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An Explanation of Impulsivity, Cognitive Flexibility, and Metacognitive Thinking in Non-Suicidal Self-Injury Behaviors

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Quantitative Study

Abstract

Background: Non-suicidal self-injury (NSSI) is a common symptom of psychiatric disorders. The main aim of the current study was to explain the role of three specific aspects of executive functioning (EF) (impulsivity, cognitive flexibility, and metacognitive thinking) in the prediction of adolescent NSSI.

Methods: This was a descriptive and correlational study. The statistical population consisted of all online responders in Iran under the age of 18, in the year 2022-2023. An online sample of 250 individuals was selected using voluntary sampling. The subjects completed the Barratt Impulsiveness Scale-11 (BIS-11), Cognitive Flexibility Inventory-Iranian Version (CFI-I), the Metacognitions Questionnaire-30 (MCQ-30), and Deliberate Self-Harm Inventory (DSHI). To analyze data, descriptive statistics, correlation matrix, Pearson correlation coefficient, and multiple regression method with SPSS software were used.

Results: The patients with deliberate self-harm (DSH) showed a positive and significant relationship between impulsivity and self-harm ($r = 0.526$, $P < 0.001$). Besides, there was a negative and significant relationship between the variable of cognitive flexibility and self-harm ($r = -0.519$, $P < 0.001$). Research has suggested an association between NSSI behaviors in adolescence and deficits in EF.

Conclusion: According to the study, metacognitive thinking and impulsivity were significantly associated with self-harm. More research is needed to understand the implications of such deficits, and if the results could be used for adapting treatment services and strategies.

Keywords: Impulsivity behavior; Cognition; Flexibility; Metacognition; Thinking; Non-suicidal self-injury; Adolescence

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Introduction

Non-suicidal self-injury (NSSI) is among the most frequent maladaptive behaviors reported in adolescence, with prevalence rates around 18%-22% in community samples worldwide. The onset of NSSI typically occurs between early and middle adolescence, with a peak during middle adolescence (14-15 years) and a subsequent decline during late adolescence (Esposito, Dragone, Affuso, Amodeo, & Bacchini, 2022). A comprehensive systematic review reported the prevalence of NSSI in adolescence between 7.5% and 46.5% (Cipriano, Cella, & Cotrufo, 2017). In another review study, the prevalence of NSSI in Iranian adolescents was 4.3% to 26.8% (Ezakian, Mirzaian, & Hosseini, 2018). In an Iranian study, results showed that the lifetime prevalence of NSSI among students was 6.2% (Marin et al., 2020). Despite its prevalence and lifelong consequences, there has been little progress in the accurate prediction of self-harm (Westers & Plener, 2020).

Adolescence and young adulthood are critical periods of biological and social development. Usually beginning with the onset of puberty, major physical and neurobiological changes occur, characterized by the development of key brain circuits responsible for higher-order cognitive and emotional functions that, if suboptimal or disrupted, can have a significant impact on behaviors and the development of the disorder (Iorfino et al., 2019). Neurocognitive deficits have been documented in adolescents with NSSI (Murner-Lavanchy et al., 2022). Neuro-cognition is one of the factors potentially contributing to an enhanced risk for self-harming behavior. As such, the youth engaging in these behaviors show difficulties regulating their emotions and a lack of impulse control (Kaess, Resch, Parzer, von Ceumern-Lindenstjerna, Henze, & Brunner, 2013). Interestingly, on task-inducing forms of negative affect relevant to NSSI, deficits in inhibitory control have been found more consistently (Allen, Fox, Schatten, & Hooley, 2019).

A systematic review and meta-analysis conducted by McHugh et al. (2019) demonstrated that deficits in inhibitory control, prediction interval, and impulsive decision-making were associated with self-harm or suicidal behavior (SB) (McHugh, Chun Lee, Hermens, Corderoy, Large, & Hickie, 2019). Previous cross-sectional studies have indicated that symptoms of hyperactivity-impulsivity, but not inattention, are associated with NSSI among adolescents (Gerrard, 2018). However, in a longitudinal study of girls with and without attention deficit hyperactivity disorder (ADHD) in childhood, both symptoms of inattention and hyperactivity-impulsivity were associated with NSSI and SB in adolescence and young adulthood (Meza, Owens, & Hinshaw, 2021). In the study of Mozafari et al. (2022), adolescents who reported NSSI had higher scores on risky decision-making, behavioral inhibition, and emotion dysregulation, and lower scores on cognitive flexibility than participants without a history of NSSI (Mozafari, Bagherian, Zadeh Mohammadi, & Heidari, 2022).

