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Original Article

The role of brain-behavioral systems (BAS/BIS) and assertive behavior on impulsivity in individuals with attention deficit hyperactivity disorder (ADHD) with regard to the mediating role of frustration tolerance

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Abstract

This study investigates the role of brain-behavioral systems and assertive behavior on impulsive behavior in individuals with attention deficit hyperactivity disorder (ADHD) with regard to the mediating role of frustration tolerance. The population included all students with ADHD during 2021-2022. From the aforementioned population, 96 people were selected as samples using multi-stage cluster sampling. To collect information, the brain-behavioral systems questionnaire of Carver and White, Gambrill and Richey's Assertiveness Inventory, Patton, Stanford, and Barratt's Impulsiveness Scale, and Harrington's Frustration Tolerance Scale, and Conners's Parents Rating Scale for Attention Deficit Hyperactivity Disorder were used. The data was analyzed using Pearson correlation and structural equation modeling in AMOS24.The findings of this study indicated that components of the behavioral brain systems (behavioral activation and behavioral inhibition) and assertive behavior significantly predict impulsive behavior in students with ADHD. Moreover, frustration tolerance plays a key mediating role in explaining these relationships. These results suggest that educational and therapeutic interventions focused on enhancing assertiveness, increasing frustration tolerance, and modifying patterns of behavioral activation and inhibition may effectively reduce impulsivity and improve behavioral adjustment in this group of students.

Keywords

Attention deficit hyperactivity disorder
Assertive behavior
Brain-behavioral systems
Frustration tolerance
Impulsive behavior

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Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most prevalent neurodevelopmental disorders of childhood, exerting substantial influence on emotional, behavioral, and academic functioning (Popit et al., 2024). Global epidemiological evidence estimates the prevalence of ADHD among children and adolescents to be approximately 5–7%, although rates vary across diagnostic systems and cultural contexts (Salari et al., 2023). Recent national surveillance data from the United States indicate that nearly 11% of children aged 3–17 years have been diagnosed with ADHD, with boys showing higher rates than girls (Centers for Disease Control and Prevention, 2024). Symptoms typically emerge in early childhood, with hyperactivity and impulsivity often preceding school entry. As children transition into formal education, attentional deficits become more pronounced due to increased cognitive and behavioral demands (Arnett et al., 2013).

ADHD is associated with significant academic challenges, including reduced classroom engagement, lower academic achievement, and increased risk of grade retention and school dropout (Baamer, 2025). Social functioning is also adversely affected; children with ADHD frequently struggle to initiate and maintain peer relationships, resulting in restricted social networks and heightened vulnerability to emotional difficulties (Ros & Graziano, 2018). Given these broad impairments, contemporary clinical guidelines emphasize multimodal interventions, including behavioral parent training and school-based behavioral strategies for younger children, and combined behavioral–pharmacological approaches for older children and adolescents (Albalawi et al., 2026).

From a theoretical perspective, recent neuropsychological models highlight deficits in executive functions—particularly inhibitory control, working memory, and cognitive flexibility—as core mechanisms underlying ADHD (Kofler et al., 2019). Barkley's model remains influential, proposing that impairments in behavioral inhibition disrupt the development of self-regulation systems (Barkley, 1997). Neuroimaging studies conducted in recent years support this framework,

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demonstrating atypical development in frontostriatal and frontoparietal networks associated with cognitive control and reward processing (Rubia, 2018).

Complementary biological perspectives, particularly Gray's reinforcement sensitivity theory (RST), emphasize dysregulation in the behavioral inhibition system (BIS) and behavioral activation system (BAS) (Corr, 2004). Empirical studies suggest that children with ADHD often exhibit heightened BAS sensitivity—reflecting increased reward-seeking tendencies—and reduced BIS functioning, contributing to impulsivity and difficulties in behavioral regulation (Tenenbaum et al., 2018). These findings underscore the importance of integrating neurobiological, cognitive, and environmental factors to understand the etiology and developmental trajectory of ADHD (Thapar & Cooper, 2016).

