bottom-up regulation involves regulation of the lower part of the brain, particularly the amygdala, which regulates the autonomic nervous system and emotional and physiological arousal (McRae et al., 2012). Regulation of emotional and physiological arousal can lead to greater regulation of higher parts of the brain (bottom-up regulation), especially within the prefrontal cortex, which can lead to recovery of cognitive abilities, such as rational thinking, careful judgement making, learning, and memory. Conversely, top-down regulation involves regulation of the higher parts of the brain, such as the prefrontal cortex, that manage cognitive abilities for down-regulating the lower parts of the brain (Dahlitz, 2015). Top-down approaches thereby reduce activation of the sympathetic nervous system and control emotional and physiological reactions.

Conventional psychotherapy models, such as top-down-focused cognitive behavioural therapy (CBT), narrative therapy, and psychoanalytic therapy, primarily focus on top-down regulation of the brain through techniques such as cognitive restructuring, construction of narratives, and development of a new understanding of experience, respectively (Grawe, 2007). In contrast, bottom-up regulation is facilitated by therapeutic elements and techniques such as positive interpersonal interactions within a therapeutic relationship (Schore, 2007), meditation and mindfulness (Taren et al., 2015), exposure (McNally, 2007), and art therapy (King et al., 2019).

Besides psychotherapy, bottom-up regulation of the brain is influenced by lifestyle activities, such as sleep, exercise, diet, muscle relaxation, breathing, laughter, and touch (Lopresti et al., 2013), and environmental factors, such as level of air pollution, temperature, humidity, brightness, and noise (Fonken et al., 2011). These findings suggest that lifestyle activities and environmental factors also play a vital role in the maintenance of healthy psychological and physical wellbeing and that they can become active contributors or protectors in the onset and maintenance of psychological disorders.

Developing neuroscience-informed psychotherapy models that attempt, by means of integrating this new knowledge from clinical neuroscience, to refine existing practices in psychotherapy is a current focus of psychotherapy research. Over the last decade, a variety of neuroscience-informed psychotherapy models have been proposed by researchers, particularly for the treatment of depression and anxiety disorders, which are the most prevalent mental disorders in the world (Santomauro et al., 2021). These models are commonly referred to as brain-based therapy, neuroscience-informed/based therapy, or neuropsychotherapy. It is expected that cross-analysis of such models will be useful for understanding the extent to which integration of the latest neuroscientific knowledge can advance the conventional practice of psychotherapy for depression and anxiety disorders. However, no reviews have been conducted to compare and evaluate neuroscience-informed models.

Objectives of the Present Study

The present review aimed to understand how the integration of neuroscience can advance the conventional practice of psychotherapy for depression and anxiety disorders by reviewing a range of neuroscience-informed psychotherapy models specifically designed to treat depression and anxiety disorders. The review specifically examined whether research studies have supported the better efficacy of neuroscience-informed psychotherapy models compared with conventional psychotherapy models. The present review focused on neuroscience-informed psychotherapy models designed to treat depression and anxiety disorders, since these are currently the most common type of neuroscience-informed psychotherapy models. This review appraised the existing literature on neuroscience-informed psychotherapy models designed for the treatment of depression and/or anxiety disorders in terms of the therapeutic process, elements and techniques, targeted psychological disorders, operationalisation, and research evidence.

Method

Search Procedure

A search was conducted of the following online databases: PubMed, Embase, PsychInfo, Science Direct, and Cochrane Library. The following search terms were used: (Neuroscience OR Neuro OR Neurological OR Neuroscientific OR Neuropsychotherapy OR Neuroscience informed) AND (Counselling OR Counseling OR Psychotherapy) AND (Depression OR Anxiety). Bibliographies of the literature searched were reviewed for citations to supplement the search.

Inclusion and Exclusion Criteria

The search included only peer-reviewed academic journal articles written in English and published within the last 15 years because the development of neuroscience-informed psychotherapeutic models is a relatively new phenomenon. The search included conceptual articles describing neuroscience-informed psychotherapy models that involve modifications of the therapeutic process, elements, or techniques used in traditional psychotherapeutic models, such as CBT, and that integrate neuroscientific knowledge. Empirical articles, such as case studies and randomised controlled trials, on neuroscience-informed psychotherapy models, were also included. The search excluded items that only described the neurological basis of existing psychotherapy approaches. For example, literature related to neuro-psychoanalysis

was excluded because neuro-psychoanalysis is merely an attempt to understand the neurological basis of psychoanalysis rather than the creation of a refined model of psychoanalysis that integrates neuroscientific knowledge.

