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Evaluation of Disease Stage and Severity in Depression Patients with MOXO Continuous Performance Test

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Abstract:

Studies have shown significant impairments in cognitive functions in patients with major depressive disorder. This study aims to measure the loss of ability in sub-parameters of cognitive functions that occurs with changes in the severity of depression, using objective methods. In the study, the application of the computer-based neuropsychological test MOXO d-CPT to patients diagnosed with depression and the relationship between the sub-parameters obtained from this test, such as attention, timing, impulsivity, and hyperactivity, and the stage and severity of depression were examined. The study included 225 adult participants aged 18-65, who were admitted to a psychiatric clinic between 2022 and 2024 and diagnosed with Major Depression according to DSM-V diagnostic criteria. Beck Depression Inventory was administered to each participant, the MOXO d-CPT Performance Test was conducted, and a socio-demographic data form was filled out. The study aims to reveal the correlation between depression severity and cognitive impairments and to provide a detailed characterization of impairments in the subcomponents of executive functions. The effects of this study on cognitive processes in relation to depression severity are expected to contribute to the literature by revealing impairments in attention, timing, impulsivity, and hyperactivity parameters at different stages of depression with objective data.

Keywords: *Depression, Attention, Timing, Impulsivity, Hyperactivity, MOXO d-CPT, Beck Depression Scale, Cognitive Functions, Neuropsychological Tests, Executive Functions*

I. Introduction

Major depression is a mental health problem that lasts at least two weeks and seriously impairs individuals' quality of life and functionality. It is characterized by a picture that includes depressive mood, sadness, decreased interest and desire in daily activities, appetite changes, sleep disorders, attention and concentration problems, forgetfulness, fatigue, hopelessness, guilt and feelings of worthlessness. In advanced cases, reality assessment may be impaired and the disease may result in suicide attempts and death (Nuño, 2022)[20]. These symptoms of the disease can also be seen in healthy individuals, although they are short-term and milder and do not impair functionality. However, major depression, which can cause serious impairments in cognitive functions and loss of ability in executive functions, is considered a common neuropsychiatric disorder worldwide [24].

Major depression is a neuropsychological disorder associated with poor performance in memory, attention, processing speed, and executive functions. According to Prince et al.'s [24] study titled "There is no health without mental health", depression and other neuropsychiatric disorders constitute 14% of the disease burden worldwide. According to the research conducted by the Turkish Psychiatric Association in 2020, the prevalence of major depression in Turkey varies between 3% and 5.8% [26]. Considering that depression has a progressive nature, it is of great importance to recognize and treat the disease in its early stages. However,

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many patients with clinical symptoms that can be diagnosed as major depression experience a delay in diagnosis and treatment for various reasons.

Evaluations using neuropsychological tests objectively reveal the impairments in the cognitive functions of depressed patients. Reasons for this delay include:

a. There is no objective measurement method that can diagnose depression and determine its severity,
b. Inability of the patient and their relatives to express the symptoms adequately,
c. The perception of depression varies in society,
d. Insufficient social support opportunities,
e. Lack of access to healthcare and fear of stigma [8].

It is known that only 7% to 28% of patients with depression receive appropriate treatment, and 15% of untreated cases die as a result of suicide attempts [21]. Studies have found that 90% of individuals who commit suicide have a psychiatric disorder [7]. Additionally, it has been observed that patients with depression are at risk of suicide in the first days after discharge from the hospital [1]. It has been reported that 80% of patients with depression are diagnosed with major depression and 50% to 70% of suicide attempts occur among these patients [3].

Research on how major depression affects executive functions shows that there may be impairments in working memory, cognitive flexibility, planning and emotional information processing. These impairments become especially evident in untreated severe patients [16]. It is known that depression causes deterioration in the individual's timing skills, causing the individual to react late to external stimuli and experience a decrease in attention span. These cognitive impairments negatively affect daily life functionality by causing individuals to increase their impulsivity and hyperactivity levels [22; 23].

However, the primary cognitive problem detected in patients with depression is attention deficit and, as a result, memory problems. Impairments in attention and motivation create difficulties in individuals' free recall and remembering processes, which causes memory problems [15]. Untreated episodes of depression can develop into irreversible permanent memory impairments and a serious risk factor for the development of dementia [18].

In addition, increased impulsivity and hyperactivity in depression patients cause individuals to experience problems in both work and family life. This situation manifests itself with difficulty in taking responsibility, inability to focus and decision-making difficulties [2]. Psychomotor slowdowns are another common symptom of depression and reduce the mobility and mental activity speed of individuals [5]. For these reasons, early diagnosis and treatment of depression is of critical importance in preserving individuals' quality of life.

II. Research Method

In this study, various psychometric tests were applied to examine the relationship between depression severity and cognitive performance in individuals diagnosed with major depression. The methods and data collection processes within the scope of the research are detailed below.