Within this framework, hyperactivity and impulsive behaviors are frequently examined alongside constructs such as risk-taking, sensation seeking, and heightened behavioral activation(Bijttebier et al., 2009). Impulsivity defined as rapid action without adequate forethought or diminished reflective processing is considered a core psychological characteristic influenced by BIS/BAS dysregulation (Hamilton et al., 2015). While some studies associate ADHD symptoms primarily with heightened BAS sensitivity, others emphasize deficits in BIS functioning, suggesting heterogeneous neurobiological profiles rather than a single underlying mechanism (Bijttebier et al., 2009; Tenenbaum et al., 2018).

Assertiveness is another essential psychological skill relevant to individuals with ADHD. Defined as the ability to express one's thoughts, needs, and rights in a direct and socially appropriate manner (Eslami, 2020), assertiveness plays a crucial role in emotional well-being and interpersonal functioning. Individuals with low assertiveness often struggle to defend personal boundaries, leading to passivity, self-blame, and avoidance (Moss et al., 2021). Research consistently demonstrates that assertiveness training enhances interpersonal competence, emotional regulation, and social functioning across age groups (Mahmoudi, 2021).

Frustration tolerance—defined as the capacity to endure obstacles and emotionally challenging situations without maladaptive reactions—is another construct closely linked to ADHD (Van stralen, 2016). Low frustration tolerance is associated with deficits in executive functioning, impaired emotional regulation, and heightened stress sensitivity (Poznyak & Debbané, 2025). Individuals with low frustration tolerance often exhibit anxiety, tension, distractibility, and withdrawal (Mattar et al., 2025). Persistent frustration may trigger aggressive or antisocial behaviors, particularly among individuals with pre-existing self-regulation difficulties (Lagios et al., 2025).

Recent empirical findings highlight meaningful associations between frustration tolerance, impulsivity, assertiveness, and BIS/BAS functioning (Irandoust et al., 2026). Individuals with ADHD commonly exhibit high impulsivity, low assertiveness, and reduced frustration tolerance, contributing to academic underachievement, interpersonal conflict, emotional dysregulation, and risk-taking behaviors (Beheshti et al., 2020). Emerging evidence suggests that BIS/BAS functioning may serve as a shared neurobiological mechanism underlying these behavioral and emotional patterns(Corr, 2004).

Despite extensive research on ADHD, few studies have simultaneously examined the interplay between behavioral brain systems (BIS/BAS), assertiveness, impulsivity, and frustration tolerance within a unified conceptual framework. Understanding these relationships is essential for developing targeted interventions aimed at improving emotional regulation, social functioning, and adaptive behavior in individuals with ADHD. Therefore, the present study addresses a critical gap in the literature by providing an integrated examination of these psychological and neurobiological factors. In light of the theoretical foundations and empirical evidence reviewed above, the present study seeks to determine the extent to which the behavioral brain systems (BIS/BAS) are associated with assertiveness, impulsivity, and frustration tolerance among individuals diagnosed with ADHD.

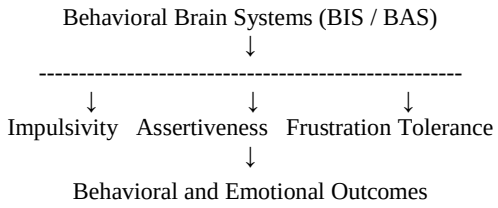

Figure 1. Conceptual Model

Method

Participants

This study was a descriptive and correlational research of the path analysis type. The population of this study included all elementary school students in regular schools in Urmia city in the academic year 2021-2022 who were diagnosed with attention deficit hyperactivity disorder. The study employed a multi-stage cluster sampling method. In the first stage, sixteen elementary schools were randomly selected from District 2 of Urmia. In the second stage, all sixth-grade classes within these schools were screened. After initial consultation with teachers, students suspected of having attention-deficit/ hyperactivity disorder were identified and subsequently evaluated using the Child Symptom Inventory–4 (CSI-4), Parent Form. The Hyperactivity–Impulsivity subscale of the CSI-4 was used as the primary screening tool, and students who obtained a score of 70 or higher were considered to exhibit clinically significant symptoms according to the instrument's scoring guidelines.