Cognitive flexibility refers to the ability to adapt responses/strategies based on environmental feedback. Greater cognitive flexibility may increase one's cognitive access to suicide, making it a more appropriate option in times of distress, especially for those with a prior history of NSSI. Conversely, lower cognitive flexibility may create a negative bias that exacerbates the effects of NSSI on suicidality (Park & Ammerman, 2023). There is evidence that individuals who engage in deliberate self-harm (DSH) may have difficulty dissociating their attention from aversive emotional experiences and other DSH-related stimuli, as well as difficulties shifting their attention to alternative stimuli (Dixon-Gordon, Gratz, McDermott, & Tull, 2014). In a related study, Nilsson et al. (2021) found that patients with DSH showed deficits

in cognitive flexibility and inhibition compared to healthy individuals. In addition, patients with DSH had more deficits in cognitive flexibility than patients without DSH. This effect was independent of the concurrent severity of depressive symptoms, but not of borderline symptoms (Nilsson, Lundh, Westrin, & Westling, 2021).

Moreover, in a comparison between patients seeking treatment for NSSI and a non-psychiatric comparison group, Garreto et al. (2017) found that the NSSI group showed significantly lower problem-solving capacity and mental flexibility (Garreto, Giusti, Oliveira, Tavares, Rossini, & Scivoletto, 2017). In Young et al. (2021) study, regardless of NSSI history, state self-criticism led to more negative insight capacity and reduced participants' metacognitive insight. In individuals without a history of NSSI, state self-criticism also increased auditory accuracy – an effect that was reduced in those with NSSI. These findings suggest that individuals with NSSI are characterized by a blunted and intermittent response to negatively valenced self-focused attention (Young, Davies, Freegard, & Benton, 2021). Considering the role of these variables in teenagers' performance and considering that in the background of the research, these variables have not been discussed together, the purpose of the present research is to explain impulsivity, cognitive flexibility, and metacognitive thinking in NSSI behaviors in adolescence.

Methods

The current research design was correlational. The statistical population included online respondents under the age of 18 in 2022-2023. Regarding the sample size, it was determined by using Morgan's sample size table (n = 180 if N > 280). A voluntary sample of 482 participants from Iran was selected online. Using the cut point of the questionnaire [Inventory of Statements About Self-Injury (ISAS)], among 482 participants, 250 teenagers with self-harm were identified and analyzed. The particular criteria to include in the research process were: being at least 13 years old, being a middle school or high school student, not using psychiatric drugs, not having a stressful event in the past six months, having access to the Internet and virtual space, and not using psychiatric drugs. Exclusion criteria included incomplete questionnaires and missing some questions that were prepared as an online survey using Proseline. Then the link to the online questionnaire was shared through social media and messaging platforms including Instagram, WhatsApp, and Telegram. After removing incomplete items, the final 250 responses were obtained. Researcher considered compliance with ethical guidelines for all ethical principles in this paper.

The Barratt Impulsiveness Scale-11 (BIS-11): This scale has been designed by Barratt (1995). The BIS-11 is a 30-item self-report measure that assesses impulsivity using a 4-point Likert scale (1 = rarely/never and 4 = almost always/always). Higher scores indicate higher levels of impulsivity. Reliability coefficients were calculated using Cronbach's alpha and retest methods, which were 0.81 and 0.77, respectively. The results provide evidence that the structure of the BIS-11 scale applies to the Iranian sample (Javid, Mohammadi, & Rahimi, 2012). In this study, Cronbach's alpha was 0.80.

Cognitive Flexibility Inventory-Iranian Version (CFI-I): The Cognitive Flexibility Inventory (CFI) is a brief 20-item self-reporting instrument designed to measure aspects of cognitive flexibility that enable individuals to challenge and replace maladaptive thoughts with more adaptive ones (Dennis & Vander Wal, 2010). More precisely, Cronbach's alpha for CFI, control, and alternative subscales were 0.91, 0.84, and 0.91, respectively. The seven-week retest reliability coefficients for the CFI, control, and alternative subscales were 0.81, 0.77, and 0.75, respectively (Dennis &

Vander Wal, 2010). The original version of the CFI provided by its developers was first translated into Persian and then re-translated by two expert assistant professors in the English language department of Shiraz University, Shiraz, Iran, to ensure its consistency with the original version. Cronbach's alpha coefficients and retest coefficients for CFI-I reliability were 0.90 and 0.71, respectively (Shareh, Farmani, & Soltani, 2014). Cronbach's alpha in this study was 0.68.

