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Review Article:

An Overview of Symptoms and Treatments of Obsessive-compulsive Disorder (OCD)

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Abstract

Context: The investigation of obsessive-compulsive disorder (OCD) is paramount in comprehending the fundamental causes, symptoms, and potential therapeutic approaches for this incapacitating psychological condition. OCD is characterized by intrusive thoughts or obsessions, as well as repetitive behaviors or compulsions, which hinder daily functioning and may impact sleep patterns. Understanding the underlying mechanisms of OCD can aid healthcare professionals in devising more efficacious treatment modalities and interventions for individuals afflicted by this disorder. Research on this mental illness can also help diminish the stigma surrounding mental health disorders and promote awareness regarding the importance of seeking assistance for those grappling with OCD. Additionally, research on OCD is imperative for advancing our understanding of the brain and mental health in a broader sense. Such investigations could yield groundbreaking discoveries that might ultimately enhance the overall quality of life for individuals suffering from OCD and other related mental health issues.

Evidence Acquisition: Treatment with Selective Serotonin Reuptake Inhibitors (SSRIs) or cognitive-behavioral therapy (CBT), alone or in a combined approach, are considered to be the most effective methods for treating OCD. In addition, Neurofeedback has also represented promise as a treatment for OCD. The difficulties that people with OCD encounter on a daily basis, including the effects on their relationships, career, and emotional well-being, will be covered in this article.

Results: Therefore, in this review, we intend to discuss most popular and efficient OCD treatments, including CBT, SSRIs, and neurofeedback. The pros and cons of these treatments will be covered.

Conclusion: Despite extensive studies, the use of neuroimaging and electroencephalogram (EEG) comparisons in understanding and treating OCD is not well investigated. EEG studies have yielded promising results in identifying neural patterns associated with OCD and determining the efficacy of different treatment approaches.

Keyword: Cognitive Behavioral Therapy (CBT), Obsessive Compulsive Disorder (OCD), Neurotic disorder, Neurofeedback, Selective Serotonin Reuptake Inhibitors (SSRIs)

1. Context

Obsessive-compulsive disorder (OCD) is a common, persistent, and long-lasting mental disorder in which a person experiences uncontrollable, recurrent thoughts (also known as "obsessions") and/or behaviors (also known as "compulsions") that they feel the urge to repeat until their anxiety has subsided [1].

Obsessions are repeated thoughts, images, or impulses that a person feels they have no control over. OCD individuals do not want to have these thoughts and find them to be unsettling. Most of the time, OCD sufferers are aware that these thoughts are illogical. The following are examples of common symptoms: Fear of germs or contamination; unwanted thoughts of sex, religion, or harm; aggression toward others or oneself; a need for things to be symmetrical or in perfect order.

Compulsions are repetitive actions that an OCD individual feels driven to carry out in response to an intrusive thought to feel less/stop being stressed or anxious or make the obsession go away. Common compulsive behaviors include: excessive hand washing or cleaning; placing and arranging things in a specific, exact manner; repeatedly checking to see if things are in order [2].

One thing about OCD is that most individuals have had stressful, traumatic experiences or unexpected exposure to contaminants leading to the onset of their disorder. When treating OCD, it is preferable to intervene earlier rather than later because compulsive behaviors worsen conditioned anxieties and fears [3].

OCD individuals face various difficulties such as reduced quality of life, morbidity, relationship problems, personal and social life hardships (over washing, fear of contamination and more) [4, 5].

Fortunately, there are some ways and treatments available to OCD people which could help them in overcoming their OCD to some degree and live a better life. In this article we will cover Cognitive-behavioral therapy, selective serotonin reuptake and Neurofeedback.

There are some ways for the scientists and doctors to study OCD better or make more accurate diagnosis. we will cover EEG comparisons in OCD in this article.

(Writer's opinion) To overcome the challenges of OCD, one must be determined to make positive changes in their life. Fortunately, the internet has an abundance of resources that provide coping skills to help manage OCD symptoms. However, access to these resources is just the beginning. The commitment of the individual to start on a journey of self-discovery and healing is the key to living a better life free of OCD's grasp.

Research on OCD patients is crucial for several reasons. Firstly, OCD is a complex and debilitating disorder that affects millions of people worldwide in daytime and nighttime. By conducting research on OCD patients, scientists can better understand the underlying causes, symptoms, and treatment options for the disorder. This research can lead to the development of more effective therapies and interventions that can improve the quality of life for individuals living with OCD.

Furthermore, research on OCD patients can help identify the factors that contribute to the development and progression of the disorder. By studying genetic, environmental, and neurobiological influences, researchers can gain valuable insights into the underlying mechanisms of OCD. This information can inform the development of personalized treatment approaches that target the specific needs of individual patients, leading to more successful outcomes and reduced burden on patients and their caregivers.

