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Original Article

Developing a model for the relationship between cognitive defusion and problem-solving with the mediating role of metacognitive awareness in borderline personality disorder

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Abstract

In recent years, the study of neuropsychology has played a significant role in explaining the symptoms of borderline personality disorder. Therefore, the purpose of this study was to model the relationship between cognitive defusion and problem-solving, considering the mediating role of metacognitive awareness in individuals with borderline personality disorder. The population of this research included all individuals with borderline personality disorder in Kurdistan province, aged between 18 and 60 years, during 2020 and 2021. A purposive sampling method was employed, following the "Kline" rule, and a total of 234 individuals were selected from this population. The participants completed the Cognitive Fusion Questionnaire by Gillanders et al. (2014), the Metacognitive Awareness Inventory by Schraw and Dennison (1994), and the Social Problem Solving Inventory by D'Zurilla and Nezu (2002). The data were analyzed using structural equation modeling in Amos-22 software. The results confirmed the mediating role of metacognitive awareness in the relationship between cognitive defusion and problem-solving abilities in individuals with borderline personality disorder. Specifically, cognitive defusion directly and positively influences problem-solving skills ($p < 0.01$, $\beta=0.47$), and metacognitive awareness also directly and positively affects problem-solving skills ($p < 0.01$, $\beta=0.19$). Additionally, cognitive defusion indirectly affects problem-solving skills by influencing metacognitive awareness ($p < 0.05$, $\beta=0.07$). These results highlight the significance of both cognitive defusion and metacognitive awareness in predicting and improving problem-solving abilities in individuals with borderline personality disorder.

Keywords

Cognitive defusion,
Metacognitive awareness
Problem-solving
Borderline personality disorder

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Introduction

Borderline personality disorder (BPD) is a chronic mental disorder associated with pervasive patterns of interpersonal relationship instability, impulsivity and self-injury behaviors (Leichsenring et al., 2023). Research evidence suggests that hypoactivation of prefrontal regions, and consecutive alterations of fronto-limbic network functionality in BPD play an important role in executive functions (Molavi et al., 2020). Executive functions are neurological processes that begin to grow from childhood and evolve later, They can be improved at any point in life if needed (Muir et al., 2023) since executive functions play a role in controlling and regulating behavior (Hofmann et al., 2012). It is hypothesized that defecits in these functions may underlie some of BPD symptoms, such as impulsivity, aggression, and self-injurious behaviors (Dusi et al., 2021). Problem-solving is one of these functions (Cancer et al., 2023) in which people with BPD show a wide range of problems (Dixon-Gordon et al., 2011)**.** For example, studies have shown that patients with a history of self-injurious behaviors or suicide attempts, including those with BPD (Turner et al., 2015), do not respond successfully to social problem-solving scenarios that increase suicide attempts (Walker et al., 2017). Because people with BPD have a negative attitude toward the problem with impulsive/careless and avoidant styles (Bray et al., 2007), which leads to poor decisions and not learning from their bad decisions even with dangerous consequences (Paret et al., 2017), therefore, it can be assumed that solving social problems is a coping method that, if efficient, reduces the effect of stress on mental and physical health (Nezu et al., 2019) and, if inefficient, causes mental

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disorders (Chang et al., 2020). The result will be that paying attention to problem-solving and increasing it will increase optimal social performance (D'Zurilla et al., 2002). Since low social functioning is one of the important components of personality disorder (Vivarini et al., 2023), it is necessary to address problem-solving in patients with BPD**.** On the other hand, underlying cognitive factors and consequent obstacles to problem-solving (Chen et al., 2020) need to be identified to understand it better**.**

Cognitive flexibility is described as one of these processes, which means changing one's thinking from old situations to new ones, overcoming common responses or thinking, as well as adapting to new situations (Wendiggensen & Beste, 2023). That can be effective in problem-solving through adaptation of other cognitive processes in order to deal with new and unexpected life situations (CaÑAs et al., 2003). Cognitive defusion, a component of cognitive flexibility, can help a person avoid problematic thoughts and solve them better (Hayes et al., 2006). In cognitive Defusion, the principle is that one can accept that his thoughts are separate from him and are nothing more than temporary private events.

