






## Development and Evaluation of a Group Psycho-Cognitive Remediation Intervention for Adults with Major Depressive Disorder

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### Abstract

**Background:** Despite notable advances in the psychological treatment of major depressive disorder (MDD), many treatment challenges remain, such as the high probability of relapse after recovery, lack of treatment efficacy for many patients, and functional impairment after treatment. In overcoming these challenges, ignoring mediator factors such as cold cognition impairment which may be caused or associated with causation mechanisms

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**How to Cite:** Khodabandeloo, Y., Sohrabi, F., Borjali, A., Isamorad, A., Motamedi, A. (2023). Development and Evaluation of a Group Psycho-Cognitive Remediation Intervention for Adults with Major Depressive Disorder, *Journal of Clinical Psychology Studies*, 13(49), 87-114.

leading to these challenges appears to play a major role. Therefore, this study seeks to (I) develop a manual based on the hot and cold cognition model of depression, (II) investigate the content validity of the manual, and (III) test its effectiveness on psychological and neuropsychological symptoms. **Methods:** In 2022, this research was conducted in three stages: First, a psycho-cognitive remediation treatment manual was developed based on the most reliable existing treatments: Cognitive Behavior Therapy (CBT) and Cognitive Remediation Therapy (CRT). 8 experts evaluated the content validity of the manual at a second stage. Lastly, the quasi-experimental method and an active control group in a pre-test post-test follow-up design assessed the effectiveness of the developed treatment. Finally, the effectiveness of the developed treatment was evaluated by the quasi-experimental method with an active control group, pretest-posttest follow-up design. 28 adults aged 24-45 years who had been diagnosed with MDD were purposefully selected and assigned to one of the two experimental or control groups. The experimental group participated in 12 two-hour weekly sessions and the control group played video games at home. The Beck Depression Inventory-Second Edition (BDI-II) and the THINC-it tools as neuropsychological tests were used for gathering data. Only 25 patients remained in the study at week 12. To statistically analyze the data, One-way analysis of covariance was used (SPSS 26). **Results:** Data analysis showed that depression and anhedonia were substantially lower at the post-test compared to the pre-test, according to the BDI-II and SHAPS scores. All objective and subjective cognitive functions were significantly improved. The three-month follow-up scores remained noticeably stable compared to the post-test scores, indicating the treatment effects' durability. **Conclusion:** As far as the authors know, this is the first study to evaluate two validated combined therapies in adults with MDD. It was evaluated based on feasibility, acceptability, and effectiveness. In clinical practice, the authors of the study advise healthcare professionals to use these combinations. Although this treatment manual had a good effect, some of its limitations must be addressed in future research.

**Keywords:** Major Depressive Disorder, Cognitive Behavior Therapy, Cognitive Remediation, Cognitive Dysfunction.

## **1. Introduction**

Major depressive disorder (MDD) is a common mental illness that affects many people, with 2-21% of the population experiencing it at some point in their lives (Gutiérrez-Rojas et al., 2020). Since the probability of relapse after recovery is high (Buckman et al., 2018), the treatment is not effective for many patients (Galecki et al., 2022), the improvement in symptoms is often not accompanied by full functional recovery (Levada & Troyan, 2019; Groves et al., 2018) and there has high comorbidity with mental and physical health problems (Gutiérrez-Rojas et al., 2020). The need to consider new therapeutic strategies and develop current therapies in the area of MDD has grown significantly. As such, an initiative to improve the treatment outcome can be helped by looking into possible fundamental mechanisms of MDD. Focusing on indicators that could predict recurrence, such as cognitive impairment, can be effective because each is the cause or result of a causal mechanism underlying recurrent risk (Buckman et al., 2018; Groves et al., 2018).

Considering the repeated emphasis of research on targeting cognitive impairments along with providing other interventions (Colwell et al., 2022; Perini et al., 2019; Sumiyoshi et al., 2019; Woo et al., 2016; Bortolato et al., 2016; Rock et al., 2014), the current research seeks to design a psycho-cognitive remediation group therapy package based on the hot and cold cognition model (Roiser and Sahakian, 2013), which can lead to the improvement of psychological and neuro-psychological symptoms of people with MDD. Thus, the researcher seeks to find a scientific answer to this basic research question: Does the psycho-cognitive remediation group therapy package that will be designed by the researchers, have the necessary validity? Can this treatment package lead to a significant reduction of psychological symptoms (depression, anhedonia, and perceived cognitive impairments) and a significant improvement in neuropsychological impairments (executive functions, processing speed, and attention) in people with MDD?

