

Meta-cognition, Decision Making and Working Memory as Mediators Between Coping with Stress Styles and Major Depressive Disorder

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Abstract: This study aimed to investigate the mediator roles of meta-cognition, decision making and working memory between coping with stress styles and major depressive disorder (MDD). The sample size was 250 participants that filled in five scales to assess MDD, coping with stress styles and executive functions. The model representing the mediation role of meta-cognition, decision making and working memory between coping with stress styles and MDD is fit. The effect of problem focused coping (PFC) on meta-cognition as well as the effect of emotion focused coping (EFC) on working memory was strongly significant. Decision making was an executive function that independently influenced on MDD. Our overall results represented that the main executive functions that strongly influenced the correlation between coping with stress styles and MDD were meta-cognition, working memory and decision making respectively.

Keywords: Coping with Stress Styles, Decision Making, Executive Functions, Major Depressive Disorder, Meta-cognition & Working Memory

1. Introduction

One of the important topics of information processing approach is the role of prefrontal cortex in mental disorders. Many robust and extensive researches show that this part of brain contains the executive functions (Baddeley, 2003; Cummings & Miller, 2007; Abedi 1, Alilou, Mousazadeh, 2014). Executive functions are the brain's higher cognitive functions developed by mixing the lower cognitive functions (e.g. attention, short-term memory, long-term memory and learning). As the executive functions are the mixed cognitive functions, impairment in one cognitive function could not destroy the executive functions for the brain can compensate the weakness in one by integrating the other functions. Executive functions have also been called executive systems as they are responsible for supervising and organizing cognitions, behaviors and emotions (Miller & Cummings, 2007). Executive functions may cause psychological adjustment, especially in changing conditions, the formulation and

maintenance of intellectual goals, establishing proportionality between duty and capability, and controlling the behavior and emotions. Therefore, impairment in their mechanisms may affect patients' response and adjustment. Barkley (2001) focused on the prefrontal cortex and the role of this area of brain in executive functioning. He believed the main task of executive functions are supervising and managing the cognitive processes. He underscored that the executive functions interact among each other and the consequence of these interactions would be the formation of a complex system of regulation and management process that acts as an integrated model. Hence, the disruption in one part of this system may affect and disrupt the other parts of the system. He specified the inhibition and working memory as the most important executive functions that manage the performance of the other units (Barkley, Murphy & Fischer, 2008). Any malfunction in meta-cognition, working memory, decision making and the other functions influence the person's compatibility and coping with stress styles and the consequence of this pattern would be mental disorders

(McAvinue, Golemme, Castorina, Tatti, Pigni, et. al. 2013; Hughes, Beier, Hartoonian, Turner, Amtmann & Ehde, 2015; Cook, Salmon, Dunn, Holcombe, Cornford & Fisher, 2015; Russo, Mahon & Burdick, 2015). It means these executive malfunctions may lead people to coping emotionally with stressful situations such as avoidance, flight, aggression to someone, addiction to drugs, etc. The consequences of these coping styles may be mental disorders such as depression.

Coping with stress styles are the cognitive behavioral efforts that manage internal/external demands and conflicts (Khorram & Mohammadkhani, 2010). When the individual efforts successfully manage the conflicts the coping process is positively developed by cognitive assessment. In contrast, the unsuccessful managing the conflicts leads people to negative assessments. Moreover, the coping process is not automatic but is a learned pattern of purposeful responses to stressful situations. Problem-focused coping (PFC) primarily begins with arousal and then it is followed by first and second positive assessments. In consequence, it leads to solving problems; whereas emotion focused coping (EFC) begins with arousal and usually activate the first and second negative assessments and accordingly leads to mental health disorders such as depression and anxiety (Lazarus & Folkman, 1984). According to DSMV, MDD is a mood disorder with one or more periods of major depression without manic or hypomanic periods that may last at least for two weeks. Typically, the patient is depressed and loses his/her interest in most activities. To diagnose MDD the patient should at least display four of MDD signs (American Psychiatric Association, 2014).