Evidence suggests that cognitive Defusion in people with a BPD is lower than the normal population and has a high correlation with symptoms of the disorder (Imani & Pourshahbazi, 2017).

Another underlying cognitive factor associated with problem-solving in patients with BPD is metacognition, which is related to defects (Lysaker et al., 2017).

Researches showed that there is a high correlation between metacognitive skills and success in problem-solving, and the difference in the level of performance in metacognitive skills shows the degree of success or failure of individuals in problem-solving (Dindar et al., 2020; Krieger et al., 2022). The conclusion drawn from these findings is that part of the underlying cognitive defects in problem-solving in BPD may be due to metacognitive deficits and cognitive Defusion**.**

According to D'Zurilla et al., (2004) theoretical model, problem-solving has three levels: basic cognitive level, metacognition level, and performance level. The metacognitive level is composed of awareness and overall assessment of life problems and solving their problems. The performance level is composed of a specific individual problem-solving style or the way in which the individual specifically tries to solve the problem. At the basic cognitive level, mental abilities and information processing are the basis of learning and performing the abilities and skills of the other two levels and affect them. It is noteworthy that it is still unclear which basic cognitive function is most important for problem-solving. This model does not examine basic cognitive level abilities. Because it is assumed that most people, both clinical and normative populations, already have fundamental abilities to allow them to learn from experiences and acquire constructive problem-solving skills and abilities at metacognitive and functional levels (D'zurilla et al., 2004).

Other studies investigating the relationship between these functions and symptoms of BPD have not determined the path of these relationships according to the Higher order abilities. Therefore, this study, in line with the theoretical model of D'Zurilla et al., (2004), seeks to answer these questions about the relationship between cognitive Defusion as a basic cognitive function and metacognition with problem-solving in people with BPD in Iranian society, and what role metacognition plays as a mediator variable according to the theoretical model of D'Zurilla et al., (2004).

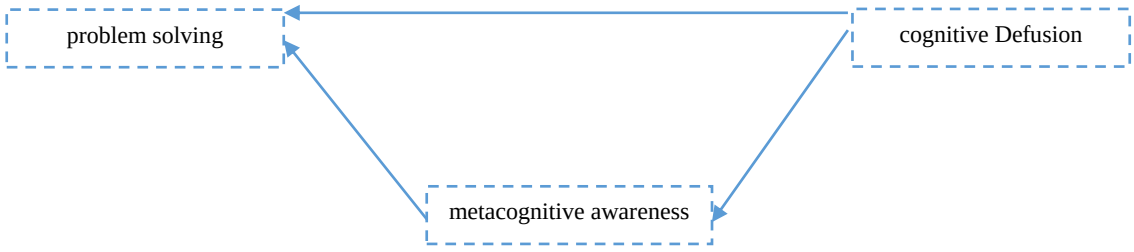

Figure 1. The conceptual model of research

Method

Participants

In terms of implementation, this research was based on structural equations and was part of descriptive research of correlation type in terms of data type. The population of this research included all people with BPD who referred to counseling centers and psychiatric clinics and Ghods Hospital in Kurdistan province in the years 2020 and 2021, of whom 234 people were selected based on the " Kline" rule for sampling in structural equations (Kline, 2023). They were selected through purposeful sampling. To estimate the sample size, the method of Kline (2023) was used, which proposed different models for estimating the sample in structural equations. One of them is determining the sample size based on the number of main structures in the structural equations. If the number of main structures is 5 structures or less, the minimum sample size is 100 and the maximum is 300 units. For this reason, 234 people were targeted sampling selected for the adequacy of the sample size in this study. in the research project were selected according to the inclusion criteria including diagnosis of BPD based on DSM-5 diagnostic interview, Realization of borderline personality clinical measures in the Millon Test, having a minimum education in ninth grade and having an age between 18