Data Extraction

The first author performed the literature search. The appropriateness of extracted literature was independently checked by one of the co-authors against the objectives of the study and the inclusion and exclusion criteria. In cases of disagreement about the appropriateness of literature, the first author and co-author discussed this until agreement on inclusion or exclusion was achieved. Only the mutually agreed upon studies for inclusion by the first author and co-author were included in the final list of literature for review.

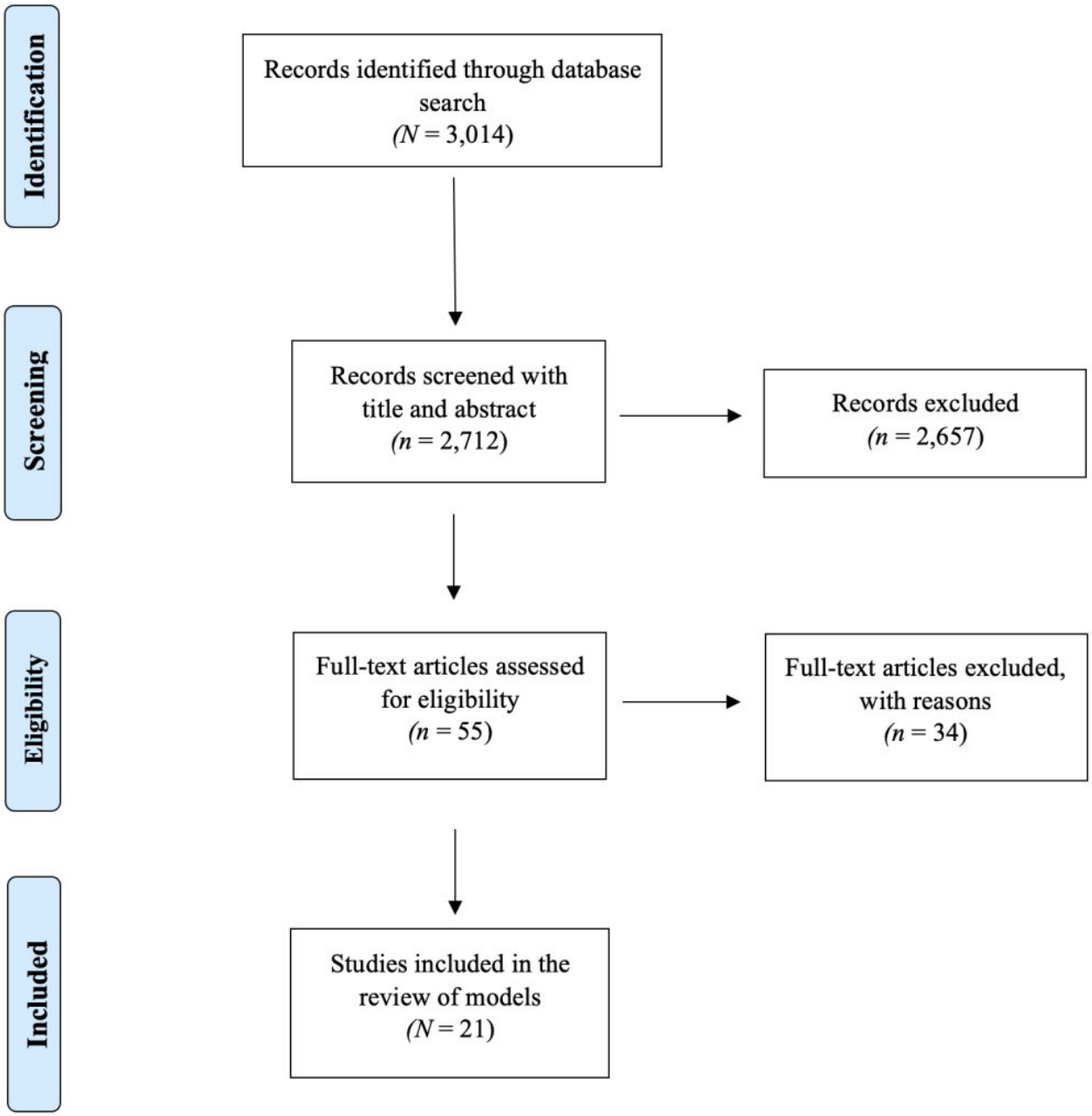
Data Analysis Methods

The literature analysis involved reviewing the critical characteristics of the articles, including the neuroscience-informed psychotherapy models implemented, journals of publication, types of articles, and home countries of the articles' authors. The neuroscience-informed psychotherapy models reported in the articles reviewed were compared in terms of their purpose for development; therapeutic orientations; targeted psychological disorders; operationalisation; psychotherapeutic process, elements and techniques; and research evidence.

