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The Mechanisms of Behavioral Activation to Depression

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Abstract. Behavioral activation (BA) of depression is a structured treatment method supported by empirical support, which allows individuals to participate more in the pleasure of environmental rewards, increases individual enthusiasm, and breaks the vicious cycle of depression avoidance behavior. Since the 1970 s, BA therapy has been repeatedly compared with cognitive therapy, drug therapy and other depression therapies. Its efficacy has been recognized by the American Psychological Association and the general public, but the current research on the mechanism of behavioral activation is still insufficient. Based on the technical description provided in the latest BA empirical articles, this paper gives a brief overview of the history, effectiveness and applicable population of BA, and then attempts to summarize and describe the BA mechanism from three aspects: behavior, cognition and neurobiology.

Keywords: behavioral activation, depression, mechanisms of BA

1. Introduction

Depression is a widespread mental condition and the second greatest cause of disability in the world. From 2011 to 2030, the total global economic expenditure related to depression is expected to reach $ 5.36 trillion [1]. Behavioral activation (BA) as a ' recognized, validated treatment for depression ' [2]. BA is also considered to be a common mechanism of change in different treatments and diseases. In order to explain how it works, researchers need to pay attention to the mechanism of change, that is, which processes lead to which results. However, there is currently a lack of literature on a comprehensive overview of the BA mechanism. This paper systematically identifies and summarizes the possible mechanisms that have been studied, and discusses its future development direction.

1.1. Brief history and effectiveness of BA

BA is based on behaviorism. The initial wave of behaviorism encompasses the behavioral pattern of depression, predicated on the notion that depression arises when the source of positive reinforcement diminishes or vanishes. The second wave of psychotherapy masks the further development of BA. Beck and associates acknowledged the significance of behavioral strategies and integrated them into cognitive therapy (CT). Jacobson et al compared 150 adult MDD patients who were then treated with BA and CT [3]. They found that the efficacy of BA was comparable to that of CT. Then BA began as an independent intervention for the treatment of depression. Hayes et al.

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proposed that psychotherapy is not focused on changing and eliminating problems, but on identifying problems to find change. Therefore, BA has become one of the third wave of psychotherapy methods in the contemporary era [4].

A meta-analysis of 780 participants observed a pooled effect of 0.87 between the experimental and control groups, and there were also differences between the two groups in comparing BA and CT [5]. Another included 26 randomized controlled trials of 1,524 participants [6] found that the standard deviation (SMD) difference between the BA group and the control group was 0.74. In the study of the comparison between BA and drug therapy, there was an advantage of 0.42 SMD, which confirmed the clinical efficacy of BA.

1.2. BA applicable population

Research indicates that BA therapy can improve depressive symptoms in various populations, including individuals with emotional reactivity, psychomotor retardation, and interpersonal withdrawal, as well as patients with comorbid depression and PTSD, type 2 diabetes, and cancer [7], veterans [8], Latino [9] and African American populations [10], children and adolescents [11], pregnant women [12], and drug addicts hospitalized for substance abuse treatment [13].

2. Method

This paper follows the systematic search strategy and aims to identify and synthesize relevant literature on the mechanism of behavioral activation. Due to the scarcity of articles on BA mechanism and the heterogeneity of research population, methods and results measurement, it is decided to a meta-analysis will not be performed, as consolidating this diverse material provides no additional benefit for researchers or physicians in understanding the processes of BA [14,15]. In August 2024, a comprehensive search of HowNet, APA, Google Scholar database was performed utilizing the terms 'behavioral activation therapy' and 'mechanism of behavioral activation', and ' mechanism of depressive behavioral activation '. The search is limited to relevant articles published between 2007 and 2024.

The language is limited to Chinese and English, and the publication status is published. Studies can include patients with depression, dysthymia or depressive symptoms at any age, compare any variant of BA treatment or conventional behavioral counseling for depression against any control group. Various modalities of environment and execution are permitted, encompassing hospital and aftercare populations, both private and group sessions, as well as conventional in-person self-help services (Online or reading therapy). The primary finding of this article is the correlation between BA therapy, its mechanism, and depression outcomes. Depression outcomes can be evaluated using several numerical self-assessment tools or doctor rating scales specialized to depression.

The author made a preliminary screening of the abstracts and titles, and then evaluated the complete text of the chosen papers, and tried to extract and narratively synthesize the data on the main points and limitations of the research to determine the new trends and gaps in the literature. As for the classification and effectiveness of the BA mechanism, there is no fixed measure in the literature, which is why this paper pays more attention to the possibility of the BA mechanism rather than the effectiveness in the narrative synthesis.