and 60 years. The reason for choosing this age range was that BPD is first diagnosed from the age of 18 and above, and memory problems are highly prevalent from the age of 60 .Exclusion criteria included drug and psychological treatments in the past six months, substance or alcohol abuse, and psychological disorders . The samples completed the research questionnaires. The descriptive statistical method of mean and standard deviation and inferential statistical method of structural equation modeling were used in Amos software.

Instrument

Cognitive Fusion Questionnaire (CFQ):

The Cognitive Fusion Questionnaire (CFQ) was developed by Gillanders et al. in 2010. This questionnaire consists of 12 items and assesses cognitive fusion and cognitive defusion as two components using a six-point Likert-type scale. Example items include "Even when distressing thoughts come into my mind, I know that these thoughts ultimately become unimportant." The minimum possible score is 12, and the maximum score is 72. Scores between 12 and 24 indicate low levels of cognitive fusion, scores between 24 and 48 indicate moderate levels of cognitive fusion, and scores above 48 indicate high levels of cognitive fusion. The cognitive defusion component includes three items (1, 2, and 9), while the cognitive fusion component includes nine items (3, 4, 5, 6, 7, 8, 10, 11, and 12). The validity and reliability of this questionnaire have been established (Gillanders et al., 2014). In Iran, the Cronbach's alpha coefficient for this tool has been determined as 0.87 (Saeidpoor et al., 2017). In the present study, Cronbach's alpha coefficient was 0.66. Both subscales were used, and Cronbach's alpha coefficient of cognitive fault was 0.65, and cognitive fusion was 61.1.

Metacognitive Awareness Inventory (MAI):

The Metacognitive Awareness Scale was initially developed by Schraw & Dennison (1994). It consists of 52 true or false items that assess various dimensions of metacognitive awareness. Each correct answer is scored as 1, while each incorrect answer receives a score of 0. The scale measures two main dimensions: knowledge about cognition (expressive knowledge, process knowledge, and situational knowledge) and cognitive regulation (planning, information management strategies, reading comprehension monitoring, problem-solving strategies, and evaluation). The authors of the questionnaire reported internal consistency coefficients ranging from 0.88 to 0.93 and a reliability coefficient of 0.93 using the Cronbach's alpha method, indicating good reliability for both the cognitive and cognitive regulation dimensions (Schraw & Dennison, 1994). In Iranian studies, the total alpha coefficient of the questionnaire was 0.82, and for the subscales, it was 0.84. Specifically, the Cronbach's alpha coefficient for the overall scale was 0.808, while for the dimensions of knowledge recognition and cognitive regulation, it was 0.853 and 0.786, respectively (Kooshki & Shavandi, 2019). In the present study, the Cronbach's alpha coefficient for the overall scale of this tool was found to be 0.79.

Social Problem Solving Inventory (REVISED):

The Social Problem-Solving Inventory Scale (SPSI-R) is a revised short form of social problem-solving developed by D'Zurilla et al., (2002) with 25 questions. It aims to assess individuals' skills in solving social problems. The subscales of the SPSI-R include Positive Problem Orientation (PPO), Rational Problem Solving (RPS), which are constructive problem-solving subscales and scored positively, and Negative Problem Orientation (NPO), Impulsiveness/Carelessness Style (ICS), and Avoidance Style (AS), which are inefficient problem-solving styles and scored inversely. Therefore, according to this tool, higher scores in PPO and RPS and lower scores in NPO, ICS, and AS indicate better social problem-solving abilities, while lower scores in PPO and RPS and higher scores in NPO, ICS, and AS indicate weaker social problem-solving abilities. The test-retest reliability for this questionnaire has been reported between 0.68 and 0.91, and the alpha coefficient ranges from 0.69 to 0.95 (D'Zurilla et al., 2002). In Iran too reported an alpha coefficient of 0.85 for the total score of the questionnaire's five factors and a test-retest reliability coefficient of 0.88 (Mokhberi et al., 2011). In the present study, the Cronbach's alpha coefficient for the overall scale of the Social Problem-Solving Inventory Scale (SPSI-R) was found to be 0.81.

