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Evaluation of impairment in fine motor skills in patients with major depressive disorder

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Ethics Committee Approval
This study, which was carried out within the framework of Kırıkkale University Faculty of Medicine, Department of Psychiatry Specialization Program, was accepted as a specialization thesis by the members of the psychiatry department jury and received medical faculty ethics committee approval. Higher Education Institution thesis date and reference number: 2012/351334.
This study was conducted in accordance with the principles of the Declaration of Helsinki, following the approval of the Ethics Committee of the Faculty of Medicine at Kırıkkale University, dated 28th April 2011, and numbered 2011/0052.

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Abstract

Background/Aim: Major Depressive Disorder (MDD) is a prevalent psychiatric condition linked to chronic conditions, suicide and relapse, leading to disability. Fine motor skills (FMS) can potentially provide valuable insights into the suspected psychomotor slowing associated with depression. This experimental, observational study aims to use a fresh paradigm to probe how the slowing of FMS impacts MDD patients, particularly in relation to motor and cognitive processes.

Methods: This study involved 28 patients with MDD and 28 healthy control subjects. We developed the Serial Reaction Time Task (SRTT), Finger Tapping Test (FTT), and Target Hitting Test (THT) to examine the impact on FMS in relation to motor and cognitive processes. The THT incorporates cognitive elements like strategy and action monitoring and assimilates the other two tests. Participants were asked to complete the SRTT, FTT, THT, Beck Depression Inventory (BDI), and Beck Anxiety Inventory (BAI) in two separate sessions.

Results: We found significant differences between the groups across BDI, BAI, FTT, and SRTT data ($P<0.001$ for BDI, BAI, $P=0.019$ for FTT, $P=0.032$ for SRTT). There was also a noticeable difference in THT performance among the groups ($P=0.013$). The disparity between the depression group and the control group was primarily attributed to the THT error score ($P=0.003$). We noted that when BDI and SRTT scores increased, THT target values decreased ($P=0.001$ and $P<0.001$, respectively), but they increased with higher FTT scores ($P<0.001$). The depression group performed worse than the control group on all three computerized tests related to FMS (SRTT, FTT, THT). The poorer performance of patients with depression in THT was mostly due to THT error values. This suggests that these patients may have exerted more effort on motor performance to hit the target, compensating with physical effort rather than applying the necessary cognitive strategy required by the test.

Conclusion: This study's findings indicate that MDD primarily impacts cognitive functions while also impairing FMS.

Keywords: cognitive, depressive, depression, psychomotor, fine motor skills

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Introduction

Major depressive disorder (MDD) is characterized by symptoms such as a depressed mood, diminished interest in activities, slowed thinking, speech, and movement, feelings of worthlessness, negativity, and a decrease in physiological functions [1]. The increased prevalence of depression has branded it a significant health problem worldwide, given its high risk of becoming chronic, recurrent, and leading to suicide, workforce loss, and disability [2,3]. Furthermore, its impact on disability and adverse outcomes emphasizes its importance in diagnostic, treatment, and preventive approaches. Psychomotor retardation, characterized by a slowed-down evaluation of direct behavioral movements such as speaking, facial expressions, eye movements, self-touch, posture, and general motion degrees, is a symptom of depression [1,4]. Various studies examining psychomotor behavior in depression have explored different behavioral clusters using varied methods. It is speculated that observing fine motor skills could reveal the processes behind psychomotor retardation. Research on fine motor skills mainly assesses hand and finger movements, using experimental models to measure cognitive and motor processes both separately [5,6] and collectively [7,8].

While some studies have inferred conclusions without entirely differentiating between motor and cognitive components [7,8], others have attempted interpretations by investigating the relationship between these two distinct elements [9]. However, assessing motor tests alongside a fine motor skills test, which incorporates cognitive processes like strategy and action monitoring, could provide a more accurate insight into the relationship between cognitive and motor processes. Hence, this study aims to scrutinize both cognitive and motor processes separately through the introduction of a novel paradigm system.

Materials and methods

The study involved 28 patients diagnosed with MDD and 28 healthy volunteers. We excluded patients with organic brain syndrome, dementia, mental retardation, and substance addiction. In addition, those with psychotic symptoms, bipolar disorder, obsessive-compulsive disorder, panic disorder, generalized anxiety disorder, somatoform disorder, post-traumatic stress disorder, eating disorders, and personality disorders were not included. Patients with neurological diseases such as epilepsy, Parkinson's disease, and cerebrovascular disease, along with metabolic diseases such as diabetes, thyroid disease, and kidney failure, were also excluded. We did not consider patients using any of the following medications: antidepressants, antipsychotics, anticonvulsants, anxiolytics, hypnotics, sedatives, anticholinergics, antihistamines, steroids, antihypertensives, antiarrhythmics, antidiabetics, or antithyroid drugs. Finally, those who had received electroconvulsive therapy within the last 6 months, as well as pregnant or breastfeeding women, were not included in the study.