BA is effective, but in order to explain how it works, attention needs to be paid to the mechanisms that lead to changes in depression outcomes. In this paper, BA intervention is used as an independent variable, and depression results are used as dependent variables to explore the BA mechanism. Therefore, if BA intervention leads to changes in depression results, it is called BA

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mechanism - although the intervention is not necessarily a mechanism - but it can point out the possible mechanism responsible for depression results. By understanding the mechanism to understand how the treatment works, we can improve the existing BA framework and improve the efficacy.

3. Result

The database search produced 18,000 results, of which 17935 failed to satisfy the selection requirement, and the remaining 65 needed full-text screening. From these, this article included 16 papers that met the inclusion criteria.

3.1. Behavioral mechanism

According to Lewinsohn and his associates, the behavioral model of depression [16] point out that the increase of negative reinforcement leads to depressive behavior, and the decrease of positive reinforcement can explain depressive behavior. The behavioral mechanism of BA is to enhance favorable reinforcement and diminish undesirable reinforcement by strengthening mediated activity intervention and depression results.

3.1.1. Increase positive reinforcement

Lewinsohn posits that removal and diminution of response contingent reinforcement (RCPR) can entirely elucidate the onset of depression, while also facilitating the documentation of an enjoyable plan that serves as supportive reinforcement. [17,18]. BA therapy aims to increase a person 's positive reinforcement rate by increasing potential reward activities [19]. Studies have shown that the hypothesis of the mechanism of behavioral activation [19-21]: (1) increased positive reinforcement of potentially beneficial activities, and (2) increased favorable reinforcement results in reduced depressed symptoms.

In BA studies, EROS [22] is commonly used to measure RCPR in order to evaluate contact with positive enhancement. One study [23] used the bootstrapping method for mediation analysis to investigate the mediating role of changes in positive reinforcement on the correlation between alterations in BA activation and the improvement of symptoms associated with depression. The study included 61 18-19-year-old students with mild to moderate rather than severe depression. The BDI-II scale was used to measure the effectiveness of BA intervention, and the EROS scale was used as a criterion for positive reinforcement to improve depression. The findings indicated that encouraging feedback significantly influenced the correlation between activity and depression. (indirect effect estimation: .15,95 % bias-corrected confidence interval: 0.33 to 0.03).

3.1.2. Reduce avoidant behavior

The depression scenario model proposed by Ferster [24] puts avoidance behavior at the core and believes that depression results from the negative reinforcement associated with avoidance and the patterns of avoidance behavior. Martell et al. [25] introduced the TRAP / TRAC (Trigger, Response, Avoidance Patterns / Trigger, Response, Alternative Coping) paradigm to elucidate the background of avoidance behavior in patients with depression and the BA intervention for these avoidance patterns. When The experience elicits an undesirable response ('trigger'), it will show an ' avoidance mode ', resulting in the loss of the opportunity to solve the problem or obtain available reinforcements. Avoidance behavior will miss the opportunity to respond to subsequent situational

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triggers, thus forming a feedback loop of depression. However, participation in constructive behaviors, such as 'alternative coping' strategies, can disrupt the cycle of avoidance and alleviate depression. Therefore, the reduction of avoidance response leads to an increased opportunity for reward sources in the participating environment [4]. For example, in a case study [26], therapists and patients identified avoidance behavior (watching late night television) through the BADS scale and then replaced it with reading, breaking the avoidance behavior pattern to improve depressive symptoms.

3.2. Cognitive mechanism

3.2.1. The change of negative thinking mode

Negative cognitive content is examined in Lewinsohn's initial theory [27], and many versions of Behavioral Activation incorporate techniques for covert speaking acts. [25,28-30]. Different from the later CT methods, these methods do not attempt to reorganize the cognitive content, aim to diminish the occurrence of negative covert speech acts while enhancing the prevalence of positive covert speech acts. The procedures for speech acts include thought monitoring, replacing negative ideas with good thoughts, inhibiting directly, practicing affirmative self-reflections and doctors' demonstration of constructive self-dialogue [30]. Lewinsohn et al. [28] outlined methods including thought-stopping procedures and positive thought rehearsals as developed by Wolpe and Lazarus [31] to target ' compulsive thinking ' Martell and his colleagues to treat rumination as an escape behavior, encouraging therapists and patients to recognize rumination.

A study [32] has shown that negative thinking patterns (rumination) are closely related to depression, and the hyperfunction of the DMN circuit is connected in a greater degree of depressive rumination in MDD. Therefore, the results of Yokoyama and his colleagues showed that [33], BA treatment can improve depression outcomes by activating dACC (facilitates the identification of rewards and the selection of positive behaviors) and regulating the default mode network associated with rumination.