## **2. Literature Review**

### ***2.1. Depression as a cognitive disorder***

Cognitive impairments have previously been considered a secondary symptom of some mental disorders, and current evidence suggests that cognitive impairments are the primary symptom or core feature of

schizophrenia and mood disorders (Martínez et al., 2021; Douglas et al., 2020). Several studies have shown that people with MDD suffer from such impairments (Varghese et al., 2022; Ji et al., 2020; Perini et al., 2020; Rock et al., 2014) and these impairments predict recurrence in patients with MDD (Wang et al., 2019; Buckman et al., 2018). In particular, cognitive impairments have emerged as a significant predictor of the functional outcome of depression (Groves et al., 2018; McIntyre & Lee, 2016; Bortolato et al., 2016). Moreover, it is believed that reduced overall recovery rates and functional impairment are explained by cognitive impairments (Wang et al., 2019; Groves et al., 2018).

Researchers suggest that cognitive impairments that are already present in the first episode of depression (Varghese et al., 2022; Schmid & Hammar, 2021), are still present in recovered patients (Kriesche et al., 2023; Hack et al., 2023), and despite the provision of pharmacological and psychological interventions, significant different cognitive impairments have been found in acute and recovered stages of depression (Colwell et al., 2022; Wang et al., 2019). Especially, cognitive impairments in memory, attention, and executive functions are associated with greater functional disability and impairment in daily activities such as housework, grocery shopping, and financial management (Knight & Baune, 2018), and it may mediate the negative effects of MDD on disability at work (Woo et al., 2016). This finding suggests that cognitive impairment is a central feature of depression that occurs separately during episodes of low mood and persists in the absence of clinical symptoms (Coles et al., 2020; Rock et al., 2014).

## ***2.2. Hot and cold cognition model of depression***

According to the hot and cold cognition model of depression (Roiser & Sahakian, 2013), the onset and continuation of depression are attributed to cold cognition impairments, such as impaired attention and concentration, and hot cognition impairments, such as anhedonia and emotional processing. The interactive model of hot and cold cognition states that, for example, when someone with depression has to handle many customers at work, their perceived stress worsens. This perception of stress makes it difficult for this patient to stop focusing on negative stimulants by stimulating the interaction of weak inhibitory processes and working memory with activated negative

schemas. In other words, an attention and/or processing bias is formed towards the negative contents. As a result, cognitive resources are reduced. This cycle makes depression symptoms worse which in turn further impairs cognitive functions. These impairments have a direct impact on normal functioning and may lead to subsequent hot repetitive thinking (rumination). The interaction between hot and cold pathways contributes to the perpetuation of active schema and attentional and/or processing bias, which together worsen depressive symptoms (Ahern et al., 2019).

### ***2.3. Treatment of hot and cold cognitive impairments in MDD***

Hot cognitive impairment has been well studied throughout the research literature, but insufficient attention was paid to cold cognitive impairment (Ahern et al., 2019). Hence, cold cognition has been increasingly recommended by clinical research as an essential therapeutic target to ensure functional recovery after a depressive episode (Colwell et al., 2022; Perini et al., 2019; Sumiyoshi et al., 2019; Woo et al., 2016; Bortolato et al., 2016; Rock et al., 2014). Among the drugs, Vortioxetine is the only FDA-approved antidepressant for the treatment of cognitive impairments in patients with MDD (Parker, 2016), even though it's effective in some patients and just a few cognitive domains (Colwell et al., 2022). In research, approximately 95% of patients continued to experience persistent problems with attention, verbal memory, inhibitory reaction, and process speed; not all improvements were reached at the same rate (Shilyansky et al., 2016). In psychological treatments such as cognitive behavior therapy (CBT), the evidence about the effectiveness of such interventions on cognitive impairments in people with depression is conflicting (Krysta, 2015). Probably the overemphasis on thought processes in such psychological treatments leads to neglect of other underlying factors involved. For example, neglecting cold cognitive impairments can lead to less attention to treatment content, less learning, poorer output, and increased nervous breakdown (Medalia et al., 2009).

Considering the importance of the two-way interaction of hot and cold cognitive impairments in the onset and continuation of depression, and the neglect of existing treatments to target cold cognitive impairments, innovative complementary therapies should be explored to guide and ultimately lead to the integration of cold

cognitive remediation strategies with valid existing psychological treatments.

### **3. Methodology**

#### ***3.1. Method of implementation and data collection***

In several stages, the research has been carried out. In the first stage, to initiate the development process and to assess whether there are manual interventions in managing MDD, we have reviewed previous studies to verify that empirical evidence supports them. For this purpose, the words MDD, Cognitive Behavior Therapy (CBT), depression, unipolar depression, Cognitive Remediation Therapy (CRT), cognitive rehabilitation, cognitive training, cold cognition, hot cognition, cognitive dysfunction, and cognitive deficits were googled alone or in combination. Also, a large literature search to find manualized intervention in the management of MDD and cognitive impairment has been undertaken irrespective of settings or population. Among these sources, the most important were a paper about the hot and cold cognitive model of depression (Roiser & Sahakian, 2013), the books “Treatment Plans and Interventions for Depression and Anxiety Disorders” (Leahy et al., 2012), and “Cognitive remediation for psychological disorders” (Medalia et al., 2009), which became the basis for developing a new treatment manual for MDD patients. Furthermore, the recommendations and techniques that were proposed in other articles and books were used (for example, Porter et al., 2013). Finally, CBT and CRT were chosen as the optimal base manuals for adaptation to MDD patients (Zuckerman et al., 2018).