In the study, participants provided demographic information and took the Beck Depression Inventory and Beck Anxiety Inventory to assess depression and anxiety levels. They also took three performance tests during the same session: the Finger Tapping Test (FTT), the Serial Reaction Time Test (SRTT), and the Target Hitting Test (THT).

The FTT, a purely motor test used to assess motor performance since the 19th century, involves rapidly pressing the left mouse button over 15 seconds [10]. Reports indicate this test correlates with high intelligence and neuropsychological test scores. Variations of the FTT, such as tapping a table or digital screen or snapping fingers, have been used [6,11–14]. In this study, the FTT score was the number of mouse clicks in 15 seconds.

The SRTT, which has been used extensively in recent studies, measures the participants' response to stimuli on a computer screen. The study varied the stimulus intervals between 1 and 2 seconds, avoiding predictable patterns and focusing participant attention. Participants had to click the mouse button corresponding to the stimulus side as quickly as possible. The test measured attention and visuomotor performance through the accuracy and speed of their responses [15].

The THT combined elements of the FTT and SRTT, requiring participants to monitor and strategize actions. Participants tried to move an on-screen black box as far right as possible by hitting a moving target red cube. Successful hits moved the box right; errors moved it left. The cube's random movements, between four fixed points each second, added difficulty. Thus, the THT measures participants' ability to strategize, monitor their actions, and respond accurately to stimuli.

The test is divided into two sessions of 30 seconds each. It records the total count of errors and target hits in three segments, each lasting 10 seconds. This way, it tracks performance fluctuations throughout the test. This setup reveals how subjects monitor their performance and accordingly devise strategies. Thus, successful test performance leans more on strategic thinking than merely on rapid mouse clicks. To succeed, one must swiftly move the mouse icon to the target point, anticipate the target's next move, and quickly respond when it shifts.

Statistical analysis

First, to determine if THT incorporates cognitive components such as strategy development and action monitoring, we performed an analysis of variance (ANOVA) on the THT error and target values from the control group. Our hypothesis suggested that enhanced test performance would correlate with cognitive functions, implying a significant segment effect. The segments (divided into the first, second, and third 10-second intervals each session) and sessions (first and second 30-second sessions) served as independent variables.

We also examined the possible habituation effect by comparing the total stroke numbers (THT error + THT target hit) in the first and second sessions for the control group using a paired T-test. We calculated the total stroke count for the first and second sessions and used a Student-T-test to assess any discrepancies between the groups.

Right-hand FTT values, BDI, BAI and SRTT scores were separately compared using a Student-T-test. A MANCOVA included right-hand finger tapping and Serial Reaction Time Test values and BDI scores as covariates. THT target high and THT error scores served as dependent variables, while the group (depression and control), session, and segment served as independent variables. If significant findings arose, a post-hoc ANOVA identified the root of those differences (error, target, or both).

SPSS version 21.0 was used for all statistical analyses, with a significance level of α=0.05. We employed post-hoc G*Power analysis to ascertain the study's power and sensitivity to significant variations. With a sample size of 28 for both groups and an effect size of 0.8, the study's actual power was determined to be 83.64%.

Results

Significant differences in BDI (*P*=0.001), BAI (*P*=0.001), FTT (*P*=0.019), and SRTT (*P*=0.032) scores were observed between the groups (Table 1). Likewise, a discrepancy in THT performance was noted between the groups (*P*=0.013). Within and between the sessions, THT scores also varied (*P*<0.001 and *P*=0.003, respectively). The score variance for THT error was a distinctive difference between the depression and control groups (*P*=0.003).

Table 1: The differences between the groups in age, BDI, BAI, FTT and SRTT scores

	Group	n	Mean (SD)	*P*-value
Age	Control	28	27.35 (6.57)	0.687
	Depressive	28	26.67 (5.92)	
BDI	Control	28	5.857 (3.83)	**<0.001**
	Depressive	28	24.25 (6.92)	
BAI	Control	28	5.60 (5.85)	**<0.001**
	Depressive	28	21.78 (10.03)	
FTT	Control	28	80.96 (8.37)	**0.019**
	Depressive	28	74.71 (10.78)	
SRTT	Control	28	28.65 (3.67)	**0.032**
	Depressive	28	32.02 (7.15)	

SD: standard deviation, BDI: Beck Depression Inventory, BAI: Beck Anxiety Inventory, FTT: Finger Tapping Test, SRTT: Serial Reaction Time Task