Results

This initial search yielded 3,014 hits, of which 302 duplicates were excluded. The remaining 2,712 articles were further screened via the title and abstract for their relevance for inclusion in this review, of which 2,657 were excluded. The remaining 55 articles were further screened via full-text reading for their relevance for inclusion in this review (Figure 1). This procedure resulted in a total of 21 peer-reviewed journal articles for review.

Figure 1. Search Strategy and Outcome



Key Characteristics of Journal Articles

The 21 peer-reviewed articles for review reported the theoretical foundation or the intervention studies of five different types of neuroscience-informed psychotherapy models, namely, trauma affect regulation: guide for education and therapy (TARGET); neuropsychotherapy; neuroscience-informed CBT; neuroscience-based cognitive therapy; and brain-based therapy (see Table 1). TARGET was developed by Ford and Russo (2006) from the United Kingdom. Neuropsychotherapy was conceptualised by Grawe (2007) from Germany and further developed by Rossouw (2014) and Dahlitz (2015) from Australia. Neuroscience-informed CBT was developed by Field et al. (2016) from the United States. Neuroscience-based cognitive therapy was developed by Scrimali (2019) from Italy. Finally, brain-based therapy was developed by Arden and Linford (2009) from the United States.

TARGET was covered by nine peer-reviewed journal articles, two of which focused on theory/discussion, while seven reviewed TARGET intervention studies. Neuropsychotherapy was the focus of seven journal articles, one of which reviewed a case study and six presented theory/discussion. Neuroscience-informed CBT was examined by three articles, including one journal article in terms of theory/discussion and two reporting intervention studies. Neuroscience-based cognitive therapy was the focus of one article, which reported a related case study. Finally, brain-based therapy was reviewed by one journal article in terms of theory/discussion. All the journal articles analysed were published by authors from Western countries, including the United Kingdom, United States, Australia, and Italy. Seventeen of the 21 articles for review were relatively recent articles, published after 2010.

Table 1. Literature Search Strategy Results

Author	Year	Journal	Type of publication	Model reported	Country of authors
Ford & Russo	2006	*American Journal of Psychotherapy*	Theory/discussion	TARGET	UK
Frisman et al.	2008	*Journal of Groups in Addiction & Recovery*	Intervention study	TARGET	UK
Ford et al.	2011	*Behavior Therapy*	Intervention study	TARGET	UK
Ford & Hawke	2012	*Journal of Aggression, Maltreatment & Trauma*	Intervention study	TARGET	UK
Marrow et al.	2012	*Journal of Child & Adolescent Trauma*	Intervention study	TARGET	UK
Ford et al.	2013	*Behavior Therapy*	Intervention study	TARGET	UK
Ford	2015	*Journal of Cognitive Psychotherapy*	Theory/discussion	TARGET	UK
Ford et al.	2018a	*Clinical Psychology & Psychotherapy*	Intervention stud	TARGET	UK

Author	Year	Journal	Type of publication	Model reported	Country of authors
Ford et al.	2018b	*Journal of Child & Adolescent Substance Abuse*	Intervention study	TARGET	UK
Dahlitz	2015	*International Journal of Neuropsychotherapy*	Theory/discussion	Neuropsychotherapy	Australia
Allison & Rossouw	2013	*International Journal of Neuropsychotherapy*	Theory/discussion	Neuropsychotherapy	Australia
Voelkerer & Rossouw	2014	*Neuropsychotherapy in Australia*	Intervention study-Case study	Neuropsychotherapy	Australia
Rossouw	2011	*Neuropsychotherapy*	Theory/discussion	Neuropsychotherapy	Australia
Rossouw	2012	*Neuropsychotherapy*	Theory/discussion	Neuropsychotherapy	Australia
Rossouw	2013	*Neuropsychotherapy in Australia*	Theory/discussion	Neuropsychotherapy	Australia
Rossouw & Leggett	2014	*International Journal of Neuropsychotherapy*	Theory/discussion	Neuropsychotherapy	Australia
Field et al.	2015	*Journal of Mental Health Counseling*	Theory/discussion	Neuroscience-informed CBT	US
Field et al.	2016	*Journal of Mental Health Counseling*	Intervention study	Neuroscience-informed CBT	US
Field et al.	2017	*Journal of Mental Health Counseling*	Intervention study	Neuroscience-informed CBT	US
Linford & Arden	2009	*Psychotherapy in Australia*	Theory/discussion	Brain-based therapy	US
Scrimali	2019	*International Journal of Neuropsychotherapy*	Intervention study-Case study	Neuroscience-based cognitive therapy	Italy