In the second stage, a questionnaire of experts has been prepared so that they may examine this treatment manual and then change it to reflect their experience and observations to determine its content validity. All experts with expertise in the areas of clinical psychology, cognitive sciences, CBT, and CRT had been targeted to provide statistical data for the validation of the developed treatment manual. Using available sampling, eight people were chosen from these experts.

In the third stage, the study of the effectiveness of the manual, a quasi-experimental design with a pretest-posttest-follow-up structure with an active control group was used. At this stage, the statistical population included all the people living in Tehran who had seen the research announcements in cyberspace from December 2021 to April

2022. To attract volunteers to participate in this research, several bulletins have been positioned inside the research segment of the Divar® marketing app or other apps such as Facebook®. People whose chief complaint was depression were screened and entered into an online interview if they received initial approval. Among the hundreds of people who participated in the initial screening, 52 people entered the online interview based on the Persian version of the Structured Clinical Interview for DSM-5 (SCID-5; Mohammadkhani et al., 2020) after signing the consent forms. A clinical professional with 10 years of experience in the assessment and treatment of depression administered an Internet interview. As a result, 28 persons aged 22 to 45 years of age were recruited from 52 volunteers who met the criteria for participation and agreed to participate. A random assignment of 14 people to an experimental group and 14 persons to an active control group was also carried out. The intervention of CBT and CRT was introduced in 12 weekly two-hour sessions for the experiment group after forming treatment groups. The first half of the experiment sessions was a CBT session and the second half was a CRT session. Between the two of them, there was a fifteen-minute break. Also, the Twisty Arrow® video game was played by members of the active control group at home. The measurements were done in three stages: before the start of the intervention, one day to one week after the end of the intervention, and three months after the intervention (three-month follow-up). Follow-up data were only available for the experimental group, and the control group entered treatment after the post-test was administered. A briefing for each member was held to discuss the group's goals and expectations before starting treatment, to enable participants to enter a group treatment session. Treatment was provided at the Saye-Sare-Omid Clinic in Tehran. An overview of the CBT+CRT manual goals to be achieved during each session is given in Table 1.

The inclusion criteria were: age 18 to 60 years (to be able to do computerized cognitive training; CCT); the DSM-5 diagnosis of MDD; obtaining a minimum score of 23 in the Beck-II; the optimum cut-point score for detecting MDD based on Park, et al. (2020) study; the existence of at least one significant cognitive impairment (a standard deviation or more below average); and injection of at least two doses of the COVID-19 vaccine. Patients with a history of receiving CBT in the last 2 years, simultaneous participation in other

psychological and medical therapies, comorbid personality and/or psychotic disorder, a history of mania or hypomania, active drug abuse, active suicidal ideation, and lack of stabilization in the use of psychiatric drugs (for at least 3 months) were excluded.

**Table 1. Overview of the group CBT+CRT manual goals, contents, and tasks in the sessions**

Sessions	Goals	Contents	Tasks
Session 1	Familiarization and introduction	Introducing group members and building relationships; increasing knowledge about depression, exploring the depressive symptoms of group members	Completing my depression worksheet and the daily mood scale
Session 2	Evaluation, setting goals, and initiating treatment	Collecting information about learning style, cognitive difficulties, and personal interest areas; setting treatment goals; beginning behavioral activation, and introducing depression from the perspective of the hot and cold cognition model	Completing the daily mood scale and the cognitive, behavioral, and interpersonal evaluation form, doing CCT exercises (as N-back), reading bulletins
Session 3	Cognitive restructuring and cognitive remediation	Eliminating suicidal thoughts; reducing frustration and automatic negative thoughts; and increasing self-reward for performing positive behaviors (once a day); informal assessment of cognitive abilities; introducing some of the cognitive abilities	Completing the daily mood scale, three columns of the table of thoughts, and the activity planning diary worksheet; doing CCT exercises (as N-back); reading bulletins
Session 4	Engagement with treatment	Engaging in a rewarding activity (once a day); reducing automatic negative thoughts and mental ruminations; identifying the best CCT exercises that engage the group members; providing corrective feedback to increase failure tolerance and processing speed	Completing the daily mood scale, four columns of the table of thoughts, and the activity planning diary worksheet; doing CRT exercises (as Attention Training Technique; ATT); reading bulletins
Session 5	Practice social skills and recall techniques 1	Reducing automatic negative thoughts and mental ruminations; increasing social	Completing the daily mood scale and five columns of the table of