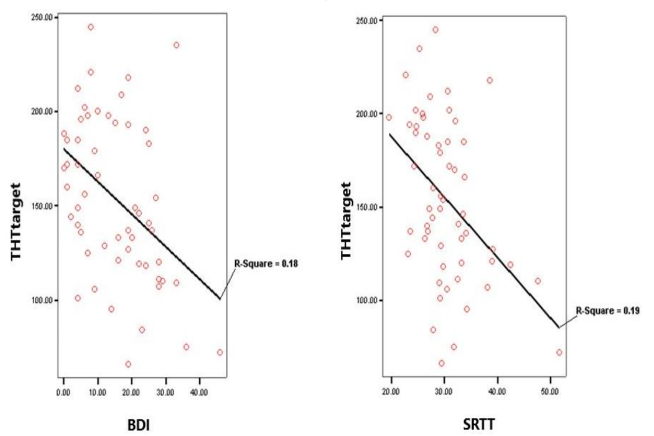
Table 2: The differences between the group in the THTperformance, THTtarget and THTerror values

	Group	Session	Segment
THTperform.	***P*=0.013**	***P*=0.003**	***P*<0.001**
THTtarget	*P*=0.070	***P*=0.001**	***P*<0.001**
THTerror	***P*=0.003**	***P*<0.001**	***P*<0.001**

THTperform: Target Hitting Test perform, THTtarget: Target Hitting Test target, THTerror: Target Hitting Test error

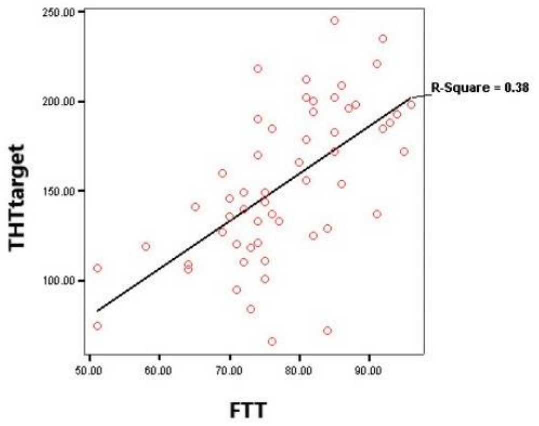
Although THT target values held steady between groups, factors such as the number of sessions and segments affected them (*P*=0.001 and *P*<0.01, respectively), resulting in increased values (Table 2). THT target values also decreased in line with rising BDI (THT1 target *P*=0.001, THT2 target *P*=0.001) and SRTT scores (THT1 target *P*<0.001, THT2 target *P*<0.001). In contrast, these values increased with higher FTT scores (THT1 target *P*<0.001, THT2 target *P*<0.001) (Figures 1 and 2).

Figure 1: The interactions between the THTtarget values and BDI, SRTT scores



THTtarget: Target Hitting Test target, BDI: Beck Depression Inventory, SRTT: Serial Reaction Time Task

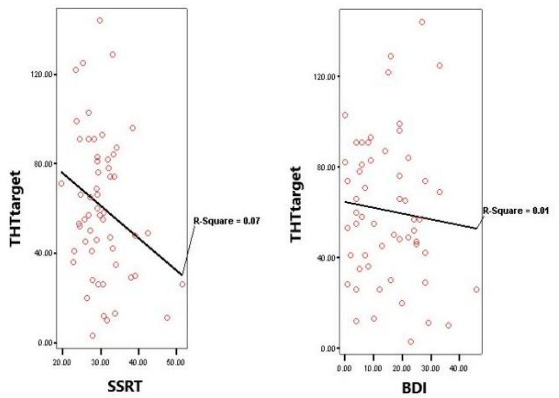
Figure 2: The interaction between the THTtarget values and FTT scores



THTtarget: Target Hitting Test target, FTT: Finger Tapping Test

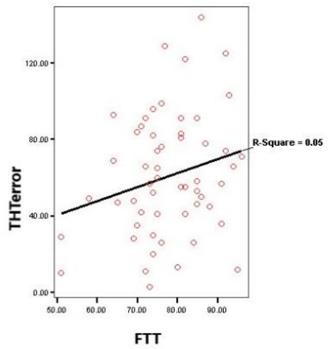
Notably, a significant interaction was identified between THT error scores and BDI (*P*=0.024), FTT (THT1 error *P*=0.033, THT2 error *P*=0.020), and SRTT scores. Concretely, THT1 error was inversely related to SRTT scores (r=-0.390, *P*=0.040). This implies that as THT1 error increases, SRTT scores decrease, and vice versa (Figures 3 and 4).