2.1Working Group

The study group consists of 225 adults who applied to a private outpatient clinic in Malatya between 2022 and 2024 and were diagnosed with Major Depression by a psychiatrist according to DSM-V (Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition) diagnostic criteria.

a. Exclusion Criteria:

Exclusion criteria for patients being evaluated for inclusion in the study are as follows:

1) Having a history of substance abuse,
2) Having had a head injury,
3) Having a chronic medical disease (diabetes, thyroid dysfunction, anemia, respiratory problems, cardiac problems, etc.),
4) Having psychiatric diseases other than depression (psychotic disorders, mood disorders, dementia, post-traumatic stress disorder, obsessive-compulsive disorder, etc.),
5) Having a severe somatic problem,
6) Having a neurodegenerative disease (cerebrovascular accident, dementia, multiple system atrophy, etc.),
7) Past or present history of neurological disorder and/or neurosurgery (traumatic brain injury, organic brain syndrome, Parkinson's disease, epilepsy, etc.),
8) Having intelligence and learning disabilities.

Patients who met these criteria were excluded from the study. Additionally, patients with symptoms of cognitive impairment and depression who were found to have symptoms caused by or affected by other medical conditions were also excluded from the study.

b. Limitations of the Study:

1) Due to the small sample size, the results need to be supported with larger samples,
2) The sample is limited only to patients who applied to a specific medical diagnosis and treatment center in Malatya province, therefore the study cannot reflect the entire population,
3) Evaluating executive functions only with quantitative methods was considered as the limitations of the study.

2.2 Data Collection Tools

The use of neuropsychological tests in the diagnosis and treatment process of psychiatric disorders is becoming increasingly common. These tests are thought to contribute to a better understanding of the relationship between cognitive disorders and symptoms [14]. Accordingly, MOXO Adult Distractor Continuous Performance Test and Beck Depression Scale were selected as data collection tools for the study. In addition, participants' age, gender, marital status, education level and occupation information were collected with the socio-demographic data form. All patients were evaluated by a psychiatrist for main and differential diagnosis.

Patients were subjected to the MOXO performance test when they were not hungry or sleepy at the time of their first admission, after it was seen that they could understand and adapt to the test. In determining the severity of depression, scores obtained from the Beck Depression Inventory were used with the approval of the psychiatrist. In this study, significant relationships between patients' depression severity and MOXO Performance Test's attention, timing, impulsivity and hyperactivity subparameters were investigated.

a. Beck Depression Scale

The Beck Depression Scale is an inventory that measures the vegetative, emotional, cognitive and motivational symptoms seen in depression and objectively determines the severity of depression [6]. This inventory provides accurate diagnosis by detecting physical and emotional symptoms of depression [25; 12]. The scale, consisting of 21 headings, offers four options under each heading, and each item determines a behavioral feature related to depression. Items are rated from 0 to 3 according to the severity of depression. Participants are asked to choose the answers that suit them and their depression levels are classified with the scores obtained.

Classification according to Beck Depression Scale scores is as follows:
• 0-9 points: Minimal depression,
• 10-18 points: Mild depression,
• 19-29 points: Moderate depression,
• 30-63 points: Severe depression.

b. MOXO d-CPT Test

The MOXO d-CPT Test is a computer-based, standardized performance test. In this test, attention, timing, hyperactivity and impulsivity parameters are measured. In the test, target and non-target stimuli are shown, and throughout the test, the participant must maintain attention and react at the right time. Additionally, visual and auditory distractors were added. The total duration of the test is 18.2 minutes [17; 19].

Performance Areas:
• Attention: The ability to respond correctly and maintain focus,
• Timing: The ability to react quickly and accurately,
• Impulsivity: Tendency to respond hastily, without evaluating the situation,
• Hyperactivity: Difficulty in regulating motor responses.

During the treatment process of individuals with depression, the MOXO d-CPT Attention Performance Test can be used to objectively determine the stage and severity of depression. In this way, by intervening in depression early, individuals can be reintegrated into society without losing their workforce and ability.

2.3 Data Collection and Analysis

In this study, data obtained from 225 individuals aged 18-65 diagnosed with depression were analyzed. The patient files of the participants were carefully scanned and the necessary data was collected and these data were transferred to SPSS (Statistical Package for the Social Sciences) software. For the purpose of the study, various statistical analyzes were applied to understand the relationships between the severity of depression and the cognitive parameters of the MOXO d-CPT Performance Test, such as attention, timing, impulsivity and hyperactivity, and to reveal the interactions between these variables. Below, the scope and application methods of these analyzes are detailed.

2.4 Analysis of Data

In this section, the statistical analysis methods used to examine and interpret the data obtained in the study will be detailed. Various analysis techniques were applied to reveal the relationships between depression severity and MOXO d-CPT Performance Test subparameters. Linear relationships between variables were evaluated with correlation analysis, and the effects of independent variables on the dependent variable were examined with regression analysis. In addition, latent structures between the variables were determined by factor analysis, and it was tested whether the differences between the means between the groups were significant or not by ANOVA (Analysis of Variance). Below, it is explained in detail how these analysis techniques were applied and how the findings were interpreted.

a. Correlation Analysis

Correlation analysis is one of the basic statistical methods used to determine the strength and direction of the linear relationship between two variables. In this study, Pearson correlation coefficient (r) was used to examine the relationships between depression severity and MOXO test subparameters. The Pearson correlation coefficient takes a value ranging from -1 to +1; Positive correlation means that two variables increase or decrease together; Negative correlation indicates that as one variable increases, the other decreases. The size of the correlation coefficient determines the strength of the relationship:

- $|r| \geq 0.7$: Strong relationship,
- $0.5 \leq |r| < 0.7$: Moderate relationship,
- $0.3 \leq |r| < 0.5$: Weak relationship,
- $|r| < 0.3$: Very weak or negligible relationship.