Note. TARGET = trauma affect regulation: guide for education and therapy.

Purpose of the Development and Therapeutic Orientation of Models

Regarding the development of neuroscience-informed psychotherapy models, the authors of all five models intended to create a therapeutic model that could produce more consistent effects than the top-down-focused CBT model, which primarily focuses on top-down regulation of physiological and emotional arousal by changing cognitive patterns, with limited consideration of bottom-up regulation (see Table 2). All authors acknowledged the weakness of the top-down-focused CBT model, namely, that while many clinical trials support the efficacy of top-down-focused CBT for the treatment of depression and anxiety disorders, a segment of the population does not respond to the treatment or frequently relapses. The authors attempted to overcome this weakness of the top-down-focused CBT model by integrating neuroscientific knowledge with psychotherapy understanding but through different pathways.

The authors of papers focusing on neuropsychotherapy, brain-based therapy, and TARGET attempted to develop integrative therapeutic models by drawing on the underlying neuroscientific knowledge guiding a variety of therapeutic theories, elements, and techniques (see Table 2). In contrast, the authors of neuroscience-informed CBT and neuroscience-based cognitive therapy attempted to develop enhanced CBT models by integrating non-traditional CBT components and techniques and refining the therapeutic process of traditional CBT.

Table 2. Pathways for Development and Therapeutic Orientation of Models

Models	Pathways for development	Therapeutic orientation of models
Neuropsychotherapy	Development of the most effective therapeutic model	Integrative therapeutic model
Brain-based therapy	Development of the most effective therapeutic model	Integrative therapeutic model
Neuroscience-informed CBT	Development of enhanced CBT	CBT
Neuroscience-based cognitive therapy	Development of enhanced CBT	CBT and biofeedback
TARGET	Development of the most effective therapeutic model	Integrative therapeutic model

Notes. CBT = cognitive behavioural therapy; TARGET = trauma affect regulation: guide for education and therapy.

Targeted Psychological Disorders and Operationalisation of Models

The neuroscience-informed models reported in the literature reviewed revealed different levels of specificity for targeted psychological disorders (see Table 3). TARGET is the most focused model, specifically designed for the treatment of post-traumatic stress disorder (PTSD), while other models were formulated for the general treatment of depression and anxiety disorders.

The neuroscience-informed models had been operationalised differently in the papers reviewed. TARGET is the most formally structured model. TARGET is manualised and provides step-by-step instructions for therapists and clients to follow. Neuroscience-informed CBT and neuroscience-based cognitive therapy also provide steps to follow, with different procedures for the respective therapeutic models. Neuropsychotherapy and brain-based therapy do not provide a structure with precise steps to follow but instead describe the key process, elements, and techniques to be addressed in therapy.

Table 3. Summary of Targeted Psychological Disorders and Operationalisation

Models	Targeted psychological disorders	Operationalisation
Neuropsychotherapy	Depression, anxiety disorders	Not structured, provides general guidelines
Brain-based therapy	Depression, anxiety disorders	Non-structured, provides general guidelines
Neuroscience-informed CBT	Depression, anxiety disorders	Structured, provides steps for treatment
Neuroscience-based cognitive therapy	Depression, anxiety disorders	Structured, provides steps for treatment
TARGET	PTSD	Structured, manualised

Notes. CBT = cognitive behavioural therapy; TARGET = trauma affect regulation: guide for education and therapy; PTSD = post-traumatic stress disorder.