Lastly, research on OCD patients is essential for advancing our understanding of comorbidities and co-occurring conditions that often accompany OCD. Many individuals with OCD also experience symptoms of anxiety, depression, and other mental health disorders. Understanding the relationships between these conditions and developing comprehensive treatment strategies can lead to more holistic and effective care for patients with OCD. Overall, research on OCD patients is vital for advancing our knowledge and improving outcomes for individuals struggling with this challenging disorder.

Causes and Challenges of living with OCD

The repeating of compulsive behaviors in response to obsessions has the potential to prolong symptoms by reinforcing the link between the obsessions, anxiety, and the temporary relief derived from engaging in compulsions. Over time, this reinforcement can lead to the persistence and aggravation of OCD symptoms.

Patients with OCD frequently have experiences that affect the development of their disorder. Trauma, stressful life events, and contaminants exposure, fear of disease, reduction in or lack of social interactions and economic problems can all contribute to the development of OCD. These occurrences have been linked to the beginning of OCD. Furthermore, there is a relationship between maltreatment, sexual abuse, and family instability and the severity of obsessive-compulsive symptoms [6].

The onset of obsessive-compulsive disorder (OCD) can be attributed to various factors, including but not limited to family issues, pregnancy and childbirth, job changes or transfers, sleep disorders, dissociative identity disorder. Additionally, specific incidents or experiences can trigger OCD symptoms. Some examples of such triggers could include childhood

trauma, running over a cat with a car by mistake, accidentally splashing toilet water while assisting a family member, feeling distressed when classmates let an insect run over them, making a mistake at work, lending a pencil that was contaminated with a classmate's sweat, experiencing the loss of a pet due to someone else's actions, feeling uncomfortable after being touched by disliked person.

These were some examples of how OCD could be developed or caused in an individual. After someone develops OCD, their quality of life drops significantly and their impaired functionality in life irritates them. However, some individuals may accept their OCD disorder and find ways to cope with their symptoms, they would still experience a hard life. Although there are treatments for OCD, but it may be a tiring experience to find the right one, not all treatments work for people and it is connected to many factors.

Some factors may be as the following age, gender, income, beliefs, and concerns [7].

OCD is considered to be one of the top 10 most disabling conditions because of its effect on one's life. Some individuals may come to term with their condition, Others, on the other hand, may feel furious, unhappy, or resentful [8].

2. Evidence Acquisition

Cognitive-behavioral therapy

CBT is an efficient treatment for a variety of mental health problems, including OCD and other anxiety disorders. CBT is a structured and short-term form of talking therapy which has its focus on the person's present issues rather than their past. Most of OCD individuals choose this treatment over others. CBT's recovery efficiency in helping people with OCD rates up to 80%. It has minimal risks and side effects which makes it more preferable, it is endorsed by organizations like NICE and CADAT.

The primary psychological therapy for OCD is cognitive-behavioral therapy (CBT) with a technique called exposure and response prevention (ERP). This approach assists individuals facing and enduring circumstances or triggers that bring about their obsessive thoughts and compulsive behaviors. By gradually exposing themselves to these situations without giving in to the compulsion to engage in repetitive actions, patients learn to tolerate the distress and resist the urge to act on their obsessions. In summary, CBT with ERP helps patients with OCD confront and tolerate the conditions that trigger their obsessions and compulsions, empowering them to resist acting on these thoughts and behaviors. Therapy teaches OCD people that the thoughts themselves aren't the actual problem. It's more about how they think about those thoughts and what they do in response to them [9].

For patients who refuse ERP, OCD-specific cognitive therapy (CT) is suggested. The 2005 NICE guidelines recommend low-intensity psychological treatments for mild OCD symptoms, pharmacological therapy for moderate symptoms, and combination therapy (SSRI and CBT with ERP) for more severe or resistant illness. Also (CBT) helps clients overcome fear-inducing stimuli and develop new neural connections to suppress fear[10, 11].

Cognitive behavioral theories

Mowrer's two-stage theory explains how fear, anxiety, and avoidance happen in OCD. It says that a neutral event (conditioned stimulus) and an unconditioned stimulus lead to fear and distress. Then, people with OCD develop behaviors which repeated then becomes rituals or compulsions to escape or avoid these feelings, which help lessen anxiety or distress. An example to understand this theory better: A car horn (conditioned stimulus) and previous accident experience (unconditioned stimulus). A person which had an accident before, a car horn might become traumatic and cause the individual great distress

Foa and Kozak put forth the idea that individuals with OCD exhibit faulty thought patterns. They tend to perceive harmless situations as highly dangerous, magnify the severity of negative events, and constantly seek reassurance of safety. Five core beliefs commonly found in OCD were proposed by Salkowskis: thinking about an action is equivalent to actually carrying it out, not preventing harm is morally equivalent to causing harm, personal responsibility for harm is not diminished by external factors, resisting rituals in response to intrusive thoughts is seen as intending harm, and individuals should have complete control over their thoughts. Interestingly, even though OCD sufferers find their obsessions unacceptable, they view their compulsions as acceptable means to alleviate anxiety [12].