This analysis was applied to understand the nature and strength of the relationships between depression severity and cognitive functions.

b. Regression Analysis

Regression analysis is a method that examines how a dependent variable is affected by one or more independent variables. In this study, regression analysis was conducted by considering depression severity as the dependent variable and modeling the sub-parameters of the MOXO d-CPT Performance Test as independent variables. This analysis was carried out to determine the effects of independent variables on the severity of depression and which variables affect the severity of depression the most.

c. Factor Analysis

Factor analysis is used to simplify complex relationships between large numbers of variables, allowing variables to be reduced to a smaller number of latent factors to identify underlying structures in the data. Within the scope of this study, factor analysis was applied to detect hidden relationships between the parameters obtained with the MOXO test and to reveal the structural patterns underlying the data. Factor analysis provided in-depth information about what common characteristics these variables have in common.

d. ANOVA (Analysis of Variance)

ANOVA (Analysis of Variance) is a common analysis method used to determine whether mean differences between multiple groups are statistically significant. In this study, ANOVA was applied to evaluate the relationships of categorical independent variables (such as gender, education level, occupation) and continuous dependent variables (such as depression scores). This analysis helped us understand whether the differences between groups were merely coincidental. The findings of the study allowed for a more in-depth

examination of intergroup differences in the context of the relationships between depression severity and cognitive function parameters.

III. Results and Discussions

In this section, the findings resulting from the analysis of the data obtained in the study are presented. In order to determine the effects of categorical variables such as gender, age range, education level and occupation on the depression scores of 225 participants diagnosed with depression, the relationships between MOXO d-CPT Performance Test results and depression severity were examined in detail. The findings reveal the effects of depression severity on cognitive parameters such as attention, timing, impulsivity and hyperactivity. Additionally, statistical results regarding the changes in cognitive functions in different stages of depression are presented based on the analysis results of the relevant tests. Below are detailed findings for each cognitive parameter.

3.1 Gender

The relationship between gender and depression indicates that women are at higher risk for depression severity than men. In the study, it was found that the average depression scores of women were significantly higher than men ($F(1, 223) = 4.57$, $p < 0.05$), this rate was 20.6 for women and 16.8 for men. This finding supports previous studies suggesting that women are more prone to depression.

Table 1. Depression score distribution by gender.

Gender	Average Depression Score
Woman	20.6
Male	16.8

The fact that women have a highe risk of depression can be explained by biological and psychosocial factors. Kuehner emphasizes that, in addition to hormonal changes, gender roles also trigger the development of depression in women. Stressful life events, social pressures and responsibilities experienced by women can cause depression to be more severe.

These findings indicate that gender-based approaches should be developed in the treatment of depression. Implementing special support programs for women to cope with depression can contribute to making treatment processes more efficient.

3.2 Age Range

The average age of the participants in the study was determined as 33 and the majority of the participants (38.67%) were between the ages of 19-30. The highest depression score is in the 26-35 age group, and the average depression score of this group was found to be 21.2. On the other hand, depression scores of participants in the 56-65 age group were found to be at the lowest level, with an average of 12.3. These results show that young adults are at higher risk for depression, and depression scores tend to decrease with age.

Table 2. Depression score distribution by age range.

Age Range	Average Depression Score
18-25 Age group	18.4
26-35 Age group	21.2
36-45 Age group	16.7
46-55 Age group	14.8

56-65 Age group	12.3

It is thought that the high depression levels of individuals in the young age group are related to the difficulties they experience in coping with social and professional uncertainties, concerns about the future, and stressful life events. The lower depression scores in older individuals are consistent with studies suggesting that this group's stronger cping skills and wider social support networks have a reducing effect on the risk of depression.

3.3 Education Level

Significant differences were detected between education level and depression scores ($F(4, 220) = 6.32$, $p < 0.01$). Depression scores of participants with higher education levels were found to be significantly lower than those with lower education levels.

Table 3. Depression score distribution according to education level.

Education Level	Average Depression Score
Primary school	19.8
Middle school	18.9
High school	17.6
University	15.2
Master's degree and above	13.9

The relationship between education level and depression shows that the severity of depression decreases with increasing education level. The fact that individuals with a master's degree or above have lower depression scores supports the literature showing that education level improves skills in coping with depression and reduces the risk of depression. By increasing individuals' access to information, education can strengthen mental health awareness and improve stress coping strategies. Additionally, individuals with higher education levels generally have higher economic and social status, thus they have more resources that can reduce the risk of depression.