Therapeutic Process, Elements, and Techniques of Models

The therapeutic process, elements, and techniques of neuroscience-informed models are summarised in Table 4. Neuropsychotherapy predominantly focused on bottom-up regulation through the establishment of a trusting therapeutic relationship and the use of techniques such as prolonged exposure, motivational priming, resource activation, and mindfulness. Neuroscience-informed CBT, neuroscience-based cognitive therapy, and TARGET focused on implementing bottom-up regulation approaches before top-down regulation. Neuroscience-informed CBT employed bottom-up regulation techniques, such as mindfulness,

bio/neurofeedback, systematic desensitisation (exposure), and top-down regulation techniques, such as cognitive restructuring. Neuroscience-based cognitive therapy employed bottom-up regulation techniques, such as monitoring of electrodermal activity, bio/neurofeedback, exposure, and top-down regulation techniques, such as cognitive restructuring and exposure scripts. TARGET employed bottom-up regulation techniques, such as mindfulness, exposure, and art therapy, and top-down regulation techniques, such as cognitive restructuring and construction of narratives. Brain-based therapy was the only model that suggested the simultaneous implementation of bottom-up and top-down regulation and employed bottom-up regulation elements and techniques, such as the establishment of trusting therapeutic relationships, mindfulness, exposure, and regulation of sleep, exercise, and diet, alongside top-down regulation techniques, such as cognitive restructuring.

In terms of therapeutic elements and techniques, all models included exposure to anxiety-provoking stimuli and/or situations for down-regulation of the brain. Mindfulness was also a popular technique included in four models, besides neuroscience-based cognitive therapy, for down-regulation. Cognitive restructuring was the most popular technique for top-down regulation, employed by four of the models with the exclusion of neuropsychotherapy. Therapeutic relationship, bio-neurofeedback, and construction of narratives were each included in two different models. Motivational priming, resource activation, regulation of sleep, exercise and diet, and homework were each addressed by only one of the models.

Table 4. Summary of Therapeutic Process, Elements and Techniques

Models	Therapeutic process	Key therapeutic elements and techniques
Neuropsychotherapy	Mainly bottom-up	Exposure, motivational priming, resource activation, therapeutic relationship, mindfulness
Brain-based therapy	Simultaneous bottom-up and top-down	Exposure, cognitive restructuring, therapeutic relationship, mindfulness, regulation of sleep, exercise, and diet
Neuroscience-informed CBT	Bottom-up, followed by top-down	Mindfulness, bio/neurofeedback, systematic desensitisation (exposure), cognitive restructuring
Neuroscience-based cognitive therapy	Bottom-up, followed by top-down	Monitoring of electrodermal activity, bio/neurofeedback, cognitive restructuring, exposure, exposure script (construction of narrative)
TARGET	Bottom-up, followed by top-down	Exposure, cognitive restructuring, mindfulness, art therapy, construction of narrative, homework

Notes. CBT = cognitive behavioural therapy; TARGET = trauma affect regulation: guide for education and therapy.

Research Evidence of Models

The intervention studies for five neuroscience-informed psychotherapy models published in peer-reviewed journals are summarised in Table 5. TARGET was explored by research studies that supported its efficacy in reducing the symptoms of PTSD among different population groups, such as adults experiencing substance abuse and trauma (Frisman et al., 2008), mothers suffering victimisation-related PTSD (Ford et al., 2011), and youths experiencing trauma in juvenile detention (Ford et al., 2013). TARGET combined with internet-based CBT was found to be more effective than internet-based CBT alone among college students with trauma (Ford et al., 2018b). TARGET was also found to be more effective than relational supportive therapy for reducing PTSD symptoms in delinquent girls (Ford et al., 2012) and for increasing a sense of forgiveness of others who have caused harm in the past in youths in juvenile detention (Ford et al., 2013). TARGET was more effective at sustaining improvement than person-centred therapy among mothers with victimisation-related PTSD (Ford et al., 2011). However, no study directly compared the efficacy of TARGET with CBT alone. Moreover, all studies were conducted by the same group of researchers, which might have created allegiance bias in the results of studies.