3.2.2. Break the circulation of depression

The psychopathological model of BA [21] consists of a psychopathological model and a treatment model, describing the relationship between reinforcement, emotion, behavior and depression. 1. Psychological model: First, negative reinforcement increases and positive reinforcement decreases (reinforcement) produce depression (emotion); secondly, there are behavioral responses (behaviors) with reduced activation levels, increased avoidance and other depressive behaviors; finally, persistent depressive behavior causes patients to show depressive symptoms (depression). In this process, reinforcement-emotion-behavior-reinforcement forms a cycle. 2. Treatment model: First, BA technology intervention (treatment) increased activation behavior (behavior), while reducing avoidance and depression behavior (behavior); secondly, the recovery of diversity and stability of the positive reinforcement source of the environment (reinforcement) affects depression (emotion); finally, to reduce depressive symptoms (depression). This model is a simplified mechanism of BA based on behavioral theory, which strengthens positive feedback behavior by activating behavior and reverses the cycle of depression.

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3.3. Neurobiological mechanism

3.3.1. Activation of reward system

Lewinsohn and his colleagues [34] established a model of the onset and maintenance of depression from the perspective of behavior. The model was originally based on three hypotheses: 1) low-level response-related positive reinforcement triggers depressive behavior (emotional and somatic feelings) stimulation, 2) decreasing response-related positive reinforcement sufficiently accounts for depression, 3) the overall quantity of replies-connected reinforcement is a function of environmental event frequency, event probability, and event number, all of which have the potential to enhance the individual. Their theory holds that the key to the onset of depression is that the level of ' non-depressive ' behavioral response congruency positive reinforcement (RCPR) is at a low level for a long time, depressed person unable to recognize environmental rewards, making it difficult to trigger healthy

Behavioral activation therapy's primary objective [25] is to improve the level of positive reinforcement and break the avoidance and avoidance behavior patterns. With the intervention of BA, the decrease of avoidance behavior and the enhancement of proximity-oriented coping strategies are regarded as facilitating engagement in reward resources, thereby improving depressive symptoms [25].

In recent years, research has focused on the reward mechanism for BA changes, and The American Institute of Mental Health (NIMH) has incorporated the PVS field into its standard framework for research areas.[35]. The PVS field comprises multiple subdivisions of the reward function [36,37]: Expected reward, initial responsiveness, reward satisfaction, reward learning, reward probability, delay, and effort assessment. Among them, the expectation of reward is the main factor influencing the reduction of depressive symptoms following pre-lateral BA intervention, and its predictive ability is greater than the reward of results [38]. For example, in an experimental monetary incentive task (N = 1576) [39], it was shown that individuals with subthreshold depression predicted a shift to subthreshold or clinical depression after two years of follow-up compared to clinical depression in non-depressed controls, and that there was a stronger association with anhedonia than with depression. Effort assessment is another key component of the reward mechanism. A study [40] used effort expenditure on reward tasks (EEfRT) to assess the decision-making of rewarding effort in a laboratory environment. The results showed that people with elevated anhedonia and additional depressed symptoms were more likely to choose fewer high-intensity tasks, that is, depressed patients had lower willingness to pay efforts to obtain rewards.

In recent decades, neuroimaging has advanced the study of the relationship between nerves and behavior of reward mechanisms. The first is the ventral (limbic) neural circuit, when it comes to developing emotional reactions to stimuli, several brain regions—including the amygdala, insular striatum, ventral areas of the anterior cingulate cortex, and orbital frontal cortex—are involved. The hippocampus, the dorsal portion of the front prefrontal cortex, and the parietal cortex make up the dorsal neural circuit, which is involved in emotional effort management, preparing, and selective attention. [41]. The decreased activation of these circuits is related to the results of inhibition. Reduced frontal-striatal response to reward can distinguish depressed patients from non-depressed patients [42,43]. Finally, mindfulness can help patients to establish a connection with reward-related events, that is, to allow individuals to identify pleasing aspects of the activity, reduce stubborn thoughts of antecedent barriers (such as over-meditation), and increase positive emotions involved in reward activities [44].

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3.3.2. Regulation of alarm reaction

Stress response regulation, that is, the ability to regulate behavior to cope with changing environmental rewards and identify occasional reinforcement and incorporate it into subsequent behavioral choices [41]. Low levels of stress response in depressed patients lead to irregularities in reward-oriented decisions and objective-directed conduct [45,46], unable to reinforce positive behavior. BA treatment usually involves the performance of activities on patients ' emotions [47,48], allowing patients to integrate activity-related positive emotions and rewards into a sustainable behavioral pattern that interacts with the environment. There is a very perfect emergency management technology in BA [49]. Clinicians and patients jointly develop ' reward menu ' to strengthen the required behavior.