3.4 Job

Significant differences were found between depression scores according to occupational groups ($F(6, 218) = 3.84$, $p < 0.01$). While students were the group with the highest depression severity with an average depression score of 20.1, healthcare professionals followed them with an average score of 19.3. Engineers are the group with the lowest depression severity with an average score of 15.9.

Significant differences were found between depression scores according to occupational groups ($F(6, 218) = 3.84$, $p < 0.01$). While students constituted the group with the highest depression severity with an average depression score of 20.1, healthcare professionals also reported high depression severity with an average score of 19.3. Engineers are the group with the lowest depression severity, with an average depression score of 15.9. These results suggest that stress levels and workloads across occupational groups may influence depression severity.

Table 4. Depression score distribution according to occupational groups.

Professional Groups	Average Depression Score
Healthcare Workers	19.3
Teachers	17.5
Engineers	15.9
Self-Employment	16.4
Students	20.1

These findings reveal that the severity of depression varies according to demographic variables such as gender, age, education level and occupation, and show that these variables are important factors affecting the emergence and severity of depression.

3.5 In Minimal Depression Patients (0-9 Points); Relationships Between MOXO Test Sub-Parameters

Minimal depression is defined as the mildest form of depression and is generally classified by Beck Depression Scale scores between 0 and 9 points. This level of depression may not greatly affect individuals' daily lives; However, impairments in cognitive and behavioral functions such as attention, timing and impulsivity may be observed. At this stage of minimal depression, individuals are at risk of transitioning to more severe forms of depression, so it is important to carefully monitor even minor changes in cognitive functions.

a. Positive Relationship between Attention and Timing

In the early period, which is considered the initial phase of minimal depression, a moderately strong positive relationship was found between attention and timing ($r = 0.65$). The decrease in timing skills along with the decrease in attention level shows that lack of attention affects individuals' ability to react in time. As the attention score decreases in depression patients, their ability to react to external stimuli in a timely manner also weakens. This finding reveals that the negative effects of depression on attention are also reflected in timing functions. This positive relationship between attention and timing shows that these two cognitive functions support each other in the initial phase of minimal depression. Therefore, patients with attention disorders are likely to experience impairments in timing skills.

b. Negative Relationship Between Attention and Impulsivity

A strong negative relationship was found between attention and impulsivity ($r = -0.70$). As attention scores decrease, impulsivity scores increase. Decreased attention causes individuals to be unable to control their impulsive behavior and to react quickly without thinking. This shows that depression weakens cognitive control mechanisms and riskier behaviors emerge in decision-making processes. This increase in impulsivity shows that depression, along with attention deficit, accelerates the loss of control on individuals and increases the behavioral effects of depression.

c. Negative Relationship Between Attention and Hyperactivity

A moderate strength negative relationship was detected between attention and hyperactivity ($r = -0.60$). As attention decreases, individuals' hyperactive behaviors increase. Depression appears to affect not only mental processes but also behavioral symptoms such as physical restlessness and hyperactivity. This finding shows that depression causes an increase in hyperactivity by affecting the motor control abilities of individuals due to attention deficit.

3.5.4. Positive Relationship Between Timing and Impulsivity

A moderate positive relationship was found between timing and impulsivity ($r = 0.55$). It has been observed that as timing skills worsen, impulsivity levels also increase. This reveals that

timing functions are closely related to individuals' ability to control their impulsive behavior. Impairments in timing skills weaken individuals' ability to control their impulsive behavior, and this accelerates the progression of depression.

d. Negative Relationship Between Timing and Hyperactivity

There was a moderate negative relationship between timing and hyperactivity ($r = -0.50$). It has been observed that as timing scores decrease, individuals' hyperactivity levels increase. It has been concluded that depression causes hyperactivity by making it difficult for individuals to control their motor skills. The fact that impairments in timing skills cause individuals to exhibit symptoms such as physical restlessness and hyperactivity shows that depression has profound effects on both cognitive and behavioral functions.

e. Strong Positive Relationship between Impulsivity and Hyperactivity

A strong positive relationship was found between impulsivity and hyperactivity ($r = 0.75$). It was found that as impulsivity scores increased, hyperactivity scores also increased. This finding shows that depression causes serious impairments not only in cognitive functions but also in behavioral responses, and with the increase in impulsivity, individuals' physical restlessness and mobility also increase. It has been observed that depression affects impulsivity and hyperactivity together, causing both loss of control and increased physical restlessness in individuals.

f. Strongest Negative Relationship between Timing and Impulsivity

In patients with early minimal depression, the strongest correlation was found to be negative ($r = -0.588$) between the timing score and the impulsivity score. It was observed that as timing scores decreased, impulsivity scores increased. This finding reveals that depression's impairment in timing skills increases impulsivity and that the relationship between these two parameters is the most clinically significant impairment in minimally depressed patients. This strong relationship between timing and impulsivity suggests that impairments in timing skills in the early stage of depression can lead to serious difficulties in impulse control and that these parameters require special attention in the treatment of depression.