Metacognitions Questionnaire-30 (MCQ-30): This questionnaire contains 30 items and measures people's metacognitive beliefs. The questions of this questionnaire assess five subscales of metacognitive beliefs as follows: cognitive trust (items 1, 6, 11, 16, 21, and 26), positive beliefs about worry (items: 2, 7, 12, 17, 22, and 27), cognitive self-awareness (items: 3, 8, 13, 18, 23, and 28), uncontrollability and risk (items: 4, 9, 14, 19, 24, and 29), and need to control thought (items: 5, 10, 15, 20, 25, and 30). The score for each question ranges from 1 to 4 (strongly agree, agree, have no opinion, and strongly disagree). MCQ-30 has internal consistency and convergent validity, as well as acceptable test-retest reliability (Wells & Cartwright-Hatton, 2004). Cronbach's alpha coefficient and test-retest reliability coefficient of the Persian version have been reported as 0.93 and 0.78, respectively (Abolghasemi, 2007). In this version, the internal consistency coefficient of the whole scale is 0.92, while the coefficients of its subscales are between 0.73 and 0.90, which indicates the favorable validity of all subscales (Bakhtavar, Neshat-Doost, Molavi, & Bahrami, 2007). In this study, Cronbach's alpha was 0.88.

ISAS: It is a self-reporting instrument consisting of 39 questions that assess the frequency and performance of self-injurious behaviors with non-suicidal intent. The items are rated on a three-point Likert scale with a score of 0 (completely unrelated), 1 (somewhat related), and 2 (completely related). In addition, the average score of the overall scales is obtained from the sum of the scores of the subscales and their number. Therefore, the scores of each of the 13 self-injurious behavioral domains can range from 0 to 6. The internal consistency of the scale using Cronbach's alpha method was 0.84 (Klonsky & Glenn, 2009). The content validity of Persian version of the scale was confirmed by Rezaei et al. (2021). The reliability of the scale was 0.76 based on Cronbach's alpha. According to the current research, Cronbach's alpha was 0.83.

For data analysis, descriptive statistics, correlation matrix, Pearson correlation coefficient, and multiple regression methods with SPSS software (version 23, IBM Corporation, Armonk, NY, USA) were used.

Results

The mean ± standard deviation (SD) of the participants' age was 16.84 ± 7.40 years. 145 (58%) of them were girls, and 105 (42%) were boys. Of the participants, 60 (24%) were only child, and 238 (96%) lived with both parents. 118 of the participants (47.2%) were in middle schools, and 132 (52.8%) were in high schools.

Table 1 shows the results of the Kolmogorov-Smirnov test to check the assumption of normality of the distribution of the variables.

Table 1. Descriptive statistics of the variables

Variables	Mean ± SD	Min	Max	K-S	P-value	VIF	Tolerance
Impulsivity	81.16 ± 9.73	98	121	0.75	0.23	0.846	1.16
Cognitive flexibility	65.34 ± 7.65	35	78	0.68	0.28	0.571	10.29
Metacognitive thinking	59.34 ± 6.65	44	102	0.79	0.36	0.719	10.74
DSH	61.74 ± 6.19	27	68	0.82	0.33	0.814	10.68

DSH: Deliberate self-harm; SD: Standard deviation; K-S: Kolmogorov-Smirnov test; VIF: Variance inflation factor

Besides, to check the collinearity of the data, the statistics of the tolerance factor (tolerance) and the variance inflation factor (VIF) can be used. As can be seen, the value of the VIF for all predictor variables is less than 0.10, as well as the value of the tolerance factor which is greater than 0.1 for all variables. Therefore, the assumption of non-collinearity of predictor variables has been met.

The results of Durbin-Watson test to check the independence of the errors of the predictor variables were as follows: multiple correlations = 0.815, correlation coefficient = 0.667, adjusted R = 0.540, standard error (SE) = 2.36, and Durbin-Watson's value = 1.73. The Durbin-Watson statistic is in the range of 1.5 to 2.5, and it can be said that the assumption of independence of errors has been met.

The contents of table 2 shows that there was a positive and significant relationship between impulsivity and self-harm in all subjects ($r = 0.526$, $P < 0.001$). Further, there was a negative and significant relationship between the variable of cognitive flexibility and self-harm in all subjects ($r = -0.519$, $P < 0.001$). Moreover, there was a negative and significant relationship between the variable of metacognitive thinking and self-harm in all subjects ($r = -0.594$, $P < 0.001$).

As shown in table 3, according to the results of the regression analysis with the step-by-step method, among the predictor variables of self-harm, only two variables of metacognitive thinking and impulsivity were predictors for self-harm in adolescents and it is possible to obtain a prediction equation by combining two predictor variables. For a linear combination of predictor variables, the multiple correlation coefficient is 0.702, and for squared multiple correlations, it is 0.492 at the $P < 0.001$ level.