Results

In this study, the Structural Equation Modeling (SEM) method using Amos software was employed to examine the research hypotheses. The sample of the study consisted of 234 participants. Among these, the highest frequency was observed in the group of women, with 146 individuals. The highest frequency was found in the diploma group, with 131 participants in the education variable. In terms of age, the highest frequency belonged to the 21-30 age group, with 81 individuals. Regarding marital status, the highest frequency was observed among married individuals, with 118 participants. The following are descriptive indicators of research variables.

Table 1. Descriptive Indicators of Research Variables

Variable	Average	standard deviation	Skewness	kurtosis
Knowledge of cognition	0.43	0.19	-0.20	-0.76
Regulation of cognition	0.68	0.17	-0.14	-0.33
positive problem orientation	5.82	1.02	-0.46	-0.32
negative problem orientation	7.87	2.09	-0.22	-0.77
logical problem solving	11.13	4.11	0.34	-0.09
impulsive style	9.35	3.25	-0.12	0.50
avoidance style	10.01	0.89	0.21	-1.09
Total problem solving skills	39.12	8.87	0.13	-0.03
Cognitive defusion	14.81	0.85	-0.07	-0.76
Cognitive fusion	36.16	1.27	-0.14	-0.56

Table 1 shows the results of descriptive indicators related to research variables ,The average and standard deviation indices of variables indicate the appropriate distribution of data, and skewness and elongation indices indicate that the distribution of the research variables is normal. normality is another important topic in causal models (R. Kline & St, 2022).. Due to the high number of samples in these models, skewness and elongation indices investigate this issue. To examine the normality of single-variable data distribution, the absolute magnitude of skewness and elongation of variables should not exceed 3 and 10, respectively. To investigate the normality of the distribution of research variables, the Calmogrov-Smirnov test was used to perform parametric tests at the level of 0.05, which indicated the normality of the distribution of variables and, therefore, parametric tests were used to investigate the relationship between variables. Considering that correlation matrix is the basis for analysis of causal models, especially structural equation modeling; therefore, before considering the theoretical model test, the correlation matrix of hidden variables of the research along with their correlation coefficients and significance levels were calculated that the results were reported in Table 2.

Table 2. Correlation Matrix of Hidden Variables of Theoretical Model of Research

Variable	1	2	3
cognitive defusion	1		
Metacognitive Awareness	**0.315	1	
Problem Solving	**0.397	**0.289	1
*p<0.05, **p<0.01			

According to table 2 results, the relationship between cognitive defusion and metacognitive awareness was 0.315. The relationship between cognitive defusion with problem-solving was 0.397. The relationship between metacognition awareness and problem-solving was 0.289, all positive and significant at the level of 0.01.

Theoretical model test: The proposed conceptual model was investigated by path analysis using the maximum probability method to test the theoretical model. To evaluate the fit of the model, indicators of Xi's square ratio to the degree of freedom (X2/d.f), adaptive fitness index (CFI), the goodness of fit index (GFI), the goodness of fit adjustment index (GFI), and mean square error of approximation error (RMSEA) were used. Figure 2 shows the tested models of the research.