2. Literature Review

Significant positive correlation between cognitive impairment and coping with stress styles has been found in various studies. These studies showed that cognitive impairments may leave destructive effects on coping with stress styles in stressful situations (Hughes & Colleagues, 2015). The patients with severe cognitive dysfunctions have many difficulties in choosing the PFC style due to executive malfunctioning and weakness in search for detailed information about the problem. Eventually they select the flight or avoidance coping style (Pu, Nakagome, Yamada, Yokoyama, Matsumura, Mitani, et. al. 2012), whereas people with appropriate executive functions display those styles that mitigate the stress and create positive emotions and psychological health (Cook & Colleagues, 2015).

Depression is associated with working memory deficits and rumination of sadness and sorrow (Belli, 2012). It seems that depressed patients have conflict in decision making (Randenborgh, 2010), opposite outcomes processing and prolong attention to the adverse results of reward (Chase, 2010). Furthermore, patients with depression symptoms fail to response to reward stimuli (Pizzagalli, 2011). Russo & Colleagues (2015) showed that depression significantly correlates with decision-making and meta-cognition malfunctions. However training the decision-making

strategies can produce positive impacts on patients' feelings of helplessness (Kiosses, Ravdin, Gross, Raue, Kotbi, Alexopoulos, 2015).

MDD patients show significant malfunction in meta-cognitive knowledge (Rezaee, Kazemi, Khanzadeh, Miderikvand, Hashemi & Aghamohammadi, 2015). Their meta-cognitive dysfunctions lead them to be over concentrated on information so that they are sensitive and ruminative in their cognitive process. Patients may ruminate over self-cognitive processes and repeatedly try to find the cognitive errors which lead them to suffer. But it is obvious that the limited attention, wrong direction and meta-cognitive deregulation lead to severe disruptions (Jiang & Kleitman, 2015). They believe that all cognitive processes should be over-reviewed and they should check their defeats by focusing on them. These patterns effect on their depression symptoms (Cook & Colleagues, 2015).

Despite the different and notable researches on depressed patient beliefs and thoughts, the question that preoccupies the mind is why some people have dysfunctional beliefs and many others have positive beliefs in the same situations? Why they are different in coping with stress styles? Which of brain's cognitive and executive functions involve in this area? Kieron & Marie-Claude (2011) findings showed that the negative thought development is due to defects in executive functions. Gunduz (2013) also postulated that both negative attribution styles and irrational beliefs are significantly correlated with executive functions that lead to depression. Therefore it is possible to note that executive and cognitive functions meaningfully mediate the correlation between patients coping with stress styles and depression. This issue as well as other similar ones demonstrated the need for focusing on the brain's cognitive and executive functions instead of depressed patients' dysfunctional beliefs. According to Barkley's (2001) information processing theory and Lazarus & Folkman (1984) cognitive theory the role of thought and information processing are essential in behavior organization, depression and even coping with stress. But none of them identify the contribution of each function in the formation of depression. As followers of these theories, we accepted that the avoidance, flight, aggressiveness and the other types of coping with stress in depression are the results of dysfunctional beliefs but there is not a model that can explain the contribution of brain executive functions to determine the effects of coping styles on depression. Do the working memory, decision making and meta-cognition contribute the same way as the coping with stress styles affect MDD? Or do they mediate and increase these effects? Do quantitative data obtain the detailed information about patients' executive functions in order to earn a rich model regarding coping with stress styles and MDD? We know by the past studies that all executive functions correlate significantly to coping with stress styles and MDD, but it is needed to find the influences of coping styles on executive functions and the contribution of each one on MDD. SEM path analysis modeling could find the causality between variables regarding their correlation matrix (Kline, 2005).