Inclusion criteria consisted of being a sixth-grade student enrolled in one of the selected schools, having a parent willing to complete the CSI-4, and obtaining a score at or above the clinical cutoff on the Hyperactivity–Impulsivity subscale. Exclusion criteria included the presence of diagnosed intellectual disability, autism spectrum disorder, neurological disorders, or ongoing intensive psychological or pharmacological treatment for ADHD. Students whose parents did not complete the

questionnaires fully were also excluded. From the initial screening, 103 students met the clinical cutoff. Among their parents, 96 agreed to participate and completed the questionnaires. Although the final sample size may appear modest, it is considered acceptable for structural equation modeling when the model includes a limited number of latent variables and parameters. Methodological recommendations indicate that models with fewer than 30 parameters and moderate factor loadings can be reliably estimated with samples around 100 participants. Given the structure and complexity of the present model, the sample size falls within the acceptable range for SEM analyses.

Instrument

Brain-Behavioral Systems Scale:

The BIS/BAS Scale was originally developed by Carver and White (1994) and consists of 24 items. Seven items assess the Behavioral Inhibition System (BIS), and thirteen items assess the Behavioral Activation System (BAS). The remaining four items are filler items and are not included in scoring. The BAS dimension comprises three subscales—Fun Seeking, Reward Responsiveness, and Drive—and the total BAS score is calculated by summing these three components. All items are rated on a 4-point Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree). Carver and White reported internal consistency coefficients of .74 for the BIS scale and .66, .73, and .76 for the Fun Seeking, Reward Responsiveness, and Drive subscales, respectively. In Iran, Abdollahi (2011) examined the psychometric properties of the scale and reported Cronbach's alpha coefficients of .66 for the BIS scale and .61, .61, and .70 for the Fun Seeking, Reward Responsiveness, and Drive subscales, respectively. Evidence for convergent validity was demonstrated through significant correlations between the BIS scale and the Trait Anxiety subscale of the State–Trait Anxiety Inventory, as well as negative and positive affect ($r = .43$, $r = .40$, and $r = .16$, respectively, $p < .01$). The BAS scale also showed significant correlations with positive affect and related constructs ($r = .30$ and $r = .22$, $p < .01$). In the present study, internal consistency coefficients were satisfactory. Cronbach's alpha for the BIS scale was .82, and for the BAS subscales—Fun Seeking, Reward Responsiveness, and Drive—were .77, .83, and .86, respectively.

Assertiveness Scale:

The assertiveness level of participants was assessed using the Gambrill and Richey Assertiveness Inventory, a widely used instrument for evaluating assertive behavior. The questionnaire consists of 40 items divided into two sections: one assessing the degree of discomfort experienced in assertive situations, and the other measuring the likelihood of engaging in assertive behavior. The items cover several domains, including refusing requests, expressing personal limitations (e.g., admitting lack of knowledge), making requests, initiating social interactions, responding to criticism, accepting differences from others, asserting oneself when assistance is needed, and providing negative feedback. Responses are rated on a 5-point Likert scale ranging from 1 (not at all upset) to 5 (extremely upset).Gambrill and Richey (1975) reported validity coefficients ranging from .39 to .70, with reliability coefficients of .87 for the discomfort subscale and .86 for the probability of response subscale. Similarly, Zarzycka et al. (2024) found reliability coefficients of .74 and .79 for the two subscales, respectively, confirming the scale's suitability. In the present study, internal consistency was satisfactory. Cronbach's alpha was .72 for the discomfort subscale and .80 for the probability of response subscale. In Iranian validation studies, the psychometric properties of the instrument have also been supported. For example, Rajabi Jourshari et al. (2022) reported Cronbach's alpha coefficients of .78 for the discomfort subscale and .81 for the probability subscale, along with acceptable construct validity based on correlations with measures of social anxiety and interpersonal functioning.