Sessions	Goals	Contents	Tasks
		communications (once a week); teaching problem-solving and communication skills; teaching recall techniques	thoughts; practicing problem-solving and recall techniques; doing CRT exercises (ATT); reading bulletins
Session 6	Practice social skills and recall techniques 2	Reducing automatic negative thoughts and mental ruminations; increasing social communications (twice a week); teaching problem-solving and communication skills; teaching recall techniques	Completing the daily mood scale and all columns of the table of thoughts; practicing problem-solving and recall techniques; doing CRT exercises (delayed recall); reading bulletins
Session 7	Modifying schemas and bridging groups 1	Increasing social communications (three times a week); modifying inefficient core beliefs and the worthless schema (or others' schema); bridging the gap between acquisitions and real-life expectations (metacognitive groups)	Completing the daily mood scale, the behavioral experiment worksheet; the downward arrow technique worksheet and doing CRT exercises at all levels (reasoning exercises)
Session 8	Modifying schemas and bridging groups 2	Modifying inefficient core beliefs and the worthless schema (or others' schema); conversations about psychological factors that affect cognitive performance; metacognitive groups	Completing the daily mood scale and worry postponement worksheet; doing CRT exercises; reading bulletins
Session 9	Modifying schemas and bridging groups 3	Modifying inefficient core beliefs and the worthless schema (or others' schema); metacognitive groups	Completing the daily mood scale and the graded task assignment technique worksheet; doing CRT exercises
Session 10	Modifying schemas and bridging groups 4	Modifying inefficient core beliefs and the worthless schema (or others' schema); and bridging the gap between acquisitions and real-life expectations (problem-solving groups)	Completing the daily mood scale and; doing CRT exercises
Session 11	Modifying schemas and	Modifying inefficient core beliefs and the worthless	Completing the daily mood scale and doing

Sessions	Goals	Contents	Tasks
	bridging groups 5	schema (or others' schema); problem-solving groups	CRT exercises
Session 12	Relapse prevention	Teaching relapse prevention skills; problem-solving groups	Completing the daily mood scale and the relapse prevention worksheet; doing CRT exercises

### 3.2. Data collection tools

The measurement tools included these items: the Structured Clinical Interview for DSM-5 (SCID-5), the Beck Depression Inventory (BDI-II), the Snaith-Hamilton Pleasure Scale (SHAPS), and the THINC-it tools.

**The SCID-5:** This tool is a manual of interviews that covers the key diagnostic elements of DSM-5. The choice of a study population is one of the most important uses for SCID-5. The reliability and validity of the Persian version of SCID-5 were investigated for various diagnoses in a variety of clinical settings (Mohammadkhani et al., 2020). Results showed appropriate internal consistency of all diagnoses ranged from  $\alpha = 0.95$  to  $\alpha = 0.99$ , which demonstrates excellent internal reliability. Also, the agreements obtained using  $\kappa$  statistics were good to excellent for all diagnostic categories ( $\kappa = 0.63$  to  $\kappa = 0.83$ ).

**BDI-II:** This test has a 21-item that measures the severity of depressive symptoms on a four-point scale from 0 to 63. This questionnaire is a screening tool that can be implemented individually or in groups. The validity and reliability of this tool in a study were investigated. Validity was reported in terms of Cronbach's alpha coefficients from 0/73 to 0/92 and reliability was reported from 0/48 to 0/86 (Beck, Steer & Brown, 1996). In this research, Cronbach's alpha coefficient of the whole questionnaire was 0.79.

**The SHAPS:** This test has 14 items that measure the capacity and ability to obtain pleasure. This scale can be used in both clinical and research fields. The respondents can indicate their agreement or disagreement with all statements through the reading of each statement in a range of four options. Recently, Ebrahimi et al. (2018)

investigated the validity and reliability of this questionnaire and reported that this test has appropriate validity and reliability. Cronbach's alpha coefficient from the whole questionnaire was 0.73 in this study.

**THINC-it:** This battery test is a digital neuropsychological assessment tool that is specifically designed to evaluate the cognitive functions of people with depression and includes four objective cognitive tests whose validity has already been well investigated. These tests include the Spotter (choice reaction time; a reaction time test of attention), the Symbol Check (1-back test; a working memory test), the Trails (Trails Making Test B; an executive function test), and the Codebreaker (Digit Symbol Substitution Test; a coding test that measures a variety of cognitive skills). McIntyre et al. (2020) in a study investigated the THINC-it tool's sensitivity to change in adults with MDD. The results demonstrate that the THINC-it scores are highly correlated with improvements in the pencil and paper versions of the Digit Symbol Substitution Test (DSST) and the Trails Making Test B (TMTB). As a result, the THINC-it is an appropriate tool for demonstrating health outcome improvements in MDD patients. In this study, Cronbach's alpha has been 0.70, which indicates the acceptable internal consistency of this neuropsychological tool.

### **3.3. Method of data analysis**

The content validity data of the manual were calculated manually by the Content Validity Ratio (CVR) and Content Validity Index (CVI) formulas (Lawshe, 1975). Intervention data were analyzed only for the participants that remained in the study until the twelfth session, and they were absent at most two sessions during these sessions. Statistical analysis for changes in BDI-II and THINC-it scores was performed using a one-way analysis of covariance (SPSS version 26).