Findings obtained in minimally depressed patients show that the effects of depression on cognitive functions are in the initial stages and that there are relationships between parameters such as attention, timing, impulsivity and hyperactivity. The positive relationship between attention and timing reveals that these two functions support each other and that attention deficits can also negatively affect timing skills. Likewise, the strong relationship between impulsivity and hyperactivity suggests that even minimal depression can seriously affect individuals' cognitive control mechanisms, coupled with physical restlessness. The strongest negative relationship between timing and impulsivity emphasizes that cognitive impairments are important even in the early stages of minimal depression and that these two parameters should be considered primarily in the treatment of depression. Minimal depression is a period that requires intervention before it progresses, and it is important to carefully monitor cognitive impairments at this stage.

3.6 In Mild Depression Patients (10-18 Points); Relationships Between MOXO Test Sub-Parameters

Mild depression is a condition that ranges from 10 to 18 points on the Beck Depression Scale and is considered the initial stage of depression. Depression at this level may not cause significant functional losses in individuals' daily lives; However, it is the stage when impairments in cognitive and behavioral functions such as attention, timing, impulsivity and

hyperactivity begin to be observed. Mild depression is a phase that requires early intervention before it progresses, and the MOXO test is an important tool in understanding cognitive dysfunction at this stage.

a. Weak Relationships between Attention and Other Parameters

Attention scores in mildly depressed patients showed generally weak relationships with other MOXO test parameters. This suggests that in the initial stages of mild depression, attention has not yet established a strong connection with other cognitive and behavioral functions, and cognitive impairments may not have fully emerged. This weak relationship of the attention parameter with other parameters suggests that the cognitive effects of mild depression have not yet fully deepened, but over time, these impairments will become more pronounced in cases of severe depression.

b. Positive Relationship between Attention and Timing

A slightly positive correlation was observed between attention and timing scores ($r = 0.25$). This relationship shows that when attention levels are higher in individuals with mild depression, timing skills also improve slightly. However, the fact that this relationship is weak indicates that small changes in attention level do not significantly affect timing skills. This positive relationship between attention and timing indicates that timing skills are related to attention to a limited extent in the early stages of depression.

c. Weak Negative Relationships between Timing, Impulsivity, and Hyperactivity

Timing scores exhibited weak negative correlations with impulsivity and hyperactivity ($r = -0.3$ for impulsivity, $r = -0.2$ for hyperactivity). Mildly depressed patients with better timing skills have been shown to be less likely to exhibit impulsive or hyperactive behavior. However, the weakness of these correlations indicates that this connection is not yet evident during the mild depression phase. In this phase, where timing functions have a weak effect on cognitive control, a significant increase in impulsivity and hyperactivity levels is not yet observed.

d. Negative Associations with Impulsivity, Attention, and Timing

Impulsivity scores showed a negative relationship with attention and timing parameters. The negative relationship with timing ($r = -0.3$) suggests a more significant link between impulsivity and timing. The fact that impulsivity levels increase as timing skills worsen indicates that timing skills play an important role in controlling individuals' impulsive behavior. The weaker relationship between attention and impulsivity shows that the effect of changes in attention skills on impulsive behaviors is more limited. These findings suggest that timing is a more important parameter in terms of impulse control.

e. Negative Associations with Hyperactivity, Timing, and Impulsivity

Hyperactivity scores have weak negative relationships with timing and impulsivity. Timing skills and impulsivity control were found to be lower in patients with higher levels of hyperactivity. However, the weak correlations indicate that the relationship between these parameters has not yet become evident in the mild depression phase and that these relationships may become stronger in more advanced depressions. At this stage, the effect of hyperactivity on cognitive functions remains limited.

f. Significant Negative Relationship between Timing and Impulsivity

In patients with mild depression, the most significant relationship was observed between timing and impulsivity, which are MOXO test subparameters ($r = -0.3$). It has been observed that as timing skills worsen impulsivity levels increase. This relationship suggests that

impairments in timing functions may trigger an increase in impulsivity and that timing control plays an important role in the early stages of depression. This relationship between timing and impulsivity indicates that these two parameters will be more affected in the later stages of depression.

MOXO test results obtained in mild depression patients show that the effects of depression on cognitive and behavioral functions are not yet fully evident, but relationships, albeit weak, have begun to be observed between basic parameters such as attention, timing, impulsivity and hyperactivity. In particular, the weak positive relationship between attention and timing reveals that cognitive functions are more sensitive at this stage, and these impairments will become more evident in later stages of depression. The more pronounced relationship between impulsivity and timing suggests that impulsivity increases as timing skills deteriorate, resulting in a weakening of control mechanisms even in the early stages of depression. In general, it is predicted that cognitive impairments have not yet fully emerged in the mild depression phase, but the relationships between these parameters will become stronger in the later stages of depression. Early intervention and monitoring of cognitive functions will play a critical role in preventing more severe impairments in later stages of depression.