CBT therapy can be replaced with a pharmacological intervention, typically a selective serotonin reuptake inhibitor (SSRI), if the patient's treatment does not provide adequate symptom alleviation after 12-16 sessions, as both treatment modalities show large effect sizes (Figure 1).

Selective Serotonin Reuptake Inhibitors (SSRIs)

Clomipramine, a tricyclic antidepressant, was

initially recognized as a potential treatment for obsessive-compulsive disorder (OCD) during the 1960s. Early placebo-controlled trials conducted in the 1980s demonstrated its effectiveness in managing OCD symptoms. However, despite its efficacy, current treatment guidelines do not recommend clomipramine as the first-choice medication due to its troublesome side effects. Instead, selective serotonin reuptake inhibitors (SSRIs) such as fluoxetine, fluvoxamine, sertraline, paroxetine, citalopram, and escitalopram are considered the primary pharmacotherapy for OCD. These SSRIs are extensively recommended as the first-line medication in all major treatment guidelines for OCD. A Cochrane review confirmed the effectiveness of most SSRIs in treating OCD, including citalopram, fluoxetine, fluvoxamine, paroxetine, and sertraline, without significant differences. Fluoxetine, fluvoxamine, sertraline, and paroxetine have obtained approval from the United States Food and Drug Administration (FDA) and equivalent oversight authorities in other nations for the treatment of OCD. In the United States, citalopram and escitalopram are frequently prescribed off-label for this indication. However, there is limited availability of direct comparative studies between these medications, and the existing evidence does not indicate any significant differences in their effectiveness. Meta-analyses have also supported this finding, showing no discernible variance in efficacy among these drugs. In summary, clomipramine, a tricyclic antidepressant, has shown promise in treating OCD, but its side effect profile makes it less recommended as a first-line treatment. The United States Food and Drug Agency has approved six available SSRIs for OCD treatment, with citalopram and escitalopram being the most commonly used off-label agents [13-15].

serotonin, is a neurotransmitter that regulates various activities in the human body. Serotonin is a primary treatment target for psychiatric and neurological disorders with decreased CNS and plasma serotonin concentration, such as major depressive disorder, post-traumatic stress disorder, obsessive-compulsive disorder, and anxiety disorders. Other neurotransmitters, like norepinephrine and dopamine, are also targeted for treatment. Therapies affecting serotonin are often considered first-line in pharmacologic management, alongside lifestyle changes, physical exercise, and psychotherapy [16, 17].

SRI therapy has shown significant benefits in treating OCD symptoms, highlighting the role of serotonin dysregulation as a potential contributing factor. However, the causal relationship between serotonin abnormalities and OCD symptoms remains an empirical question. Genetic studies suggest that alleles of genes involved in serotonergic neurotransmission may contribute to OCD risk, although specific alleles or genes have not been identified with sufficient statistical confidence.

Serotonergic transmission changes, including serotonin-induced enhancement of postsynaptic signals, are linked to improved occipital lobe symptoms. Serotonin is transported through membrane transporter proteins, and SSRIs block membrane transporters, causing serotonin accumulation in synaptic cleft.

3. Result

Neurofeedback

Neurofeedback (NFB) is a kind of biofeedback, also it can be called as neurotherapy, involves measuring brain waves and providing feedback to teach self-control through audio or video signals. Biofeedback targets physiological signals to support medical cases identify and manage symptoms in psychiatric disorders, including obsessive-compulsive disorder (OCD). Conducting a meta-analysis and systematic review found ten studies using NFB, with high heterogeneity and inconsistency values. The overall effect size varied between medium and large, but methodological quality was low, indicating a high risk of bias. Future studies should follow high-quality guidelines to address the efficacy of biofeedback approaches in OCD and related disorders.

The hyperactive orbitofrontal-striatal circuit, involving cortices and subcortical structures, is a prominent feature of obsessive-compulsive disorder (OCD). This disorder has been incorporated into the OCD&RD category in the DSM-5, which encompasses conditions such as body dysmorphic disorder, hoarding disorder, trichotillomania, excoriation/skin-picking disorder, substance/medication-induced OCD&RD, and OCD induced by other medical conditions. These disorders share common characteristics, including compulsive behaviors, impaired behavioral inhibition, demographic profiles, neural pathways, neurotransmitter dysfunction, and treatment response profiles [19].

Furthermore, beta training modifies to improve focus, attention, reading ability, and school performance by simulating increased beta 12-14 Hz. It also boosts cognitive processing, reduces worries, overthinking, OCD, alcoholism, and insomnia. NFB improves sleep cognitive performance, reduces fatigue and stress, and reduces anxiety, epilepsy, anger, and turmoil. Beta waves in the 12-15 Hz range can also diminish worry, epileptic seizures, frustration, and distress.