## **4. Results**

The content validity results showed that the CBT+CRT-based manual has a suitable validity (CVR = 0.91 and CVI = 1). The study was only conducted with 13 participants in the experiment group and 12 from the control group. Because of early withdrawal or more than two missed meetings, three participants have been excluded from the study. Based on these 25 final participants, the results of this research

were analyzed. In the case of specialists, the average clinical activity was 11.25 (SD: 10.27) years and the average teaching experience at the university was 8.87 (SD: 12.15) years. The experimental group also had an average age of 31.84 (SD: 6.69) years and the control group was 31.58 (SD: 5.72) years. The average time spent on CCT exercises in the experimental group was 332.30 (SD: 278.81) minutes. Also, the time spent playing the video game in the control group was 251.25 (SD: 247) minutes. Table 2 shows the results of the descriptive information of the research variables.

**Table 2. Descriptive information of research variables by pre-test, post-test, and follow-up**

Variable	Group	Pre-test		Post-test		Follow-up		
		Mean	SD	Mean	SD	Mean	SD	
Depression	Experiment	40.84	7.12	23.92	5.57	21.84	8.03	
	Control	36.58	6.63	34.91	5.21	--	--	
Anhedonia	Experiment	24.84	4.56	15.46	3.43	17	3.95	
	Control	21.00	4.11	21.25	3.01	--	--	
The THINC-it	The Spotter	Experiment	2067.07	737.85	2892.30	674.62	2801.30	720.97
		Control	2347.33	664.32	2509.33	834.19	--	--
	The Symbol Check	Experiment	2223.46	796.19	3245.15	821.78	3078.46	775.39
		Control	2473.16	590.79	2668.00	815.02	--	--
	The Codebreaker	Experiment	1326.92	312.66	1773.07	510.15	1850.00	507.44
		Control	1350	383.16	1400.00	265.43	--	--
	The Trails	Experiment	2313.38	585.39	2694.07	651.89	2837.15	510.88
		Control	2074.66	746.10	2127.41	593.32	--	--
	Perceived deficit	Experiment	11.61	2.50	7.00	2.16	7.53	2.56
		Control	12.166	3.15	12.33	3.08	--	--

As shown in Table 2, the depression and anhedonia scores of the experimental group participants decreased in the pre-test compared to the post-test. Also, the mentioned scores have remained stable in the follow-up compared to the post-test. In the objective cognition tests conducted with the THINC-it tool (the Spotter, the Symbol Check, the Codebreaker, and the Trails), post-test scores improved in comparison to the pre-test scores of the experiment group. It seems that this improvement is visible in the follow-up scores compared to the post-test.

About the scores of the subjective cognition test (Perceived deficit), a decrease in scores can be seen in the experimental group from the pre-test to the post-test, and it seems that the test scores in the experimental group did not change from the post-test to the follow-up.

One-way analysis of covariance (ANCOVA) was used to check whether CBT+CRT-based intervention is effective for improving symptoms of depression, anhedonia, and the THINC-it tool tests. Before performing the analysis, the test assumptions were first analyzed. The Kolmogorov-Smirnov test was used to check the normality of the distribution of the variables. The test results for all the variables were at a non-significant level, which indicates the normality of the distribution of the variables. Also, the results showed that the significance level for interaction between a given group and its pre-test was more than 0.05 in all variables when analyzing the homogeneity of the regression line's slope. So, the hypothesis of the homogeneity of the slope of the regression line is accepted as one of the main assumptions of the covariance analysis. In addition, the significance level of the Mbox test is greater than the significance level (0.05) required to reject the null hypothesis. As a result, the assumption of homogeneity of the covariance matrix is established. Finally, the results of Levene's test to check the homogeneity of variances were confirmed. Then, the conditions for performing a one-way analysis of covariance are available. Table 3 shows the effect of independent variables on dependent variables such as depression, anhedonia, and subjective and objective cognition at the post-test using the Wilks lambda test.

**Table 3. The results of Wilks' lambda test in multivariate covariance analysis of dependent variables**

Value	F	Sig.	Eta Squared
0.25	4.16	0.001	0.74

The difference between the experimental and control groups in terms of dependent variables is generally significant at the level of 0.001 and the independent variable was able to explain 74% of the variance of the linear combination of dependent variables, as shown in Table 3. Then, it can be said that in the post-test phase, after adjusting the differences related to covariance variables (pre-test), the linear

combination of dependent variables has a significant effect on the independent variable. Based on this, it can be concluded that there is a significant difference between the two experimental and control groups at least in terms of one of the dependent variables. Now we will examine each dependent variable separately.