However, the effect of socioeconomic pressures and strong international conflicts on people of the Middle East has been a point of concern for the researchers. As clinical psychologists, the researchers are the witnesses of a new phenomenon that according to information processing approach is not relate to incompatible beliefs. High pressure and stress originated from the external events can cause depressive disorders (National Institute of Mental Health, 2013; Cohen, Janicki, Doyle, 2012; Dopkeen, Dubios, 2014). Traumatic factors can disturb the executive functions and lead to aggressiveness and significant psychosocial complication (Kieron & Marie-Claude, 2011). The main goal of this research is to investigate the working memory, decision making and meta-cognition intermediate roles in correlation between coping with stress styles and MDD. However, the long-term and practical goal is to take an important step in MDD differential diagnosis and etiology. For reach to this purpose, the SEM modeling and path analysis were applied to analyze the variables' correlation matrix. SEM modeling is a valid method to find the causality between the predictors, mediators and criterion variables. The conceptual framework of the research is provided below. It represents the mediation role of executive functions between coping styles MDD:

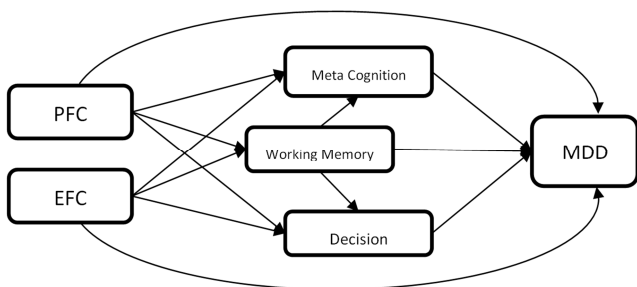


Figure 1. The conceptual framework coping with stress styles, mediators, and MDD. MDD = Major depressive disorder; PFC = Problem focused coping; EFC = Emotion focused coping.

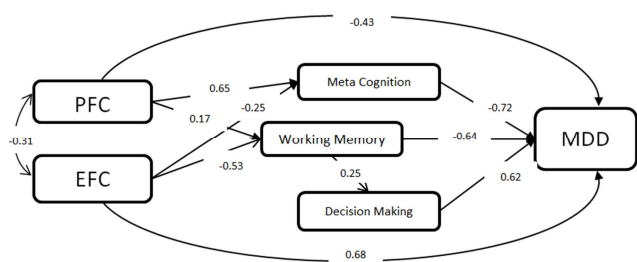


Figure 2. The model of coping with stress styles, executive functions and MDD with direct and indirect paths.

3. Methods

This research was correlation and the intermediate role of executive functions was obtained by SEM path analysis between coping with stress styles and MDD. The model in figure 1 was the study's conceptual framework and the model in figure 2 obtained by Lisrel 8.50 software (Jorreskog & Sorbom, 2001) associated with the variables' correlation

matrix. The clinical sample consisted of 250 MDD patients of mental health clinics and hospitals. The participants entry criteria were sever MDD clinical diagnosis without comorbid anxiety disorders which was previously diagnosed by health centers' psychiatrists. The duration of disorder was between two weeks and five months in patients who had not been previously treated or medicated. The patients were in middle socioeconomic level to control the effect of this variable. The coping with stress styles (emotion and problem focused styles) were predictor variables in the model and the three executive functions (working memory, decision making and meta-cognition) were the mediators between coping styles and MDD. The participants were between 20-40 years old (90 men and 155 women) with the mean of 28.5 and 74 percent of them had high school diploma, 10 percent a college degree and 16 percent a Bachelor degree. Since there are no differences in MDD clinical symptoms between men and women (American Psychiatric Association, 2014), the gender was not a control variable in this study.