The article highlights specific brainwaves along with their respective characteristics. The common brainwave frequencies and their frequency ranges (in Hz) are as follows: Delta (1-4), Theta (4-8), Alpha (8-13), Lower Alpha (8-10), Upper Alpha (10-12), SMR (Sensorimotor Rhythm) (13-15), Beta (15-20), High Beta (20-32), and Gamma (32-100 or 40). These brainwaves exhibit general characteristics as described below:

- Delta: Associated with shut-eye, restore, and intricate decision-making. Induces disregard and extreme unresponsiveness.

- Theta: Linked to innovation, deep understanding, intense states, unawareness, and optimal meditative states. Also associated with conditions such as depression, anxiety, and distractibility.

- Alpha: Characterized by alertness, peacefulness, readiness, meditation, and deep relaxation. Facilitates recalling and can optimize cognitive performance.

- Lower Alpha: Supports mental alertness and physical relaxation.

- Upper Alpha: Involved in contemplating, concentrating, long-lasting attention, traction, vigilance, and thrill.

- SMR (Sensorimotor Rhythm): Induces intensity, hyper alertness, and anxiety.

- Beta: Associated with learning, cognitive processing, problem-solving tasks, mental sharpness, brain activity, and organizing the brain.

- High Beta: Linked to intensity, hyper alertness, and anxiety.

- Gamma: Supports cognitive performance, mental alertness, and physical relaxation.

By understanding the characteristics of these brainwaves, we can gain insights into their roles in various mental states and cognitive processes [20].

Electroencephalography

Electroencephalography (EEG), a non-invasive, portable, and simple tool for clinical deployment, has been used to study obsessive-compulsive disorder (OCD) treatment. However, studies on EEG forecasters and correlates of response in OCD are limited, with few attempts to predict clinical change. Among the available literature, the most robust studies focus on event-related potentials, particularly the P300, which has been observed to exhibit abnormalities at baseline that tend to normalize following treatment. The cost-effectiveness and convenience of EEG, particularly when compared to fMRI and PET, make it an ideal choice for developing practical personalized treatment algorithms. However, further research is required to enhance the efficacy of EEG in the treatment of OCD.

EEG Electrode Placement

Electrodes on the scalp record cortical activities in nearby brain regions using the Electrode System 10-20. This method standardizes skull areas and compares data, with electrode placements over 10% or 20% of the total distance, correlated with corresponding cerebral cortical regions. (Figure 2) [21].

The Cingulate gyrus, located in areas FPZ, FZ, CZ, PZ, and OZ, is associated with various functions including mental flexibility, cooperation, attention, motivation, morals, as well as the manifestation of obsessions, compulsions, tics, perfectionism, worry, ADHD symptoms, OCD, and OCD spectrum disorders.

In a study conducted, EEG FDs were compared between 39 OCD cases and 19 healthy controls (HCs) to investigate the potential divergences in information processing complexity]. The findings revealed that OCD cases exhibited heightened FDs in frontal areas across all frequency bands compared to the HCs. Notably, meaningful increments were preceived specifically in the beta and lower gamma bands, particularly at high beta frequencies. The neurophysiological results likewise indicated a correlation between the intensity of obsessive behaviors and the intricacy of information processing, suggesting a close relationship between structural and functional impairments in OCD

The cortico-basal ganglia-thalamo-cortical loop model (CBGTC), which stems from the identification of basal ganglia loops in the orbitofrontal cortex and anterior cingulate cortex that are implicated in OCD, has been employed for the investigation of obsessive-compulsive disorder (OCD). Obsessions occur when this circuit fails to restrict implicitly processed information, consequently triggering explicit processing in the dorsolateral prefrontal cortex and hippocampus, ultimately giving rise to obsessions. This malfunction manifests as more intricate EEG recordings in specific channels.

Several neuroimaging methods have existed utilized to analysis the functional variations in the brain connected to OCD, by limited exploration using the EEG technique. EEG recordings can be categorized into different range of frequencies, containing delta [1-4 Hz], theta [4-8 Hz], alpha [8-13 Hz], beta [13-30 Hz], and gamma [>30 Hz] bands, as well as various

sub-bands such as alpha I [8-10 Hz], alpha II [10-12 Hz], beta I [12-15 Hz], beta II [15-18 Hz], beta III [18-25 Hz], and beta IV [2-30 Hz]. These frequency bands correspond to specific mental states, including attentional processes, emotional responses, and cognitive functions. Previous research based on EEG has demonstrated reduced beta and incremented theta activity in the frontal and frontotemporal areas of the brain in individuals with OCD.