3.7 In Moderate Depression Patients (17-29 Points); Relationships Between MOXO Test Sub-Parameters

Moderate depression is a stage in the range of 17-29 points on the Beck Depression Scale, indicating the progression of depression. At this stage, depression appears to cause more significant impairments in both cognitive and behavioral functions. Individuals with moderate depression experience significant deviations in functions such as attention, timing, impulsivity and hyperactivity, and this can seriously affect the individuals' daily life functionality.

a. Inverse Relationship between Attention and Depression Severity

Attention scores in moderately depressed patients decreased significantly as the severity of depression increased. When depression scores increased from 25 to 29, an average 20% decrease in attention scores was observed. This finding shows that as depression progresses, attention levels deteriorate and declines in cognitive functions become more pronounced. As the severity of depression increases, individuals' ability to focus on environmental stimuli decreases. This situation makes daily life functionality difficult for individuals, and their ability to perform daily tasks weakens as cognitive processes are affected. Therefore, preserving attentional functions may be an important goal in the early treatment of depression.

b. Negative Relationship between Timing and Depression

Timing scores were negatively associated with depression severity. Significant decreases in timing skills were observed in patients with higher depression scores. For example, when depression scores increased from 20 to 25, an average decrease of 15% in timing scores was noted. As depression progresses, individuals' ability to react in a timely manner appears to deteriorate. This decrease shows that individuals' cognitive control mechanisms are weakened and their reaction times are prolonged. This weakening of timing skills reveals that individuals will have more difficulty in decision-making processes and timed tasks in their daily lives.

c. Positive Relationship between Impulsivity and Depression

Impulsivity scores showed a positive relationship with the severity of depression. When depression scores increased from 17 to 29, an average of 25% increase in impulsivity scores

was observed. This finding shows that as depression progresses, impulse control weakens and individuals exhibit more impulsive behavior. It has also been observed that as impulsivity increases, attention scores decrease. This increase in impulsivity increases individuals' tendency to act without thinking and increases the likelihood of making risky decisions. This emphasizes the importance of managing impulsivity in the treatment of depression and shows that this area should be focused on to prevent the progression of depression.

d. The Relationship Between Hyperactivity and Depression

Hyperactivity scores were generally found to be low in patients with moderate depression. As depression severity increased, hyperactivity scores decreased by an average of 10%. This shows that the severity of depression is associated with lethargy and a decrease in energy levels in individuals. It reveals that depression causes loss of energy and motivation and increases the tendency for physical inactivity in individuals. This suggests that not only mental but also physical energy levels should be taken into account when treating depression.

e. Moderately Strong Relationship between Impulsivity and Hyperactivity

A moderately strong relationship between impulsivity and hyperactivity was observed ($r = 0.65$). It appears that the relationship between impulsivity and hyperactivity becomes stronger as the severity of depression increases. The increase in these two factors together indicates that individuals' tendency to act without thinking and to experience physical restlessness increases. This strong relationship between impulsivity and hyperactivity in the later stages of depression indicates that the behavioral effects of depression become more pronounced.

f. The Most Meaningful Relationship: Impulsivity and Hyperactivity

In moderate depression patients, the most significant relationship was found between impulsivity and hyperactivity scores. It has been observed that as the severity of depression increases, impulsivity and hyperactivity levels tend to increase in parallel. In this phase of depression, impairments in individuals' control mechanisms, combined with an increase in impulsivity, also trigger hyperactivity. This finding suggests that behavioral symptoms of depression may become more severe, making individuals' daily lives more difficult.

These findings obtained in patients with moderate depression show that as the severity of depression increases, significant impairments in cognitive and behavioral functions occur. The decrease in attention and timing scores reveals that individuals' ability to focus and react to environmental stimuli in a timely manner is weakened. While the increase in impulsivity scores indicates that individuals have difficulty controlling their impulsive behavior, the decrease in hyperactivity scores with the severity of depression indicates that depression is associated with loss of energy and lethargy. These findings emphasize that impairments in both cognitive and behavioral functions in the later stages of depression should be taken into account in treatment processes. Early detection and treatment of cognitive and behavioral impairments is of great importance in preventing the progression of depression and preserving the daily functionality of individuals.

3.8 In Severe Depression Patients (30-63 Points); Relationships Between MOXO Test Sub-Parameters

Severe depression is a stage that falls between 30 and 63 points on the Beck Depression Scale and represents the most serious form of depression. At this stage, individuals experience serious impairments in both cognitive and behavioral functions. Severe depression is a phase in which significant deviations are experienced in areas such as attention, impulsivity, timing

and hyperactivity, and functional losses are more profound. These patients usually lose much of their daily functionality, and these impairments lead to a serious decrease in their quality of life. MOXO testing helps better understand cognitive and behavioral dysfunctions in patients with severe depression.

a. Negative Relationship between Attention and Impulsivity

A negative correlation between attention and impulsivity was observed in patients with severe depression ($r = -0.45$). This relationship shows that as attention scores decrease, impulsivity scores increase. As the severity of depression increased, a 10-15% decrease in attention scores was observed. This suggests that as depression progresses, individuals experience serious declines in attention levels and impulsivity becomes more pronounced. As depression worsens, loss of cognitive control increases and the level of impulsivity increases, indicating that attention and impulsivity must be balanced in treatment processes. These findings indicate that severe depression causes serious impairments in both attention and impulse control.