Impulsivity Scale:

The Barratt Impulsiveness Scale Patton et al. (1995) is a widely used self-report instrument designed to assess trait impulsivity. The scale consists of 30 items that load onto three primary factors: Non-Planning Impulsivity, Motor Impulsivity, and Cognitive Impulsivity. Cognitive impulsivity reflects difficulties in tolerating cognitive complexity and a tendency toward rapid decision-making without adequate deliberation. Motor impulsivity refers to acting without forethought, and non-planning impulsivity reflects a lack of consideration for future consequences in behavior and decision-making. Items are rated on a 4-point Likert scale ranging from 1 (never) to 4 (always), and all items are scored in the positive direction. In the Iranian adaptation of the scale, Karimian and Chahartangi (2024) conducted a psychometric evaluation and reduced the number of items from 30 to 25 by removing five items with factor loadings below .30. In their study, Cronbach's alpha coefficients were reported as .80 for the Non-Planning Impulsivity subscale, .70 for Motor Impulsivity, .70 for Cognitive Impulsivity, and .81 for the total scale, indicating acceptable internal consistency within the Iranian population.

Frustration Tolerance Scale:

The Frustration Tolerance Scale was developed by Harrington (2005) to assess the extent to which individuals tolerate frustration and failure in the pursuit of goals. The questionnaire consists of 35 items and evaluates four dimensions: Emotional Intolerance, Discomfort Intolerance, Achievement Intolerance, and Competence. Items are rated on a 5-point Likert scale, with higher scores indicating lower frustration tolerance and lower scores reflecting greater tolerance. Harrington (2005) reported satisfactory internal consistency, with Cronbach's alpha coefficients ranging from .87 for the

Discomfort Intolerance subscale to .94 for the total scale. Psychometric evaluations conducted in Iran have also supported the reliability and validity of the instrument. For example, Azizi (2010) reported Cronbach's alpha coefficients of .75 for Emotional Intolerance, .77 for Discomfort Intolerance, .70 for Achievement Intolerance, and .81 for the total scale. Construct validity was confirmed through significant correlations with measures of emotion regulation difficulties and negative affect. In the present study, internal consistency indices were acceptable. Cronbach's alpha was .79 for Emotional Intolerance, .75 for Discomfort Intolerance, .68 for Achievement Intolerance, and .84 for the total scale.

Connors Parental Attention Deficit Hyperactivity Disorder Scale:

The Conners Parent Rating Scale is one of the most widely used instruments for assessing children's behavioral problems within a dimensional classification framework. The original version of the scale was developed by Conners (1973) and consisted of 93 items designed specifically for parents. Subsequently, Goyette et al. (1978) developed a shortened 48-item version. A later revision produced a 26-item form, which is now commonly used for screening and diagnosing attention-deficit/hyperactivity disorder (ADHD) in children.

Items are rated on a 4-point Likert scale ranging from 0 (not true at all/never) to 3 (very much true/very often). The total score ranges from 26 to 104, with higher scores indicating more severe behavioral symptoms. A mean item score of 1.5 or higher is generally considered indicative of clinically significant ADHD symptoms. A total score above 34 has been suggested as a cutoff for identifying children with attention-related difficulties, with higher scores reflecting greater symptom severity. Conners et al. (1998) reported strong internal consistency for the scale, with a reliability coefficient of .90. In Iran, psychometric evaluations have also supported the scale's reliability and validity. Alizadeh (2005) in a study conducted by the Institute for Cognitive Science Studies, reported a validity coefficient of .85. Additional Iranian studies have demonstrated acceptable reliability indices, including a test–retest coefficient of .58 and a Cronbach's alpha of .73 for the total score, supporting the scale's stability and internal consistency across its three primary factors: oppositional behavior, hyperactivity, and attention problems. In the present study, the internal consistency of the 26-item Conners Parent Rating Scale was satisfactory. Cronbach's alpha for the total score was .76, exceeding the commonly accepted threshold of .70 and indicating adequate reliability for research purposes.