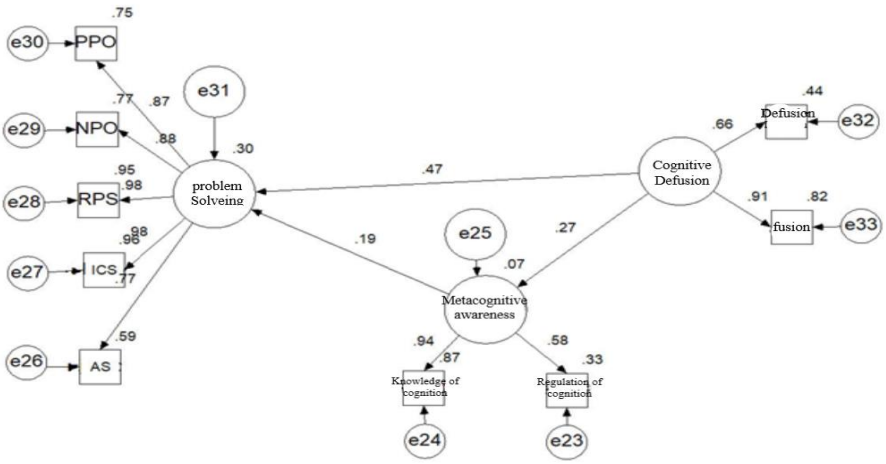

Figure 2. The tested model of the relationship between cognitive defusion and problem solving considering the mediating role of metacognition awareness

Direct effects: According to Figure 2, cognitive defusion with a coefficient of 0.47 directly affected problem-solving skills with a coefficient of 0.27 on metacognition awareness. The direct effect of metacognition awareness on problem-solving was also 0.19. It should be noted that cognitive defusion 0.17 predicts variance of metacognitive awareness and cognitive defusion along with metacognitive awareness 0.30 of problem-solving changes Table 3 shows the coefficients of direct effects, t statistics, and the significant level related to each path.

Table 3. Estimating Direct Effects Coefficients

Variables	path coefficient	t-statistic	confidence level	R^2
Metacognitive awareness of		-		0.17
Cognitive Defusion	0.27	2.90	0.01	
problem Solveing of	-	-	-	0.30
Cognitive Defusion	0.47	6.60	0.001	
Metacognitive awareness	0.19	3.12	0.001	

Table 4. Estimating Indirect Effects Coefficients

Variables	path coefficient	High level	Low level	confidence level
The effect of cognitive fault on problem solving through metacognition	0.07	0.11	0.02	0.05

Table 4 shows that the indirect effect of cognitive Defusion on problem-solving skills was 0.07, which was significant at the level of 0.05.

Model Fitness Test: In this study, the goodness of fit index (GFI), modified fit goodness index (AGFI) and root of standardized residual mean squares (RMR) as absolute fitness indices, adaptive fitness index (CFI), normative fitness index (NFI) and incremental fitness index (IFI) as adaptive fit indicators and Xi square on the degree of freedom (X2/df), IJAZ Fitness Index (PCFI) and Squared Mean Square Error Square (RMSEA) as Indicators Appropriate fits were considered and their test results were reported separately in Table 5.

Table 5. Good Indicators of Fitting the Tested Model of Research

Absolute Fitness Indicators			
Index	GFI	AGFI	RMR
The value obtained	0.91	0.82	0.40
Acceptable limit	more than 0.90	more than 0.80	Small amount
Comparative fit Index			
Index	CFI	NFI	IFI
The value obtained	0.96	0.95	0.91
Acceptable limit	more than 0.90	more than 0.90	more than 0.90
Adjusted Goodness of Fit Index			
Index	X2/df	PNFI	RMSEA
The value obtained	2.53	0.67	0.06
Acceptable limit	less than 3	more than 0.60	less than 0.08

According to Table 5 and based on the quorum of fit criteria, the fitness indicators of the present model were appropriate and acceptable. Also, the role of the mediator variable was minor because the direct effect of all variables was significant.