Table 5. Summary of Clinical Trials and Case Studies for Neuroscience-informed Models

Author	Year	Study design	Groups	*n*	Duration	Population
Frisman et al.	2008	Randomised controlled trial	TARGET + treatment as usual	213	12 months	Adults experiencing substance abuse and trauma
Ford et al.	2011	Clinical trial	TARGET + present-centred therapy + waitlist	146	12 sessions	Mothers with victimisation-related PTSD
Ford et al.	2012	Randomised controlled trial	TARGET + supportive therapy	59	12 sessions	Girls with PTSD in juvenile detention
Marrow et al.	2012	Quasi-experimental trial	TARGET + treatment as usual	74	12 sessions	Youths in juvenile detention
Ford et al.	2013	Randomised controlled trial	TARGET + supportive therapy	72	12 sessions	Women in incarceration with PTSD

Ford et al.	2018	Randomised controlled trial	Internet supported CBT and TARGET + internet supported CBT	29	8 sessions	College students experiencing problem drinking with histories of complex trauma
Ford et al.	2018	Randomised controlled trial	TARGET + prolonged exposure	31	10 sessions	Veterans with PTSD
Voelkerer & Rossouw	2014	Case study	Neuropsychotherapy	1	Not specified	Woman with depression
Scrimali	2019	Case study	Neuroscience-based cognitive therapy	1	8 months	Man with PTSD
Field et al.	2016	Single group trial	Neuroscience-informed CBT	24	6 months	Counsellors
Field et al.	2017	Single group trial	Neuroscience-informed CBT	24	12 months	Counsellors

Notes. TARGET = trauma affect regulation: guide for education and therapy; PTSD = post-traumatic stress disorder; CBT = cognitive behavioural therapy.

No published study quantitatively supported the efficacy of the remainder of the neuroscience-informed models, nor directly compared the efficacy of the models with conventional psychotherapy models, such as CBT. One pilot study on a neuroscience-informed CBT trial was published in two peer-reviewed journals, exploring the experience of counsellors in using neuroscience-informed CBT after 6 months and 12 months of receiving training in this modality. These studies reported that after receiving training, counsellors with experience providing CBT generally felt comfortable using neuroscience-informed CBT, believed neuroscience-informed CBT to be credible, and expected client improvement to occur. They also reported that both counsellor and client belief in the credibility and expectancy of improvement remained stable after use of the model with clients at 6 months and 12 months (Field et al., 2016, 2017). Analysis at 12 months also identified that follow-up with counsellors who were trained in neuroscience-informed CBT through consultations and supervision was essential for sustaining counsellors' and clients' expectations of neuroscience-informed CBT (Field et al., 2017).

Neuropsychotherapy had been explored by one case study published in a peer-reviewed journal. Voelkerer and Rossouw (2014) described a case formulation of an adult woman with depression treated with neuropsychotherapy. However, the study did not report the details of the intervention process nor the results of intervention with neuropsychotherapy. Neuroscience-based cognitive therapy was the focus of one case study published in a peer-reviewed journal concerning a 52-year-old man who suffered from PTSD (Scrimali, 2019). The study described

the interventions implemented and assessment of the outcomes in terms of a reduction in the symptoms of PTSD after receiving 4 months of treatment and maintenance of improvement at 2 years follow-up. Brain-based therapy was not explored by any clinical trial or case study published in a peer-reviewed journal.

Discussion

This study is the first review of neuroscience-informed psychotherapy models to compare neuroscience-informed models in terms of targeted psychological disorders, operationalisation, therapeutic process, elements and techniques, and research evidence. The authors of all five neuroscience-informed models shared a common goal of formulating a therapeutic model that could be more effective than the conventional CBT model, which focuses only on the top-down regulation of physiological and emotional arousal through changing cognitive patterns. Despite this shared goal, the authors developed neuroscience-informed psychotherapy models demonstrating both similarities and differences.

Similarities and Differences of Models Reviewed

All the reviewed neuroscience-informed psychotherapy models commonly emphasised the importance of bottom-up regulation of cognitive abilities through the regulation of physiological and emotional arousal, simultaneously with, or followed by, top-down regulation of physiological and emotional arousal through changing cognitive patterns. To be more specific, the authors of all models acknowledged that under moderate to severe distress, the frontal cortex—the logical and rational thinking centre—is disabled because activation of the sympathetic nervous system results in reduced cortical blood flow to the frontal cortex (Hasler et al., 2007). All models acknowledged the usefulness of the top-down approach but argued that the top-down approach should be implemented following the successful down-regulation of sympathetic reactions with a bottom-up approach. Brain-based therapy, in contrast, advocated the simultaneous application of bottom-up and top-down strategies. These findings suggest that a key to effective psychotherapy indicated by the integration of psychological and neuroscientific knowledge would be adaptation of the bottom-up approach simultaneously with, or followed by, a top-down approach.