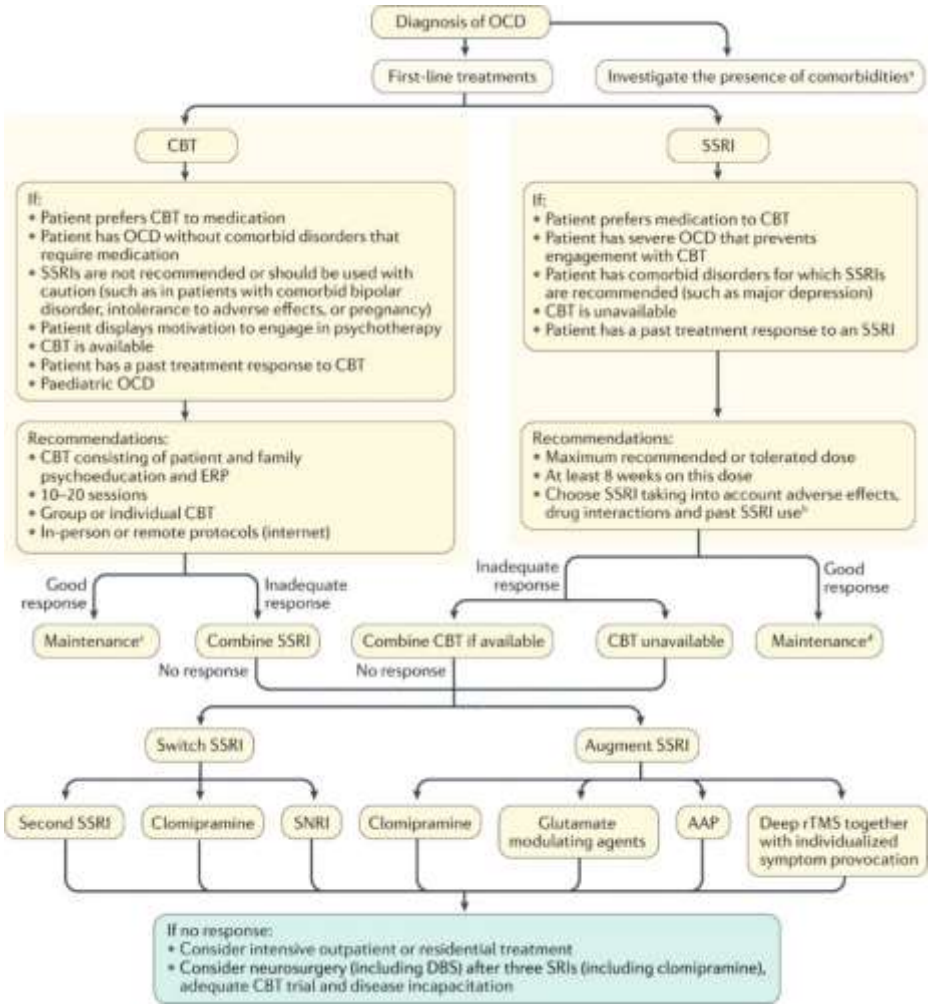

Figure 1. Algorithm on OCD treatment str [18]

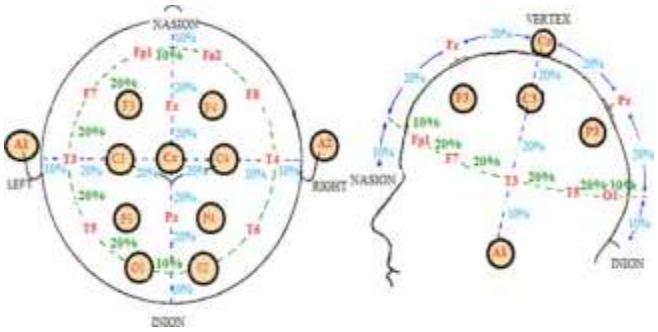

Figure 2. The 10–20 electrode placement

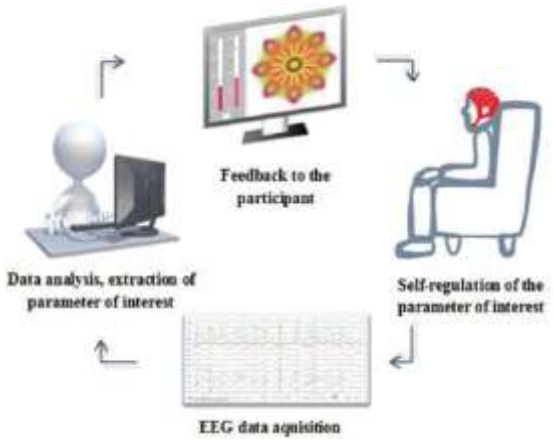

Figure 3. NFB training loop diagram [1]

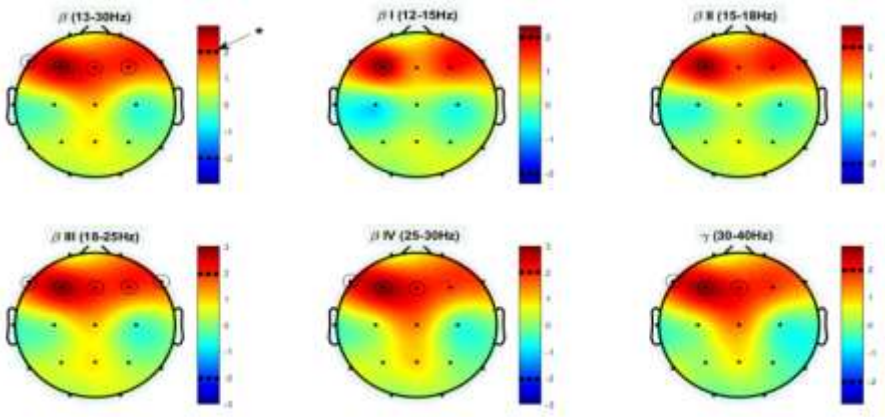

Figure 4. Statistical differences in Katz FD amongst OCD and HCs about different frequency bands[22].