Patients MDD diagnosis and excluding the comorbid anxiety disorders was performed by semi-structured inventory (SCID-I) (Spitzer, Williams, Gibbon & First, 1992); however, to obtain quantitative data we used DASS-21 scale: "The depression, anxiety and stress scale was developed to measure the constructs of depression and anxiety and to address the failure of earlier emotional measures in discriminating between anxiety and depression" (Lovibond & Lovibond, 1995). DASS-21 is able to detect the symptoms by assessing the past week in adults. The working conditions and control questionnaire (WOCCQ) were used for assessing the coping with stress styles (Lazarus & Folkman, 1984). It consists of 65 items to assess the PFC and EFC. We applied the N-Back test to measure the working memory and decision making (Chen, Mitra & Schlaghecken, 2008). The N-Back test was a software tool operated on four laptops that ran on the Microsoft Windows 7 home premium version 6.1.7600 (Khodadadi, Mashhadi & Amani, 2014). It involves three levels of measuring (1-Back, 2-Back and 3-Back) using the numbers as stimulus that run every 0.5s respectively. There were 96 trials in every levels of N-Back. For example, each number should compare with its past number in 1-Back, or with its two past numbers in 2-Back and with its three past numbers in 3-Back. Then the participants should push the correct bottom if they were similar. In contrast, participants should push the incorrect bottom if they were dissimilar. The reaction time, correct responses and incorrect responses are the criteria to evaluate the working memory and decision making.

The Behavior Rating Inventory of Executive Function-Adult version (BRIEF-A) was applied in this research (Roth, Isquith & Gioia, 2005) for measuring the meta-cognition. BRIEF-A contains two scales for behavior setting and meta-cognition based on factor analysis. The meta-cognition scale involves four subscales including initiate, organization, planning and self-regulatory subscales which were implemented in this study to measure the meta-cognition. The behavior setting subscales (inhibition, flexibility, control and supervision) were

not used in this research for there were not significant influences between them and MDD in previous study (Zandkarimi, Yazdi, Khosravi & Dehshiri, 2015).

In order to make the test reliable, the researchers obtained the internal consistency. The Cronbach's alpha coefficients for all of the variables were between 0.82 and 0.85 that there were significant values in evaluating the behavioral science test reliabilities. The criterion validity of DASS-21 in correlation with Beck anxiety inventory (BAI) is 0.81 (Brown, Akiyama, White, Jayaratne, & Anderson, 2009). Aghauseffi (2011) reported that the constructive validity of the WOCCQ inventory is acceptable. Kane, Conway, Miura, Golfesh (2007) emphasis that the constructive validities of N-Back test is significant. The convergent validity of BRIEF-A scale in correlation with the frontal systems behavior scale (FrSBe) was 0.77 that is significant (McAuley, Chen, Goos, Schachar & Crosbie (2010).

According to the cognitive approach, negative processes are known as reasons of mental disorders (Barkley, 2001). Cognitive approaches emphasize that the etiology of mental

health are in the basis of thinking, schema, and the input processes that impact on the outputs and eventually, lead to mental health problems. Furthermore, they believe that the mental disorders merely intensify the cognitive impairments but they are not the reasons of these impairments. So we do not mention on recursive paths from MDD to executive functions and coping styles in this research. To investigate the fitness of the research's model the structural equation modeling (SEM) and maximum likelihood methods were used by Lisrel 8.50 software. All of the SEM assumptions such as the data normality, interval scale, the absence of Multicollinearity between variables..., etc. were regarded in this research. Furthermore, the univariate normality and the multivariate normality were investigated.

4. Results

Table 1 displays the correlation matrix and then descriptive statistics of all variables:

Table 1. Correlation matrix and descriptive statistics of all variables.

Variables	1	2	3	4	5	6
1. MDD	1					
2. PFC	0.36**	1				
3. EFC	0.54**	-0.31**	1			
4. Working Memory	-0.58**	0.15**	-0.43**	1		
5. Decision making	-0.39**	0.08	-0.08	0.21**	1	
6. Meta-Cognition	-0.15**	0.43**	-0.35**	0	0.06	1
Mean	11.18	29.98	35.08	36.24	53.07	38.26
Standard Deviation	1.31	6.49	9.38	16.77	17.77	8.62

**p< 0.01

Note. Table 1 represents the correlation between predictor and mediator variables and MDD. The mean and standard deviation of all variables are listed below the correlation matrix.