Procedure

To collect research data, after making the necessary coordination with the General Directorate of Education of West Azerbaijan Province, from the dual districts of Urmia City, District 2, and after selecting the education region, 16 elementary schools were selected as samples from the list of regular government elementary schools in District 2 of Urmia city. After attending the above schools, we talked to the sixth-grade teachers, explained the characteristics of hyperactive students to them, and asked them to introduce students with these characteristics to us. After the initial examination and identification, the sixth-grade students who were diagnosed with attention deficit hyperactivity disorder were notified by the school to their parents, and in coordination with the management and vice-principals of the above schools, the parents were invited to attend the management room at the school at the designated time to complete the hyperactivity questionnaire. Then, a final examination was conducted to identify students with attention deficit hyperactivity disorder. Out of 245 students introduced by teachers in 16 schools, 103 were diagnosed as hyperactive. Of these, 96 parents of the above students agreed to cooperate. Then, their parents were told that if the child tested positive for attention deficit hyperactivity disorder, the necessary arrangements would be made with the school administration and the parents themselves to complete other questionnaires. They were told to come to school on a designated day and, in addition to providing the necessary guidance regarding the behavioral, academic, etc. status of their children, questionnaires on brain-behavioral systems, assertiveness, impulsivity, and failure tolerance were provided to the parents of the students to answer the questionnaires regarding their children. In this study, correlation coefficient test and regression analysis were used. The obtained data were analyzed by SPSS[24] and Amos [24] software, which used statistical tests of measurement error, structural error and variance, and to evaluate the fit of the hypothetical model, fit indices were used.

Results

In terms of gender, the percentage of boys was (57.55%) and girls was (42.45%). In terms of age, (87.74%) of the hyperactive students were 12 years old and (12.26%) of them were 13 years old. Descriptive findings of the research variables are presented in Table 1.

As can be seen in Table 1, the highest mean was for the assertive behavior variable (95.03) and the lowest mean was for the cognitive impulsivity variable (10.17). In addition, the highest standard deviation was for the frustration tolerance variable (21.224) and the lowest standard deviation was for the cognitive impulsivity variable (1.897). In order to examine the correlation between the research variables, Pearson correlation coefficient was used, the results of which can be seen in Table 2. Based on the findings in Table 2, there is a significant relationship between all variables.

Table 1. Descriptive indices of research variables

Variable	Minimum	Maximum	Mean	SD
Brain-behavioral systems	22	45	33.44	5.584
Behavioral activation	13	30	20.93	3.904
Behavioral inhibition	8	19	12.51	2.680
Impulsive behavior	45	76	59.40	4.967
Lack of planning	14	27	21.89	2,651
Motor impulsivity	20	37	27.34	3.682
Cognitive impulsivity	5	13	10.17	1.897
Tolerance of frustration	67	165	128.19	21.224
Emotional intolerance	15	40	27.21	5.941
Emotional intolerance	11	33	24.00	4.926
Progress	11	33	25.15	4.562
Competence	25	69	51.83	9.173
Hyperactivity and attention deficit	19	64	38.93	11.134
Assertive behavior	55	145	95.03	19.184

Table 2. Correlation matrix of research variables

variables	1	2	3	4	5	6	7	8	9	10	11	12	13
BBS	1												
Behavioral activation	0.879**	1											
Behavioral inhibition	0.770**	0.409**	1										
Impulsive behavior	0.451**	0.290**	-0.342**	1									
Lack of planning	0.431**	0.315**	-0.212*	-0.362**	1								
Motor impulsivity	0.340**	0.449**	-0.375**	0.797**	-0.317**	1							
Cognitive impulsivity	0.369**	0.219*	0.220*	0.555**	-0.225*	0.349**	1						
Tolerance of frustration	0.217*	0.232*	-0.435**	-0.232*	0.213*	0.375**	0.323**	1					
Emotional intolerance	0.194	-0.273**	0.188	0.227*	0.112	0.222*	0.125	0.851**	1				
Emotional intolerance	-0.290**	-0.221*	0.219*	0.222*	0.158	0.172	0.215*	0.867**	0.642**	1			
Progress	-0.235**	-0.236*	0.290**	-0.019	0.012	0.033	-0.124	0.727**	0.481**	0.625**	1		
Competence	-0.216*	-0.225*	0.139	0.133	0.052	0.119	0.041	0.928**	0.733**	0.737**	0.54**	1	
ADHA	0.472**	0.330**	-0.247**	0.287**	0.397**	0.437**	0.352**	-0.297**	-0.328**	-0.234**	-0.249**	-0.291**	1
Assertive behavior	0.117	0.111	0.082	0.231*	0.019	0.259**	0.268**	0.309**	0.214*	0.322**	0.280**	0.265**	0.208*