Discussion

The aim of this study was to examine whether three specific aspects of executive functioning (EF) (impulsivity, cognitive flexibility, and metacognitive thinking) predict adolescent NSSI. According to the results of the regression analysis with the step-by-step method, among the predictor variables of self-harm, only two variables of metacognitive thinking and impulsivity were predictors for self-harm in adolescents. The presence of a relationship between impulsivity and self-harm has been shown in many studies (Esposito et al., 2022; Cipriano et al., 2017; Westers & Plener, 2020; Murner-Lavanchy et al., 2022; McHugh et al., 2019; Raffagnato et al., 2022). McHugh et al. (2019) found that deficits in inhibitory control and impulsive decision-making were associated with self-harm or SB (McHugh et al., 2019). A study found that inpatients with both NSSI and internalization had higher levels of impulsiveness and alexithymia, and were emotionally distorted (Raffagnato et al., 2022). An important explanation for NSSI is EF, which refers to a broad category of cognitive processes that are involved in the self-regulation of thought and behavior, and make it possible for us to think before we act, stay focused on a task, resist temptations, and adapt to new situations by shifting strategy. It is assumed that higher-order capacities such as reasoning, problem-solving, and planning are built on these core EFs (Meza et al., 2021; Nilsson et al., 2021).

Table 2. Simple correlation coefficients between variables

Variables	r	P-value
Impulsivity	0.526	< 0.001
Cognitive flexibility	-0.519	< 0.001
Metacognitive thinking	-0.594	< 0.001

Table 3. The results of multiple regression analysis related to the interaction of variables with the step-by-step entry method (Part I)

Statistical index	Unstandardized beta	Standardized beta	T	P-value	Multiple correlation
Metacognitive thinking	2.317	0.693	8.93	< 0.001	0.684
Impulsivity	1.619	0.586	6.84	< 0.001	0.702

Table 3. The results of multiple regression analysis related to the interaction of variables with the step-by-step entry method (Part II)

Statistical index	Squared multiple correlation	Coefficient F	P-value
Metacognitive thinking	0.467	51.19	< 0.001
Impulsivity	0.492	39.61	< 0.001

Consequently, the researchers concluded that they might find it more difficult to control their negative moods with such a deficit. Although good working memory is necessary to distract oneself from negative moods, it takes other abilities as well (Nilsson et al., 2021).

Furthermore, the variable of cognitive flexibility was found to have a negative and significant association with self-harm. In line with this finding, numerous studies approved this relationship (Nilsson et al., 2021; Young et al., 2021; Antezana, 2022). There is a significant difference in EF, emotion regulation, and behavioral activation system/behavioral inhibition system (BAS/BIS) between adolescents with NSSI and normal counterparts based on previous results, which is in line with literature that highlights the significance of differences between adolescents with NSSI and normal adolescents. It was found that a person's capability to shift attention was associated with decreased chances of self-harming (Antezana, 2022). DSH behavior is to be associated with higher levels of depression, hopelessness, anxiety, hostility, impulsivity, self-critical rumination, lower optimism, and self-efficacy, as well as lower levels of self-esteem (Nilsson et al., 2021; Young et al., 2021). Theoretical models of self-injurious behavior have suggested that certain factors might increase the capacity to physically harm the body (Hooley & Franklin, 2018).

Moreover, there is a negative and significant relationship between the variable of metacognitive thinking and self-harm in all subjects. There has been little attention paid to this finding in previous studies. The authors could not identify the alignment or non-alignment study. In the following section, we explain the results we obtained from the related article. One of the thinking processes we can monitor to check if we experience dysfunctional thinking is metacognition. The model explains that when a situation or a stimulation triggers the worry, the first type of worry will be activated based on "positive meta-beliefs" that then will activate "negative meta-beliefs" in cascade, which will then create a meta-worry "type 2 worry" that will influence emotional, behavioral, and cognitive response. Patients need to have complex consciousness about their ideas and feelings to implement change, engage in recovery processes, and find motivation for implementing change (Marin et al., 2020).

One limitation of the current study was the use of self-reporting measures. It is possible that subjective reports differ about scales. Another limitation was due to online recruitment that may have been biased due to the confusing in answering the questionnaires. Impulsivity and cognitive flexibility may aid in suicide screening and intervention among vulnerable and high-risk populations should be done.

Conclusion

Implementing these factors in our assessment could help us orient our patients to the

right therapy, as they do not all work directly on the same processes. These results need to be generalized to stand the comparison to other individuals.

Conflict of Interests

Authors have no conflict of interests.

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