Table 2 demonstrate the effect coefficients and tolerate values of all the model effects and paths:

Table 2. Standard effect coefficients and tolerate values.

Paths	Non-standard Estimate	Standard Estimate	R ²	T-value
PFC > WM	0.15	0.17	0.03	2.83*
PFC > M-Cog	0.59	0.65	0.42	10.31*
PFC > MDD	-0.43	-0.43	0.18	-6.90*
EFC > WM	-0.56	-0.53	0.28	-8.14*
EFC > M-Cog	-0.22	-0.25	0.08	-4.30*
EFC > MDD	0.63	0.66	0.44	14.32*
WM > DECI	0.26	0.28	0.08	3.54*
WM > M-Cog	0.08	0.08	0.00	4.23*
WM > MDD	-0.60	-0.64	0.41	-20.58*
DECI > MDD	0.64	0.62	0.40	26.86*
M-Cog > MDD	-0.71	-0.74	0.55	-12.18*
PFC > WM > MDD	-0.11	-0.11	0.01	-1.98*
PFC > M-Cog > MDD	0.46	0.48	0.23	7.89*
PFC > WM > DECI > MDD	0.03	0.03	0.00	0.89
EFC > WM > MDD	0.34	0.34	0.12	4.44*
EFC > M-Cog > MDD	0.20	0.18	0.03	3.00*
EFC > WM > DECI > MDD	0.10	0.10	0.01	2.48*
WM > DECI > MDD	0.15	0.17	0.03	2.58*

* T value > 1.96

Note. The significant effects are the ones with more than 1.96 T values. The non-significant effects were excluded from the table. WM = Working Memory; M-Cog = Meta-Cognition; DECI = Decision Making.

According to Table 2 and SEM modeling, the paths could show the effect of predictors to mediators and MDD. All the PFC paths on executive functions are significant except for decision making which directly influences on MDD. Also EFC path to working memory and meta-cognition are significant. As presented in Table 2, the common mediators between both PFC and EFC and MDD are working memory and meta-cognition.

Table 3. Coping with stress, executive functions & MDD models' coefficient fitness indexes.

Chi2:DF	RMSEA	CFI	NFI	NNFI	RMR	IFI	GFI	P
(137.30:78)=1.76	0.05	0.9	0.9	0.9	0.05	0.91	0.96	0.69

Note. Model represents goodness of fit. χ^2 = Chi Square; DF = Degree of Freedom; RSMA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; NFI = Normed Fit Index; NNFI = Non-Normed Fit Index; RMR = Root Mean Square Residual; IFI = Incremental Fit Index; GFI = Goodness of Fit Index; P = P-Value.

As shown in fitness indexes, model's fitness is good and this theoretical structure is approved. To recalculate the effect coefficients, the paths with a less than 1.96 T values were excluded from the model. The developed model by Lisrel 8.50 software with path coefficients is presented below:

5. Discussion

When addressing the question of whether the executive functions mediate the correlation between coping with stress styles and MDD, our overall findings support a model represent the contribution of each mediator in determining the direct and indirect paths on MDD. Our findings stand in contrast with the findings of previous research groups (Parletta, Milte, Meyer, 2013; Shin, Kang, Kim, Jung & Kim, 2012; Panza, Frisardi & Carpurso, 2010) who found no significant correlation between depression and cognitive or executive functions.

These finding showed that coping with stress styles directly affect MDD and these effects are negative in relation to PFC and MDD. This means people with problem focused coping style are less likely to suffer from MDD, whereas EFC is a strong predictor of MDD. We could interpret the emotion focused coping styles such as avoidance, flight; aggression, addiction..., etc. are more likely to result in people suffering from depression. In contrast, problem solving, responsibility and positive thinking predict mental health.