**Table 4. The results of univariate covariance analysis**

Variables	Source	Sum of Squares	df	Mean Square	F	Sig.	Eta Squared
<b>Depression</b>	Group	931.23	1	931.23	43.78	0.0001	0.66
	Error	467.94	22	21.27			
<b>Anhedonia</b>	Group	293.08	1	293.08	42.79	0.0001	0.66
	Error	156.65	22	6.84			
<b>Perceived deficit</b>	Group	153.74	1	153.74	38.14	0.0001	0.63
	Error	88.66	22	4.03			
<b>The Spotter</b>	Group	2100332.67	1	2100332.67	6.84	0.016	0.23
	Error	6749974.75	22	306817.03			
<b>The Symbol Check</b>	Group	3556383.68	1	3556383.68	8.94	0.007	0.28
	Error	8748204.15	22	397645.64			
<b>The Codebreaker</b>	Group	954618.26	1	954618.26	9.78	0.005	0.30
	Error	2147210.47	22	97600.47			
<b>The Trails</b>	Group	844611.66	1	844611.66	8.00	0.01	0.26
	Error	88.66	22	4.03			

As the results of Table 4 show, there is a significant difference between the mean post-test scores of the THINC-it neuropsychological tests in the experimental and control groups after removing the effect of the pre-test, in the sense that the mean post-test scores of the experimental group in the variables of the THINC-it test are significantly higher than the control group, except the perceived defects score, where the average post-test scores of the experimental group are significantly lower than the control group. Also, the findings show that there is a significant difference between the mean post-test scores of the depression and anhedonia in the experimental and control groups after removing the effect of the pre-test, in the sense that the mean post-test scores of the experimental group in the mentioned variables are significantly lower than is the control group. Based on this, it can be claimed that the CBT+CRT-based group

therapy program has been significantly effective and has improved depression, anhedonia, perceived deficits, and cognitive functions of participants with MDD, and these therapeutic effects were maintained for three months after the treatment.

A repeated measurement analysis test was used to investigate the effectiveness of the CBT+CRT group therapy program on depression until the follow-up stage. The results obtained are presented below. The assumption of the variance analysis test with repeated measurement is that the variance of the difference between all the combinations related to the groups (sphericity) should be the same. To check this hypothesis, Mauchly's test of sphericity has been used (Table 5).

**Table 5. Mauchly's sphericity hypothesis test related to research variables**

Variables		Mauchly's W	Approx. Chi-Square	df	Sig.
Depression		0.59	5.68	2	0.058
Anhedonia		0.56	17.84	2	0.04
The THINC-it tests	Perceived deficit	0.38	10.64	2	0.005
	The Spotter	0.20	17.46	2	0.0001
	The Symbol Check	0.54	6.75	2	0.034
	The Codebreaker	0.65	4.66	2	0.09
	The Trails	0.95	0.49	2	0.78

The sphericity assumption has been met only about the depression, the Codebreaker, and the Trails test scores, but this assumption was not met for other variables. For this reason, the results of the Greenhouse-Geisser test were used in the output of the repeated measures of analyses of the variance of these variables. In this regard, Table 6 shows the results of the within-subjects test.

**Table 6. The results of within-subject effects on the dependent variables**

Variables	Source	Sum of Squares (Assuming sphericity)	Sum of Squares (Greenhouse-Geisser)	df	F	Sig.	Eta squared
Depression	Time	2824.5	...	2	36.10	0.0001	0.75
Anhedonia	Time	...	658.66	1.38	61.11	0.0001	0.83

Variables		Source	Sum of Squares (Assuming sphericity)	Sum of Squares (Greenhouse-Geisser)	df	F	Sig.	Eta squared
The THINC-it tests	Perceived deficit	Time	...	165.59	1.23	33.26	0.0001	0.73
	The Spotter	Time	...	5322987.12	1/11	15.26	0.001	0.56
	The Symbol Check	Time	...	7811554.82	1/37	16.06	0.0001	0.57
	The Codebreaker	Time	2073846.15	...	2	17.93	0.0001	0.59
	The Trails	Time	1905504.66	...	2	12.12	0.0001	0.50

In general, within-subject test results in Table 6 showed that the CBT+CRT-based group therapy could be effective at the  $p \leq 0.01$  level on all of the dependent variables. Due to the significant results of the within-subject test and duo to find out the exact difference between stages of evaluation, the couple's comparison of the evaluation process is presented in Table 7.

**Table 7. Pairwise comparison of the average scores of research variables in the experimental group over time**

Variable		Stage (i)	Stage (j)	Mean difference	Std. Error Mean	Sig.	
Depression	Pre-test	Post-test		16.92	1.94	0.0001	
		Follow-up		19.00	3.13	0.0001	
	Post-test	Follow-up		2.07	2.10	0.34	
Anhedonia	Pre-test	Post-test		9.38	1.12	0.0001	
		Follow-up		7.84	0.93	0.0001	
	Post-test	Follow-up		-1.53	0.57	0.020	
The THINC-it tests	The Spotter	Pre-test	Post-test		-825.23	192.98	0.001
			Follow-up		-577.84	215.32	0.020
	The Symbol	Pre-test	Post-test		-1021.69	197.90	0.0001
			Follow-up				