By taking advantage of a two-sample t-test, Katz FDs were examined amidst two groups, revealing that EEG signals in the high and extremely high beta bands (beta III and beta IV) were prominent in the frontal channels (F3). Topological plots of t-values were analyzed, demonstrating the heightened complexity of EEG signals in these frequency bands within the frontal channels [22].

EEG-NFB

EEG-NFB is a widely chosen procedure that involves the real-time monitoring EEG signals evaluation, data processing, and real-time feedback to improve control over neurophysiological parameter (real tike processing) (Figure 3). It is utilized as a supplementary therapy for various neuropsychological disorders and improves cognitive abilities, innovation, and state of tranquility in individuals without any health issues. This review discusses different types of EEG-NFB instruction, containing slow cortical potentials (SCPs) and frequency and synchronization training, and their primary findings and potential restrictions. However, concerns about EEG-NFB methodology remain, and clear conclusions on its effectiveness are difficult due to heterogeneity in research designs. Despite this, there is a clear trajectory for future EEG-NFB investigation, opening up prospects for enhancements.

NFB is a feedback loop that involves taking EEG data from a subject, either using a 1- or 2-channel system or 32 or more channels in research settings. The data is analyzed offline or in real-time to extract the desired parameter. The selected criterion is presented to the subject as an optical, sound-related, or

tactile stimulus, assisting them in controlling the parameter(s). When the threshold is reached, additional feedback or rewards can be provided to reinforce desired mental states.

Self-regulatory neuromodulation, also known as NFB, involves learning to regulate specific brain responses through real-time feedback. Self-regulatory neuromodulation (SRN) is a technique that uses real-time brain activity monitoring and associative learning to self-regulate it.

It utilizes cost-effectiveness and high temporal resolution of electroencephalograms, enabling both animals and humans to regulate brain activity.

The findings revealed a noteworthy advantage of NFB over other interventions or control conditions, with a statistically significant improvement observed. Nonetheless, it's important to note that the most frequently utilized therapeutic approaches for OCD are medication-based treatments utilizing serotonin reuptake inhibitors (SRIs) and cognitive behavioral therapy (CBT). Although both SRIs and CBT have confirmed effects, a significant percentage of people with OCD do not report significant advantages during therapeutic sessions. Despite its limitations in terms of low temporal resolution and high cost, EEG-NFB remains a popular neurological treatment for OCD. However, it does not possess the regional resolution of fMRI when it comes to regulating brain waves in deep areas. Nevertheless, the majority of studies reviewed reported a significant remission in OCD symptoms following episodes of NFB, indicating its effectiveness in alleviating symptoms of OCD [1].

Brain Activity Investigations in OCD

Neuroimaging techniques have transformed our understanding of obsessive-compulsive disorder (OCD) by revealing important insights into the underlying brain mechanisms. Electroencephalography (EEG) has emerged as a crucial tool in the analysis of OCD, providing insights into the disorder's dynamic neural activity. EEG allows researchers to investigate the oscillatory patterns, event-related potentials, and functional connectivity underlying OCD symptoms by capturing the electrical activity of the brain with great temporal resolution. In this section, we will look at how neuroimaging and electroencephalography (EEG) investigations have helped to untangle the complexity of OCD, offer insight on its pathophysiology, and inform treatment approaches.

Comparison of EEG among OCD cases and HCs

In comparison to the HC group, the OCD association exhibited heightened rhythmic strength in the delta and theta frequency bands within the fronto-temporal and parietal brain segments. Conversely, no significant disparities were observed in other frequency bands or 1/f dimensions. The analysis of consistency indicated a decrease in functional connectivity (FC) specifically in the delta band among individuals with OCD while compared to the control class. However, no significant distinctions were found in the dwPLI analysis. These findings suggest that OCD is linked to increased rhythmic strength in slower frequency ranges within fronto-temporal brain areas.

Resting-state electroencephalographic (EEG) investigations have shown considerable contrasts in brain electrical activity between individuals with OCD and HCs. The most common differences are delta, theta, and alpha differences. In OCD groups compared to HCs, several studies have observed heightened resting delta and theta power in the fronto-temporal region. However, when it comes to examining alpha activity, there are inconsistencies among studies, with some reporting increases in power while others report decreases.