Discussion

Based on the findings of the present study, the metacognitive awareness mediation model in the relationship between cognitive defusion and problem-solving skills was found to be a good fit. The relevant pathways were investigated separately to explore the mediating role of metacognitive awareness. One of the conditions for examining the role of the mediator is the significance of the direct relationship between the predictor variable and the criterion. The first path examined the direct relationship between cognitive defusion and problem-solving skills, which revealed a significant relationship. In other words, as cognitive defusion scores increase, problem-solving skills scores also increase. This finding aligns with the results of previous studies (Hayes et al., 2006; Kishita et al., 2014). Therefore, it can be argued that cognitive defusion, by enabling individuals to gain control over their thoughts and liberate themselves from destructive thinking patterns, has a greater influence on their behavior and emotions, ultimately enhancing problem-solving performance. By altering the contexts and conditions that reinforce harmful cognitive functions and recognizing the transient nature of thoughts and emotions, cognitive defusion contributes to increased self-confidence.

The results of the direct path analysis revealed a positive relationship between metacognitive awareness and problem-solving skills. These findings align with previous studies conducted by (Arum et al., 2019; Boran & Karakuş, 2022; Liu & Liu, 2020). To explain this finding, it can be stated that metacognitive awareness involves insight and regulation of the problem-solving process, which aids in problem-solving. By being aware

of their thinking process, individuals can choose the best solution for solving a problem. In other words, as cognitive fusion scores decrease, metacognitive awareness increases.

The results of the mediating effects test indicated that cognitive defusion has an indirect effect on problem-solving through metacognitive awareness. It can be argued that increasing scores in cognitive defusion lead to increased scores in metacognitive awareness, and reciprocally, higher metacognitive awareness scores contribute to higher problem-solving scores among patients with BPD. The presence of higher metacognitive awareness plays an observing role in the problem-solving process. Therefore, it can be concluded that as cognitive defusion scores increase, flexibility also increases, leading to an improvement in problem-solving skills. Cognitive defusion can be seen as the ability to observe and separate oneself from thoughts and feelings, while metacognitive awareness and cognitive defusion both refer to the ability to monitor thoughts (Hayes et al., 2006).

On the other side, metacognitive awareness acts as an observer and enhances the relationship between cognitive defusion and problem-solving skills. This suggests that individuals with BPD may struggle with problem-solving due to deficiencies in metacognition. All the findings of this study were in line with the theory proposed by D'Zurilla et al. (2004). According to their theory, problem-solving consists of three levels: the basic level, the metacognitive level, and the performance level. All these levels were confirmed in the present study. While the basic levels were not specifically studied in this theory, the present study examined this aspect of D'Zurilla et al.'s theory in terms of innovation and novelty. The findings showed that cognitive defusion, as one of the basic cognitive levels, became significantly related to problem-solving. Additionally, the metacognitive level of problem-solving, represented by metacognitive awareness in this study, was confirmed as a mediator and factor that enhances problem-solving ability. Ultimately, in accordance with D'Zurilla et al. (2004) theory, both the basic cognitive level and the metacognitive level contribute to an increase in problem-solving effectiveness, which was also demonstrated in the present study. Hence, the present study aligns with the theory proposed by D'Zurilla et al. (2004).

There were certain limitations to the present study, including the use of self-report measures that may introduce bias. Moreover, approximately 89% of the sample consisted of female patients, limiting the generalizability of the results. Based on the findings of this study, it is recommended to consider cognitive defusion skills in order to enhance problem-solving abilities in patients with BPD. Furthermore, given the impact of the metacognitive factor, interventions focusing on this variable could be implemented. Additionally, future studies could explore gender differences in the relationships between cognitive defusion and problem-solving through metacognitive awareness. It is also suggested that future research investigate the causes and inefficiencies of problem-solving in individuals with BPD using qualitative and interview-based methodologies.

Conclusion

This study aimed to investigate the mediating role of metacognitive awareness in the relationship between cognitive defusion and problem-solving. The results demonstrated the mediating role of this variable. Metacognitive awareness, with its managerial role, enhances cognitive defusion and, at the same time, improves problem-solving ability through monitoring and management.

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