Each neuroscience-informed therapeutic model suggested different sets of therapeutic elements and techniques for implementing the bottom-up and top-down approaches. Nevertheless, there were common elements and techniques across models. All models emphasised the importance of some form of exposure, either in-vivo and/or imaginal, to the source of anxiety-provoking stimuli for down-regulating the physiological and emotional reactions. This emphasis was attributed to the shared acknowledgement among authors that exposure to fear or anxiety-provoking situations was a necessary process required for neurologically re-wiring the neural network and overcoming anxiety (Grawe, 2007).

Mindfulness was another popular technique included by all models for down-regulation of the brain, except in the case of neuroscience-based cognitive therapy. The models commonly suggested the practice of mindfulness before and during exposure exercises. This practice appears to be reasonable since mindfulness is one of the most researched therapeutic techniques for down-regulating emotional and physiological reactions, evident both in psychotherapy and in neuroscientific research over recent years. While some variations exist in

mindfulness techniques, neuroimaging studies consistently support the efficacy of mindfulness for down-regulating amygdala and sympathetic responses and up-regulating activity in the prefrontal cortex (Tang & Posner, 2012).

Cognitive restructuring was the most common technique suggested for top-down regulation. This trend appeared to be reasonable because cognitive restructuring is one of the primary techniques of CBT, the most widely researched top-down psychotherapy model (Hofmann et al., 2012; van Dis et al., 2020). The authors shared an acknowledgement of neuroscientific implications that top-down regulation of emotional and physiological reactions can be effective when emotional and physiological reactions are sufficiently down-regulated with bottom-up regulation.

Other therapeutic elements and techniques included in only some of the models, such as the therapeutic relationship, the regulation of lifestyle factors, and neurofeedback, are also potentially implicated by psychological and neuroscientific research as being effective in bottom-up regulation of emotional and physiological arousal. For example, a meta-analysis of clinical trials to identify common important therapeutic factors supported that the therapeutic relationship is one of the most influential factors in any counselling and psychotherapy practice, typically accounting for 30–40% of the outcome (Wampold, 2015). Neuroscientific studies have consistently supported that a sense of safety established within the therapeutic relationship can trigger neurological changes involving hormonal reactions with oxytocin and endorphins in the client, enabling down-regulation of the sympathetic response triggered by over-activation of the amygdala (De Dreu, 2012; MacDonald & Feifel, 2014).

The regulation of sleep, exercise, and diet was also only emphasised by brain-based therapy. Recent neuroscientific studies have increasingly revealed the neurobiological mechanisms of sleep patterns, exercise, and diet, and their relationship with activation of the sympathetic and parasympathetic nervous systems as well as with patterns of cognition, emotion, and behaviours (Lopresti et al., 2013). These findings demonstrate that lifestyle factors are not merely outcomes of psychological disorders but active contributors to the onset and maintenance of psychological disorders. Therefore, interventions associated with such factors need to be considered for long-lasting improvements in psychological disorders.

The models reviewed had different levels of formality in terms of structure that could result in different strengths and weaknesses. Structured models that provided steps for psychotherapy, such as TARGET, neuroscience-informed CBT, and neuroscience-based cognitive therapy, might be easier to follow, especially for less experienced therapists, than less structured models such as neuropsychotherapy and brain-based therapy. Structured models are also more amenable to research using clinical trials because it is easier to control the treatment conditions in these models than is the case with less structured models. However, structured models may lead to more difficulties with flexibly accommodating the individual needs of clients than less structured models.

In terms of research evidence, TARGET was the only model that received support for its better efficacy regarding the treatment of PTSD compared with conventional psychotherapy models, such as relational therapy and the person-centred approach, which were not specifically designed for the treatment of PTSD. TARGET, implemented with internet-based CBT, was also found more efficacious than internet-based CBT alone for the treatment of trauma. While all models reviewed were designed to be more effective than conventional CBT, which primarily

adopts a top-down approach, none had been explored by research studies directly comparing their efficacy with that of conventional CBT. Neuroscience-informed CBT had been the focus of one preliminary trial published in two articles in peer-reviewed journals; however, the articles only explored the practitioners' impressions of using neuroscience-informed CBT and did not evaluate the efficacy of neuroscience-informed CBT with clients. A lack of clinical trials for neuropsychotherapy and brain-based therapy might be attributed to the fact that these models provide the over-arching theoretical framework for the formulation of more individualised intervention protocols tailored to the unique circumstances of clients and do not provide a manualised procedure for performing psychotherapy. This renders these models difficult to research in controlled trials. Nevertheless, there is a lack of research studies supporting the better efficacy of neuroscience-informed psychotherapy models compared with existing psychotherapy models, especially CBT.