Variable		Stage (i)	Stage (j)	Mean difference	Std. Error Mean	Sig.
Check			Follow-up	-855.00	241.72	0.004
	Post-test		Follow-up	166.69	-96.96	0.19
The Codebreaker	Pre-test		Post-test	-446.15	104.61	0.001
			Follow-up	-523.07	109.72	0.0001
	Post-test		Follow-up	-76.92	60.87	0.23
The Trails	Pre-test		Post-test	-380.69	100.95	0.003
			Follow-up	-523.76	120.36	0.001
	Post-test		Follow-up	-143.07	107.61	0.20
Perceived deficit	Pre-test		Post-test	4.61	0.75	0.0001
			Follow-up	4.07	0.70	0.0001
	Post-test		Follow-up	-0.53	0.29	0.08

As can be seen in Table 7, the mean scores of all study variables in the experimental group changed significantly from the pre-test to the post-test, but no significant change was observed between the experimental group post-test and follow-up test scores, except for the anhedonia and the perceived deficit test scores. These results demonstrated that all study variables were influenced by the CB+CRT-based intervention, and these therapeutic effects remained after 3 months of treatment.

## 5. Discussion

The development of a Group CBT+CRT-based manual for adults with MDD, which assessed its effect on psychological and neuropsychological symptoms, was the main purpose of this study. Accordingly, this research seeks to (1) develop a group CBT+CRT-based manual for adults with MDD, (2) investigate the content validity of the manual, and (3) administrate a quasi-experimental design to test the hypothesis that this manual is related to (I) a decrease in psychological symptoms of depression, anhedonia and subjective cognitive impairment and (II) an improvement in neuropsychological symptoms, in other words, objective cognitive functions. The results of the content validity study indicated that the group CBT+CRT-based manual has suitable validity. Quantitative

analysis of the data showed a significant decrease in psychological symptoms of MDD based on depression, anhedonia, and subjective cognitive impairment test scores. Furthermore, the results revealed an improvement in all cognitive impairments based on THINC-it test scores. In the following, the quantitative data of this research is analyzed and its applications in treatment and future research are discussed.

On average, patients in the experimental group participated in 10.23 out of 12 (%85) sessions (%85). This finding indicates a relatively high fidelity to treatment. However, to ensure the fidelity of practice, researchers are encouraged to use direct observation methods (Waltman et al., 2017). Since the participants were supposed to do CCT exercises or video games for 30 to 45 minutes, three days a week for 11 weeks, the time spent on practice exercises at home in the experiment group and active control group was very little. Probably the most important reason for this issue was the lack of positive reinforcement in exchange for progress in home exercises because this treatment is active (Clay et al., 2022). Other reasons may be the feeling of failure due to mistakes in any cognitive exercise or video game, a phenomenon known as a “catastrophic response to perceived failure” (Beats et al., 1996), and/or avoiding cognitive challenges especially when the challenges are difficult (Wood-Ross et al., 2021), which could lead to the stimulation of hot cognition; ruminating about why they can't do the exercises well. The motivation to continue working may be reduced by such a catastrophic response (Wang et al., 2019). Almost all the participants felt confused and anxious during the CCT exercises, especially when they faced failure. Therefore, there is a need for future research to focus on increasing internal and external motivations for doing computer-based cognitive exercises at the clinic and home.

A significant decrease in psychological symptoms with a “large” effect size and a significant improvement in neuropsychological symptoms with a “small” effect size was observed in this study. These findings are similar to the results of previous research that showed the effectiveness of CBT and/or CRT interventions in improving the psychological and/or neuropsychological symptoms of depression in adults with MDD (Mokhtari et al., 2023; Alsayednasser et al., 2022; Vicent-Gil et al., 2022; Dong et al., 2022; Hanuka et al., 2022; Thérond et al., 2021; Sharma & Fazio, 2020; Zhang et al., 2019;

Dunn, 2019; Vicent-Gil et al., 2019; Harvey et al., 2017). While the effects of CBT and CRT on hot and cold cognition in depression have been investigated separately in most previous studies, the present study examined the combined effects of these interventions and the results showed promising efficacy in patients with MDD.

The reduction of depression observed in the present study based on BDI-II total row scores probably indicated the synergistic effects of the combined intervention. In research relatively similar to the current research (Dong et al., 2017), improving the memory of patients with MDD to learn the content of treatment through memory support intervention led to improved depressive symptoms and functional impairments. In the aforementioned study, adult patients with MDD were randomly assigned to the group of cognitive therapy + memory support intervention or standard cognitive therapy. Both treatment groups were associated with a reduction in depressive symptoms and functional impairment, except for the cognitive therapy group plus memory support, which showed a lower severity of depression compared to the standard cognitive therapy at the 6-month follow-up. These findings suggest that the combined treatment may have prevented cold cognitive impairments from "becoming hot", which can weaken the vicious cycle of hot and cold cognition and ultimately lead to the reduction of depression symptoms (Ahern et al., 2019).