Meta-cognition and working memory are the mediators between coping styles and MDD; but decision making independently, positively and directly influenced on MDD. Many studies have found significant correlation between depression and decision making (Gilbert, 2009; Devisser, 2010; Mueller, Pechtel, Cohen, Douglas, & Pizzagalli, 2015). The evidence of decision making's failure in depressed patients has been of great value to clinical society as such evidence could strengthen brain-behavior relationships and highlight the nature of dysfunctional process in patients. The positive and direct effect of decision making on MDD shows that this executive function is very influential in this disorder. Most studies confirm that depression leads to making the decision to get a divorce (Smith, Daniel & Ichiro, 2014), to commit suicide (Stephoe, Angus & Arthur, 2015), to quit a job and to avoid friends and family members (Philips, 2013). Therefore, it is apparent that the impact of decision making on depression

is quite considerable and significant.

According Barkley's (2001) emphasis on inhibition and working memory that play the most important role in cognitive impairments, these findings showed that working memory plays important mediation role between coping styles, decision making and MDD; many studies confirm our results that working memory have a strong role in connecting with other executive functions and MDD (Jiang & Kleitman, 2015; Cook and Colleagues, 2015). In contrast with Barkley's (2001) theory, our previous study showed that inhibition has not the fundamental role in managing the other executive functions on depression's cognitive impairments (Zandkarimi & Colleagues, 2015). Many of the recent studies have shown that working memory plays an undeniable role in depression (Vadnais, Behm, Laake, Lopez, Oddi, Wu & Bridgett, 2012; Baddeley, Banse, Huang, Page, 2012). Our study showed that the role of working memory passes through the EFC and MDD; nevertheless, the role of PFC in this path is much less than EFC. EFC influences working memory and meta-cognition negatively whereas PFC affects them weakly and positively. Meta-cognition is the other executive function that mediated the paths between coping with stress styles and MDD. It was not influenced by working memory as well as decision making. This mediator strongly connected the paths between EFC and MDD.

Our overall research suggests the proprietary executive functions for MDD are meta-cognition, working memory, and decision making respectively which mediate the correlation between coping with stress styles and MDD.

The results obtained from this study must be interpreted in the context of its strength as well as its limitations. On the one hand, the positive aspects such as its sample size (120 participants) would help to increase the statistical power. In this respects, we relied on the method of individual and experimental measuring and clinical interviews such as SCID-I. These methods result in valuable information about the executive functions and MDD.

6. Limitation of These Studies

Confrontation with technological, demographic and modality limitation is one of the problems of every studies. Accordingly, these findings should be interpreted in the context of limitations that may categorize as technological

and demographic limitations.

Technological limitation. It is important to notice the use of the fMRI and PET scans to study on brain prefrontal reactions when participants involve with the tests. Unfortunately, these methods were absent in this study due to lack of laboratory equipment.

Demographic limitations. First, we should consider the comorbid disorders linked with MDD; however, only MDD patients suffering from anxiety disorders were excluded from the sample size. The co-morbidity of MDD with personality disorders that may affect the study findings were not excluded from this research because they overlap with the coping with stress styles. We know that according to the trait approach, stable traits in personality (Nolen-Hoeksema, Fredrickson, Loftus, Lutz, 2014) could be similar to stable processing patterns of coping with stress in cognitive approach (Lazarus & Folkman, 1984). Second, the intelligence of the participants should be controlled as it might affect the executive functioning in people. These limitations should be considered in future researches.

7. Conclusion

In conclusion, our research suggests that the mediating role of executive functions cause indirect effect from coping styles to MDD. We found out that EFC strongly influences on MDD and accordingly, working memory and meta-cognition mediate this connection. Moreover, the decision making is an executive function that predicts MDD independently and its influence is significantly meaningful. The role and efficiency of meta-cognition, working memory and decision making is suggested in treatment of depressive disorders with co-morbid anxiety by controlling the intelligence factor in the future studies.

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