In order to identify and analyze brain oscillatory activity, EEG data needs to be converted to the frequency or time-frequency amplitude. The potency observed in the frequency range represents a combination of periodic activity and the irregular, asynchronous, and non-periodic activating of neurons or neuronal conventions, which exhibit a power spectrum resembling 1/f characteristics. To ensure accurate estimation of power, it is crucial to account for non-periodic action. Additionally, another essential aspect to take into account when understanding methods of rhythmic strength is the identification and recognition of rhythmic patterns within brain oscillations.

Functional connectivity (FC) encompasses different assessments of how the neural activity of one area of the brain is connected to the activity in another region. In the context of OCD compared to HC, numerous studies have documented changes in connectivity. Several studies have highlighted reduced linkage in the alpha and beta spectral ranges, whilst a particular research has noted reduced worldwide sector coordination of frontal EEG specifically in the delta segment.

The investigation focuses on analyzing the variations in spectral strength amongst two groups: individuals with OCD and HCs. The aim is to address inconsistencies found in previous studies. The research employed a general pipeline for pre-processing EEG data and controlled for non-periodic

functioning that follows a 1/f pattern. Additionally, the study explored the features of the 1/f slope, specifically in an OCD sample, for the first time. It also conducted an exploratory examination of alterations in network-based operational association in OCD.

The findings in terms of power spectra revealed that the OCD group exhibited considerably enhanced spectral strength in the delta and theta frequency bands compared to the HC group. This difference was observed across multiple arrays of electrodes. These results align with previous studies that have reported increased delta and theta power in the same brain areas among individuals with OCD. It is believed that OCD is associated with noticeable decreases in cerebral circulation of blood in the fronto-temporal areas of the brain. This could be attributed to the excessive activations of generators responsible for producing delayed brain waves in the frontal region, which in turn leads to heightened delta and theta strength. Excessive activity of slow waves in the fronto-temporal region may indicate pathological overactivation of the frontal control network, resulting in an inability to deactivate the fronto-temporal "action" network and transition to the default "rest" network. This finding could potentially indicate an underlying depressive condition rather than OCD. The study discovered that the delta band was lower in individuals with OCD compared to HC, and a resting-state magnetoencephalography (MEG) research observed diminished linkage in the delta and theta bands within the OCD crew when contrasted to HC. A recent EEG study indicated that OCD is associated with impairment in the Salience Network and a failure of the Default Mode Network to deactivate. Impaired functional connectivity between these brain regions may contribute to inadequate interactions between networks, leading to clinical symptoms of self-control and attention deficits observed in OCD [23].

The EEG comparisons in OCD highlighted distinctive patterns of brain activity and functional connectivity, with heightened rhythmic strength in delta and theta frequency bands among individuals with OCD compared to healthy controls. This observation aligns with previous studies, indicating potential excessive activation of brain generators, particularly in the fronto-temporal region, which may contribute to difficulties transitioning to the default "rest" network and impaired functional connectivity within key brain networks such as the Salience Network and Default Mode Network. Understanding these neural mechanisms is crucial for developing novel treatment approaches, underscoring the necessity for further research to fully comprehend the complexities of brain activity and functional connectivity in OCD.

Research on OCD patients plays a pivotal role in advancing understanding and improving outcomes for individuals with OCD. By studying genetic, environmental, and neurobiological influences, valuable insights into underlying mechanisms can inform personalized treatment approaches and lead to more holistic care. Furthermore, investigating the impacts of stressful life events on OCD onset underscores the importance of addressing stress and trauma in mental health research and treatment.

In terms of treatment approaches, cognitive-behavioral therapy (CBT) and selective serotonin reuptake inhibitors (SSRIs) stand out as common interventions, with newer approaches like neurofeedback showing promise as supplemental strategies. However, additional research is necessary to ascertain their efficacy fully. Understanding distinct brain activity patterns and impaired functional connectivity in OCD patients is essential, particularly regarding the association with self-control and attention deficits.

The major findings of the review on OCD treatments emphasize the significance of evidence-based approaches, highlighting the effectiveness of treatments like CBT, SSRIs, and the potential of neurofeedback in managing OCD symptoms. Notably, CBT has been shown to effectively reduce obsessive thoughts and compulsive behaviors, while SSRIs are considered the primary pharmacotherapy for OCD, with serotonin dysregulation playing a role in OCD symptoms.

4. Conclusions

In conclusion, research on OCD patients is crucial for identifying underlying causes, symptoms, and treatment options, ultimately enhancing outcomes for individuals with OCD. Through comprehensive investigations into brain activity, functional connectivity, and treatment approaches, researchers can develop more effective therapies tailored to the unique needs of OCD patients, thereby improving their quality of life.

The general purpose of research on OCD patients is to better understand the nature of this mental health disorder and its impact on individuals. Researchers seek to uncover the underlying causes of OCD, including genetic, environmental, and biological factors, in order to develop more effective treatments

and interventions. By studying OCD patients, researchers aim to identify patterns, triggers, and comorbidities associated with the disorder, as well as explore how it manifests in different populations and demographics.