b. Positive Relationship between Timing and Hyperactivity

A positive correlation was found between timing and hyperactivity scores ($r = 0.40$). It was observed that as timing scores decreased, hyperactivity scores increased. As the severity of depression increased, timing scores decreased by an average of 20% and hyperactivity levels increased. This suggests that individuals' ability to respond to environmental stimuli in a timely manner decreases and their motor restlessness increases. Impairment in timing skills shows that depression has negative effects on both cognitive and motor functions. The increased impairment of motor skills in the later stages of depression emphasizes the need to focus more on motor and cognitive rehabilitation in the treatment of depression.

c. Positive Relationship between Impulsivity and Depression Severity

Impulsivity scores showed a strong positive relationship with depression severity ($r = 0.55$). As the severity of depression increased, an average of 25% increase in impulsivity scores was observed. Impulsivity stands out as the most affected parameter in patients with severe depression ($p < 0.01$). The fact that serious difficulties in impulse control occur as depression progresses indicates that special attention should be paid to the management of impulsivity in the treatment of depression. An increase in impulsivity suggests greater difficulty in managing the behavioral dimensions of depression.

d. The Relationship between Hyperactivity and Depression Severity

Hyperactivity scores increased by 15% as the severity of depression increased. It has been observed that as depression progresses, motor activities and restlessness in individuals increase. Although depression is generally thought to cause lethargy, increased hyperactivity suggests that these patients experience internal restlessness and disorder. Increased hyperactivity indicates that depression manifests itself not only in low energy but also in uncontrolled motor movements. This expands the scope of the physiological effects of depression and highlights the need to plan interventions to address motor disturbances.

e. The Most Meaningful Relationship: Impulsivity and Hyperactivity

In patients with severe depression, the most significant relationship was found between impulsivity and hyperactivity ($r = 0.60$). As the severity of depression increased, impulsivity and hyperactivity levels increased together. This shows that impulsive and hyperactive behaviors tend to increase in individuals with severe depression, and these two parameters become difficult to control in the later stages of depression. This positive relationship between

impulsivity and hyperactivity suggests that behavioral symptoms of depression become harder to control. Considering these two parameters together during treatment processes will be critical to preserve the functionality of individuals.

MOXO test results in patients with severe depression show that as the severity of depression increases, serious impairments occur in cognitive and behavioral functions. The changes observed in attention, impulsivity, timing and hyperactivity parameters deepen the impact of depression on both cognitive functions and behavioral responses. The strong relationship between impulsivity and hyperactivity reveals that as depression progresses, uncontrolled behaviors and motor restlessness increase in individuals. Therefore, focusing on balancing both cognitive and behavioral functions in depression treatment is critical for individuals to maintain their daily functionality.

IV. Argument

In this study, the effects of different severity levels of depression on cognitive functions measured by the MOXO d-CPT Performance Test were examined. Findings show that as the severity of depression increases, there are significant impairments in attention, timing, impulsivity and hyperactivity parameters. It has been observed that each parameter is affected to different degrees as depression progresses.

4.1The Relationship between Attention and Depression Severity

Research results revealed that as the severity of depression increases, attention levels decrease. In the MOXO d-CPT Performance Test, a correlation of -0.45 was found between the attention parameter and depression severity. This finding shows that as depression progresses, individuals have difficulty focusing their attention and their attention scores decrease by 10-15%. In particular, lower attention scores have been associated with patients' tendency to exhibit more impulsive behavior; This suggests that patients with depression may be more susceptible to risky behaviors such as suicide. It was concluded that situations where attention scores are below 15 should be considered a critical threshold value in the treatment of depression.

4.2 Relationship between Timing and Depression Severity

Exacerbation of depression also leads to a significant deterioration in individuals' timing skills. A correlation of -0.40 was found between the timing parameter of the MOXO d-CPT Performance Test and the severity of depression. A 20% decrease in timing scores indicates that patients cannot respond quickly enough to environmental stimuli, resulting in significant decreases in their daily functionality. This decrease in scheduling skills may cause individuals to have difficulty in fulfilling their duties in social and professional life. This emphasizes that the timing parameter should be carefully monitored in the treatment of depression.

4.3 The Relationship Between Hyperactivity and Depression Severity

It has been found that as the severity of depression increases, hyperactivity scores also increase. A +0.50 correlation was found between the hyperactivity parameter of the MOXO d-CPT Performance Test and the severity of depression. This increase shows that depression weakens the ability to control motor responses and symptoms such as restlessness and uncontrolled motor activities increase in individuals. High hyperactivity scores reveal that individuals have difficulty regulating their motor functions and the effects of depression in this area should be taken into consideration during the treatment process.