Figure 3: The interactions between the THTerror values and BDI, SRTT scores



THTtarget: Target Hitting Test target, SRTT: Serial Reaction Time Task, BDI: Beck Depression Inventory

Figure 4: The interactions between the THTerror values and FTT scores



THTerror: Target Hitting Test error, FTT: Finger Tapping Test

Discussion

The current study's findings indicate a considerable decline in fine motor skills among individuals with MDD. In comparison to the control group, the MDD participants performed poorly on all three computerized tests associated with fine motor skills (SRTT, FTT, THT). The deficient performance of the MDD group in the THT test was particularly influenced by high THT error scores.

This result suggests that patients may have overexerted their motor performance in an attempt to reach the target. In other words, they seemed to compensate for the situation with physical effort rather than employing the cognitive strategies required by the test. It can be asserted that the execution and coordination of fine motor skills, involving the synchronized efforts of small muscle groups, are closely intertwined with cognitive processes. One can consider actions such as speaking, painting, writing, manipulating objects, physical gestures, and facial expressions, which provide insights into mental processes as expressive functions, and they constitute one of the subcomponents of cognitive functions [16]. The decline in neurotransmitter systems, particularly the dopaminergic system, and regression in fine motor movements appear to correlate with age-related cognitive deficits. This can serve as evidence supporting the involvement of cognitive processes [17]. The literature suggests that the neocerebellum and dorsolateral prefrontal cortex are concurrently activated during both motor and cognitive tasks, highlighting the interconnectedness of motor and cognitive development [18].

Many studies, like this one, have found that depression can impair both cognitive and motor performance in patients, resulting in a decline in fine motor skills [8,19–21].

Pier and his colleagues [8] studied the elements of psychomotor slowing in depressed patients versus healthy individuals. They assigned participants a Fitts task and a figure replication task. The results showed that onset and motion times were considerably longer for those with depression compared to those without. Although the onset time for intricate figures was extended in both sets, it was particularly notable in the depressed group. Additionally, depressed patients made a significantly higher number of mistakes with complex figures. The researchers concluded that psychomotor slowing in depression is due to both cognitive and motor processing disruptions, with cognitive issues becoming more evident in the depressed group when task difficulty increases.

In another study conducted by Beheydt et al. [19], participants were administered line drawing and symbol copying tasks in addition to symbol-number matching tasks. The initiation time was defined as the duration between the presentation of the stimulus and the commencement of the first drawing movement. The findings indicated that the patient group exhibited slower performance in both cognitive and psychomotor tasks, with this difference becoming more evident as the cognitive load increased.

In their study, Bezzi et al. [20] employed the Bjerner reaction time test to gauge motor speed. Participants were instructed to move the device’s arm up and down in response to an audio stimulus. The authors found that patients with depression took longer to execute the task, showcasing a longer reaction time, and missed more commands, indicating fewer movements.

Mastoras et al. [21] investigated the relationship between depressive tendencies and psychomotor performance. They employed a smartphone application to assess participants’ typing proficiency across various applications. Data, including keystrokes, initiation of typing, completion of typing, deletions, and so forth, were recorded. The study revealed a significant correlation between typing performance and scores on the depression scale.

Some research indicates that cognitive impairment is the primary cause of delayed development in fine motor skills [5]. Hoffstaedter et al. [5] examined cognitive and motor functions in patients with depression and healthy volunteers. They employed various tests, including trail-making tests A and B, a motor coordination test, the Wechsler Adult Intelligence Scale, a multiple-choice vocabulary intelligence test, and a tripartite reaction time test (encompassing simple, serial choice, and reactive variations). The study revealed that depressed patients performed significantly slower in most tests compared to healthy volunteers. However, there was no significant difference in the fine motor skills test (FTT) outcomes.

Limitations

Our study comprised 56 participants: 28 patients and 28 healthy volunteers aged from 18 to 45, all of whom hold at least a high school diploma due to the demanding nature of the assigned tasks. The narrow age and educational range likely contributed to our small sample size. Furthermore, our sample had approximately three times as many female subjects as male, bottlenecking our study’s scope.

Conclusion

This study found that patients with MDD show a notable decline in fine motor skills linked to a decrease in cognitive functions. However, patients tend to quickly adjust to this deceleration. Often, impairments in fine motor movements, particularly psychomotor retardation, may be overlooked during clinical follow-ups. This oversight can negatively impact the patients’ quality of life and their adherence to treatment. Therefore, clinicians should address this issue more attentively. The study concludes that the reduction in MDD patients’ fine motor skills relates to both motor and cognitive processes. These insights can contribute to devising better strategies for MDD treatment and management. Yet, the generalizability of these results warrants caution, necessitating further research to reaffirm and broaden these insights.

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