Furthermore, research on OCD patients also aims to enhance the quality of care and support available to individuals struggling with this disorder. By gaining a deeper understanding of the challenges and experiences faced by OCD patients, researchers can inform the development of targeted therapies, medications, and support services that are tailored to their specific needs. Through ongoing research, the ultimate goal is to improve outcomes for OCD patients, reduce stigma associated with the disorder, and enhance the overall well-being and quality of life for those affected by OCD.

As mentioned formerly, OCD is a complex and crippling disorder. Many factors can contribute in the development of one's OCD such as traumatic events or exposure to contaminants. OCD will get stronger and more chronic by acting on the obsessions thus reinforcing the vicious cycle. OCD's impacts on the person’s life might be life wrecking if not addressed adequately, as it could lead to a reduced quality of life and great distress. While there are treatments for OCD but finding the right one is often a challenge and some might not work for an individual. Acceptance and the pursuit of coping strategies and treatments are crucial on finding a balanced and healthy life free of OCD's grasp.

There are several successful treatments for OCD, most of which involve medication, primarily selective serotonin reuptake inhibitors (SSRIs), and cognitive-behavioral therapy (CBT), especially when combined with exposure and response prevention (ERP). Although SSRIs work by controlling serotonin, CBT focuses on reshaping the patient's response to obsessive thoughts. Although further research is needed, neurofeedback also seems promising as a supplemental strategy for reducing OCD symptoms through brain activity modulation. Therefore, while many people find success with conventional therapy like CBT and SSRIs, newer approaches like neurofeedback provide even more promise, particularly for patients who do not fully respond to conventional therapies.

The comparison between individuals with Obsessive-Compulsive Disorder (OCD) and healthy controls (HC) revealed distinct patterns of brain activity and functional connectivity. The analysis demonstrated heightened rhythmic strength in the delta and theta frequency bands within the fronto-temporal and parietal brain segments in the OCD group compared to the HC group. This finding aligns with previous studies reporting increased delta and theta power in individuals with OCD in similar brain areas. The observed increase in slow-wave activity, particularly in the fronto-temporal region, suggests potential excessive activation of generators the brain activity and functioning of individuals with OCD. (Figure 4).

The observed increase in slow-wave activity, particularly in the fronto-temporal region, suggests potential excessive activation of generators responsible for producing delayed brain waves. This may indicate a pathological overactivation of the frontal control network, leading to difficulties in transitioning to the default "rest" network. Additionally, impaired functional connectivity between brain regions, specifically within the Salience Network and Default Mode Network, may contribute to the self-control and attention deficits observed in OCD.

The findings support the notion of altered brain oscillatory activity and functional connectivity in OCD, emphasizing the importance of understanding these neural mechanisms in the disorder. Future research should further explore the underlying mechanisms and their relationship to clinical symptoms, potentially shedding light on novel treatment approaches for OCD.

It should be noted that further investigations are needed to fully comprehend the complexities of brain activity and functional connectivity in OCD. Nonetheless, these findings contribute to our understanding of the neural correlates of OCD and provide valuable insights for future research and therapeutic interventions.

In conclusion, OCD is a complex and debilitating disorder that can significantly impact a person's life, causing distress and reducing their quality of life. In some cases, individuals with OCD may also engage in certain rituals or compulsions before bedtime, which can further prolong the time it takes to fall asleep. This can result in sleep deprivation and overall poorer sleep quality [24].

In addition, OCD patients experience the increased state of alertness and activation of the sympathetic nervous system during sleep. The hyperarousal during sleep can be attributed to the intrusive thoughts, obsessive worrying, and heightened anxiety that are often present in this population. These symptoms can lead to increased physiological arousal and heightened emotional reactivity, which in turn can interfere with the process of falling and staying asleep [25]. Treatment options for hyperarousal in OCD patients may include cognitive-behavioral therapy, relaxation techniques, mindfulness practices, and medications to

improve sleep quality and reduce anxiety. It is recommended that individuals with OCD consult with a mental health professional to determine the most appropriate treatment plan for their specific needs.

It is recommended to analyses the daytime brain map for patients with OCD. It is to assess and monitor the brain activity and functioning of individuals with OCD. This can help in understanding the neural mechanisms underlying OCD symptoms and behaviors, and can provide valuable information for treatment planning and intervention strategies. By mapping the brain activity during different tasks and activities throughout the day, healthcare providers can gain insights into brain and how it can be managed effectively [26]. While treatments like medication SSRIs and CBT with exposure and ERP are available, finding the right approach can be challenging. Neurofeedback shows promise as a supplemental strategy for individuals who don't respond to conventional therapies. Research has revealed distinct patterns of brain activity and impaired functional connectivity in individuals with OCD, highlighting the importance of understanding these neural mechanisms for future treatment development.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Author's contributions

Conceptualization and Supervision: Ali Ghermezian; Methodology: Dorsa Abbasi; Data collection: Alireza Karimi; Investigation, Writing – original draft, and Writing – review & editing: All authors

Conflict of interest

The authors declare no competing interests.

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