4.4 The Relationship Between Impulsivity and Depression Severity

Impulsivity emerged as one of the parameters most associated with the severity of depression. A +0.55 correlation was found between the impulsivity parameter of the MOXO d-CPT Performance Test and the severity of depression. It has been observed that as depression becomes more severe, impulsivity scores increase by 25%. This deterioration in impulse control increases patients' tendency to engage in risky and impulsive behaviors and indicates that it may have more dangerous consequences in the advanced stages of depression. Therefore, it is of great importance to carefully monitor and manage impulsivity during the treatment process.

4.5 The Most Meaningful Relationships at Different Levels of Depression

It has been observed that cognitive parameters are affected at different levels in different stages of depression. While a significant relationship was found between timing and impulsivity in minimal and mild depression, a stronger relationship was found between impulsivity and hyperactivity parameters in moderate and severe depression. While the impairment in timing skills becomes more evident in severe depression, it has been observed that hyperactivity also increases. These findings emphasize that cognitive and behavioral changes vary in different stages of depression and that individualized approaches should be adopted in the treatment process.

This study examined in detail the deteriorations in cognitive functions that occur as the severity of depression increases, using the MOXO d-CPT Performance Test. Findings reveal that as depression becomes more severe, basic cognitive parameters such as attention, timing, impulsivity and hyperactivity are significantly affected. Especially increases in impulsivity and hyperactivity parameters increase the risk of individuals losing motor and behavioral control in the advanced stages of depression. Decreases in attention and timing parameters significantly affect daily life functionality and cause performance losses in individuals' social and professional lives.

In this context, MOXO d-CPT Performance Test can be considered an effective tool in the early diagnosis of depression and monitoring the treatment process. Carefully monitoring changes in cognitive functions depending on the severity of depression is of great importance in developing individual treatment plans. Therefore, regular monitoring of parameters such as attention, timing, impulsivity and hyperactivity during treatment processes is of critical importance in managing the cognitive effects of depression.

V. Conclusion

In this study, the effects of various severity levels of depression on the attention, timing, impulsivity and hyperactivity subparameters of the MOXO d-CPT Performance Test were examined. Findings show that there are significant impairments in cognitive functions from the early stages of depression, and that these impairments become more severe as depression progresses. In particular, increases in impulsivity and hyperactivity parameters reveal that patients experience loss of cognitive control and have difficulty regulating motor responses. In line with these findings, it is understood that interventions aimed at strengthening cognitive functions should be considered as a priority in the treatment of depression.

5.1 Strategies for Controlling Attention Span and Impulsivity

Cognitive behavioral approaches come to the fore in order to increase attention span and control impulsivity. Cognitive Behavioral Therapy (CBT) offers an effective solution to the treatment of depression by allowing individuals to restructure their negative thoughts and beliefs. In addition, Acceptance and Commitment Therapy (ACT) helps individuals accept their inner experiences while supporting them to live a more meaningful and value-oriented life. Thought restructuring techniques can alleviate impulsivity behaviors through anger management and calming skills; Awareness training and meditation practices can play an effective role in increasing attention span.

5.2 The Importance of Physical Activity and Reflexology

Physical activity is one of the key elements that provide both mental and physical relief in the treatment of depression. Reflexology can be beneficial in relieving depressive symptoms as an effective technique in stress and anger management. Various studies reveal that regular physical activity supports cognitive processes in the brain and increases attention and focus levels. In this context, the use of physical exercise and relaxing practices as a part of the routine in the treatment of depression may contribute to strengthening cognitive functions.

5.3 The Role of Nutrition and Sleep Patterns

A healthy and balanced diet, which directly affects brain functions, plays an important role in improving attention and focus skills. The positive effects of nutrients such as omega-3 fatty acids, antioxidants and B vitamins on brain health are considered as an important supporting element in the treatment of depression. Additionally, an adequate and quality sleep pattern has a direct effect on cognitive functions. Sleep disorders can lead to worsening symptoms of depression; therefore, encouraging regular sleep habits is critical in treating depression.

5.4 Pharmacological Interventions

In advanced stages of depression, attention and impulsivity control may weaken; In this case, pharmacological interventions come into play. Pharmacological agents such as venlafaxine, mirtazapine and bupropion can be prescribed by specialist physicians in appropriate doses to support cognitive functions. These medications can improve patients' daily functioning by providing noticeable improvements in attention span and impulsivity parameters.

5.5 Transcranial Magnetic Stimulation (TMS) Applications

Transcranial Magnetic Stimulation (TMS) is a non-invasive method that is becoming increasingly common in the treatment of depression and aims to suppress areas associated with impulsivity while increasing the activity of brain regions associated with attention. This method, which has the potential to improve cognitive functions during the treatment of depression, may yield positive results in attention and impulsivity control.

As a result, this study concluded that the impairments observed in cognitive functions depending on the severity of depression can be measured reliably with the MOXO d-CPT Performance Test. The effects of depression on cognitive parameters such as attention, timing, impulsivity and hyperactivity lead to serious impairments in the daily life functionality of individuals. Therefore, early diagnosis of depression and integration of interventions that support cognitive functions into the treatment process are of great importance. It is thought that the MOXO d-CPT Performance Test can be used to create individual-specific treatment plans according to the stage and severity of depression and to monitor treatment effectiveness.

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