Implications of Reviewed Models for Effective Psychotherapy

Through the process of integrating and summarising the therapeutic processes, elements, and components of all five models reviewed, it appears that a comprehensive neuroscience-informed psychotherapy model initially implements bottom-up regulation of emotional and physiological reactions with therapeutic techniques such as exposure, mindfulness, neurofeedback, and regulation of sleep, exercise, and dietary patterns, within a trusting therapeutic relationship. This regulation is then followed by top-down regulation with therapeutic techniques such as cognitive restructuring. The elements and techniques included by the reviewed models are extensive. However, there are other vital elements and techniques suggested by neuroscientific studies that were not integrated into any of the models reviewed. One example is environmental intervention. Neuroscientific studies have identified that environmental factors, such as inadequate temperature, humidity, brightness, and quality of light, have impacts on the activation of the sympathetic nervous system; consequently, these factors may contribute to the onset and maintenance of psychological disorders (Fonken et al., 2011). Another important factor not addressed by any of the reviewed models is the regulation of water intake. Neuroscientific studies have also supported the strong impact of a lack of water intake on the activation of the sympathetic nervous system, implying its effects on the onset and maintenance of depression and anxiety disorders (Jordan, 2005).

Limitations of the Current Study

The current review exclusively analysed neuroscience-informed therapeutic models specifically designed to treat depression and/or anxiety disorders presented in English peer-reviewed journals listed on one of the databases searched. The review did not include models presented in other publication formats, such as books and webpages. The review did not include models presented only in non-English publications. In addition, the review did not include neuroscience-informed psychotherapy models that were not specifically designed for the treatment of depression and anxiety disorders, such as coherence therapy. These search limitations might have restricted the variety of neuroscience-informed therapeutic models reviewed.

Conclusion and Future Studies

Five different neuroscience-informed psychotherapeutic models designed for the treatment of depression and/or anxiety disorders were identified via a search of major databases. The five reviewed models commonly emphasised the importance of a bottom-up approach for effective treatment of depression and/or anxiety disorders. All models, besides brain-based therapy, suggested that the bottom-up approach should be implemented before the top-down approach, not only to recover the cognitive functioning of clients but also to utilise top-down approaches effectively for regulating the physiological and emotional arousal of clients. This common emphasis indicated by the integration of clinical neuroscience would be key to effective psychotherapy. The major limitation of the five models reviewed was that, while they were specifically designed to be more effective than traditional top-down-focused CBT models, no study had been published in a peer-reviewed journal that directly compared the efficacy of these models with CBT. Future studies are needed to compare the efficacy of neuroscience-informed psychotherapy models with CBT and other existing psychotherapy models.

A comprehensive neuroscience-informed psychotherapy model integrating the therapeutic processes, elements, and components of all five reviewed models would initially implement bottom-up regulation of emotional and physiological reactions alongside exposure, mindfulness, and regulation of sleep, exercise, and dietary patterns within a trusting therapeutic relationship. This would be followed by top-down regulation with cognitive restructuring and/or construction of narratives. As included in some of the models reviewed, other therapeutic techniques for bottom-up regulation, such as motivational priming, resource activation, electrodermal activity, and neurofeedback, and other therapeutic techniques for top-down regulation, such as the construction of narratives with or without the involvement of art therapy, are also suggested. Besides components included in these models, other important therapeutic elements and techniques were not addressed by any of the models reviewed, for example, environmental intervention and the regulation of water intake, despite neuroscientific research findings supporting the significance of their impact on cognition, emotion, and behaviour. A future neuroscience-informed model may integrate these factors to provide guidelines for effective psychotherapy for depression and anxiety disorders. Future studies may also investigate which techniques and components of psychotherapy are useful for which group of clients by employing the latest neuroscientific findings.

The development of a neuroscience-informed psychotherapeutic model is still in its infancy. Future neuroscience-informed therapeutic models will need to be continuously modified, adjusted, and developed by integrating the latest psychotherapy and neuroscientific knowledge and feedback from clinical trials and case studies. Such research will further promote the credibility and effectiveness of neuroscience-informed psychotherapeutic models.

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