Also, a significant decrease was observed in symptoms of anhedonia based on the SHAPS total row scores with a "large" effect size. The results of the present study are similar to the previous studies that examined the effects of various psychological interventions, CCT, and CRT on anhedonia in MDD (Alsayednasser et al., 2022; Hanuka et al., 2022; Zhang et al., 2019; Dunn, 2019; Taylor et al., 2017). Winer et al. (2019) believe that targeting positive emotions and enhancing positive experiences can help in increasing the experience of pleasure, contrary to traditional depression treatments, which mainly focus on negative emotions and reducing negative experiences. Maybe this was the reason why the group CBT+CRT-based intervention used new techniques such as "positive activities interventions" (Taylor et al., 2017) to reduce anhedonia. For example, the participants were asked to help a needy person only once a week as a positive activity. The effect sizes reported by Taylor et al. (2017) based on different situations were large. Moreover, it seems that the improvement of cognitive functions played a critical role (McIntyre &

Lee, 2016). It appears that the psycho-cognitive intervention has positive effects on the improvement of performance due to the overlap between neurobiological substrates related to anhedonia and cognitive impairment. For example, in research, Zhang et al. (2019) succeeded in improving anhedonia in students suffering from subsyndromal depression by using working memory training.

Neuropsychological results showed an improvement in all objective and subjective cognitive functions, such as working memory (the Symbol check test), attention (the Spotter test), executive functions (the Trails test), and processing speed (the Codebreaker test) with a “small” effect size, and subjective cognitive function (perceived deficits) with a “large” effect size. These findings are similar to other research findings (Mokhtari et al., 2023; Théron et al., 2021; Vicent-Gil et al., 2019). This finding indicates that, firstly, subjective cognition and objective cognition are relatively independent of each other (Sumiyoshi et al., 2022). Second, self-perception of cognition may be related to the severity of depressive symptoms (Sumiyoshi et al., 2022; Olsen et al., 2015). For example, self-rated cognition in depressed individuals may be subject to cognitive distortions, such as catastrophizing small cognitive declines in memory performance. This may explain why their subjective assessment of memory and thinking is worse than their objective performance on neuropsychological tests. Therefore, it can be concluded that the current intervention has been able to prevent the warming of cold cognition in patients with MDD.

## **6. Conclusion**

As far as the authors know, the present study is the first to develop and evaluate a group CBT+CRT-based intervention for the treatment of adults with MDD. The results indicated significant improvements in psychological (depression, anhedonia, and subjective cognition) and neuropsychological symptoms (executive functions, processing speed, and attention) after treatment. The evidence collectively suggests that cold cognition should be the goal of treating MDD along with hot cognition interventions, but there are still many unknowns that require more research in the future. For example, whether therapeutic effects are only visible in tests (near transfer) or whether these therapeutic effects also exist in real life (far transfer) needs to be investigated in future research. Also, anxiety and mental rumination

were common psychological characteristics that existed among the participants, it seems necessary to investigate the role of these variables to identify and improve them.

### **Limitations and suggestions**

One of the limitations of the present study was the use of the available sampling method in the screening phase of adults with major depressive disorder, and due to the non-random nature of this sampling method, caution should be exercised in generalizing the findings obtained from this study. Also, the members of the sample group of the present study included adults aged 22 to 45 years old with MDD, so caution should be exercised in generalizing the results of this study to other different populations with different age ranges. Another limitation of the research was the limited assessment of cognitive functions, which may not cover some cognitive domains. This limitation in the evaluation of cognitive functions can provide a limited cognitive profile of the participants and distort the comprehensive picture of the relationship between research variables. Also, since the neuropsychological evaluation was done using digital tactile tests, the cognitive profile of the subjects may have been distorted, because some subjects sometimes faced problems in the answering process due to a long nail (or artificial nail). Finally, according to the previous findings regarding the effect of external motivation on the implementation of cognitive exercises, the absence of external motivation is one of the possible limitations of the current research.

Considering the limitations of the research in using available sampling and caution in the generalizability of the research findings, it's suggested to use the random sampling method in the selection of subjects in future research so that the results can be generalized more confidently. Also, it is suggested to investigate the effectiveness of psycho-cognitive group therapy on people of different ages and clinical populations to make the research findings more generalizable. It recommended that to assess cognitive abilities more broadly, it should be used in combination with larger clinical neuropsychological tests like Cambridge Automated Neuropsychology Tests (CANTAB) or RehaCom. Finally, considering the importance of motivation and progress in computer-based cognitive training programs, external motivation through incentives such as financial rewards is suggested

in future research.

**Acknowledgments**

The authors would like to express their deepest gratitude to the Saye-Sare Omid clinic for providing clinics to perform evaluations and treatment, and to Alireza Shamloo Ahmadi and Milad Zaree for their help in facilitating the implementation of this research.

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**How to Cite:** Khodabandelo, Y., Sohrabi, F., Borjali, A., Isamorad, A., Motamedi, A. (2023). Development and Evaluation of a Group Psycho-Cognitive Remediation Intervention for Adults with Major Depressive Disorder, *Journal of Clinical Psychology Studies*, 13(49), 87-114.



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