Stress response regulation is mainly evaluated at the altitude of behavioral examination based on lab assignments. For instance, in the probability reward trial (PRT), Vrieze et al. [50] set up MDD patients and non-clinical control groups, and frequently intensified stimuli during the task to evaluate the participants 'inverse bias. In the task, the bias of depression patients ' enhanced response with stimulation was significantly reduced. In addition, individuals with poor performance reward function during the task were more likely to be diagnosed with persistent MMD after 8 weeks (OR = 7.84). This also shows that the decrease in the level of stress response regulation is related to depression and reward dysfunction, and is expected to be a predictor of antidepressant treatment response.

4. Discussion

Next, I will go over the review's key points and then talk about the studies' and the review's shortcomings.

4.1. How to determine whether the BA mechanism improves depression outcomes

First, the changes in the scores of various depression scales and their subsystems can be directly observed [23]; secondly, it is the patient 's behavior change or subjective feedback [26]; finally, the changes of brain regions before and after treatment can be observed by neuroimaging [4].

4.2. What is the difference between mediation and mechanism

Mediation is a process in which a variable describes the relationship between the other two variables, which often points to a specific result; the mechanism refers to the potential process in which BA plays a role in emotion and behavior. The results it points to are uncertain and only have a certain correlation [51].

An investigation involving BA treatment (X), depression symptoms (Y), and positive reinforcement (Z) to be a mediator showed that activity (X) had no discernible influence on symptoms of depression (Y) (assessment of direct effects: 21,95 % confidence interval with bias correction: 0.52 to 0.07), the connection between activity (X) and depressive symptoms (Y) was significantly mediated by reinforcement (Z) (assessment of indirect effects: .15,95 % confidence interval with bias correction: 0.33 to 0.03). Furthermore, reinforcement was directly affected by activity. (assessment of direct effects: .34,95 % confidence interval with bias correction: 0.11 to 0.54), and reinforcement exerted a direct influence on depression symptoms (assessment of direct effects: .43,95 % confidence interval with bias correction: 0.86 to 0.01). As shown in Table 1.

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Table 1: BA's mechanism and mediator

activities（x）	Mediation reinforcement（z）	depressive symptoms（y）
√		
√	√	√
	√	

It can be seen from Table 1 that the uncertainty of depressive symptoms (Y) is caused by activity change (X) or mediation (Z), which has potential. When the mediating reinforcement describes the relationship between BA activity and depressive symptoms, it has been determined that it is caused by reinforcement rather than activity, and there is certainty.

4.3. What is the core mechanism of BA

The purpose of BA is to encourage patients to participate in more meaningful / active activities, thereby reducing the occurrence of depressive behavior and breaking the depression cycle. Therefore, the core mechanism of BA is activation / positive reinforcement, that is, participating in activities to obtain environmental rewards. With the deepening of research, some researchers believe that negative reinforcement is the main reason for the maintenance of depression. Many studies have confirmed this view and gradually shifted the focus of research to rumination [44].

4.4. Why should we discuss the BA mechanism from different analytical levels

This article is a literature review on the BA mechanism. In addition to searching for relevant literature as much as possible, it also allows later researchers to have a comprehensive understanding of the BA mechanism at a more comprehensive analysis level. For example, positive reinforcement is a mechanism by which patients are rewarded by the contingency of activity arrangements, increase positive emotions, and then increase accidental behavior in the future. The reward system in neurobiology are different manifestations of the same mechanism. In the theory of behavior, it is manifested as behavioral response; in neurobiology, it corresponds to changes in different brain regions.

4.5. Future development direction

Although BA has the characteristics of simple, easy to operate, good economic and cultural adaptability [1], it is still very difficult to change the behavior pattern of depression in patients with low-level activation. There are still some problems in BA 's autonomous intervention, such as excessive meditation, insomnia, etc. [41]. If more efficient surgical intervention can be found by studying the BA mechanism, it can greatly improve the depressive symptoms of patients and has universal clinical benefits.

4.6. Limitations of this article

The authors extensively searched the literature in three related databases, and abandoned a small number of studies that needed to be paid in the initial screening process, languages are limited to Chinese and English. In addition, there is a complex and uncertain interaction between mechanism

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and depression, and there is a non-linear relationship. The search scope of this paper cannot be fully involved.

5. Conclusion

This article is the first study to describe the mechanism of BA from three different levels of behavior, cognition and neurobiology. In general, the final results show that the scientific proof supporting the efficacy of the BA mechanism is insufficient, as well as the process is overly intricate to establish a direct correlation between the mechanism and depression results. This problem can be solved by mediation analysis in future BA mechanism research.

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