*p<0.01 **p<0.05

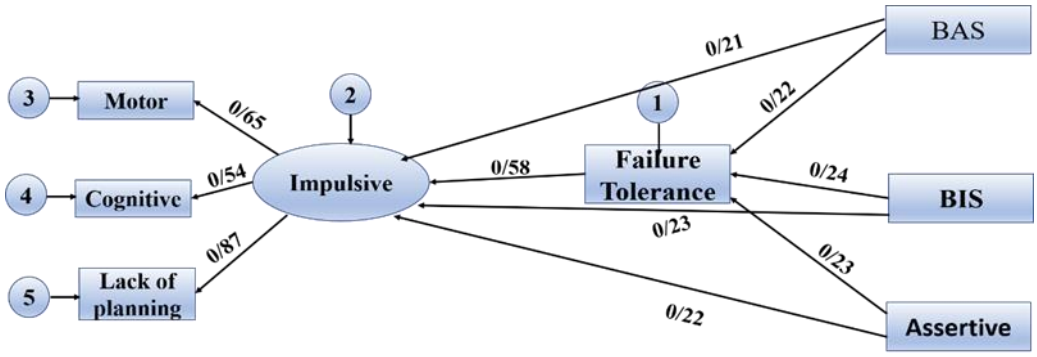

Figure 2. Standardized coefficients of the modified model

To examine the model fit, fit indices proposed by Gefen et al. (2000) were used. These indices include the following: the ratio of the chi-square to the degree of freedom (X2/df) index, where values less than 3 are acceptable, the comparative fit index (CFI), the goodness-of-fit index (GFI), where values greater than 0.9 indicate a good fit of the model, and the adjusted goodness-of-fit index (AGFI), where values greater than 0.80 indicate a good fit of the model, and the root mean square error of approximation (RMSEA), where values less than 0.08 indicate a good fit of the model. In the present study, adaptability, climate of cohesion, competition, task orientation, and friction are endogenous constructs of the model whose variance is explained by variables within the model, and basic needs satisfaction is exogenous constructs of the model whose variance is explained by factors outside the model. The fit of the original model was evaluated using Amos software version 22 and based on the introduced fit indices. Although the values of some fit indices such as CFI, AGFI, and GFI indicated an acceptable fit of the proposed model with the data, the root mean square error of approximation (RMSEA) index showed that the model needed modification. To improve the fit of the original model, the error variables e3 and e4 were correlated based on the proposed AMOS correction indices. After applying the changes, the modified model was retested.

Table 3. Overall fit indices of the tested model in the present study

index	X^2	df	X2/df	CFI	GFI	AGFI	RMSEA
model	p=0.045(14.36)	7	2.05	0.98	0.98	0.96	0.057

In Table 3, the fit indices of the tested model are reported. The overall tested model has a good fit with the collected data.

Table 4. Standardized coefficients of direct, indirect, and total effects and explained variance of variables

variables	Direct effect	Indirect effect	Total effect	R^2	Standardize parameter estimates	unstandardized parameter estimates	Std. Error	t	Sig
Towards impulsive behavior from	-	-	-	0.44	-	-	-	-	
Behavioral activation of the behavioral brain system	0.21	0.13	0.34	-	0.21	0.42	0.10	4.08	0.001
Towards impulsive behavior from	-	-	-	0.48	-	-	-	-	-
Behavioral inhibition of the behavioral brain system	0.23	0.14	0.37	-	0.23	0.45	0.09	4.15	0.001
Towards impulsive behavior from	-	-	-	0.47	-	-	--		
assertive behavior	0.22	0.14	0.36	-	0.22	0.44	0.12	4.27	0.001
Tolerance of failure	0.58	-	0.58	-	0.58	0.14	0.01	9.76	0.001
Towards tolerance of failure from	-	-	-	0.05	-	-			0.001
Behavioral activation of the behavioral brain system	0.22	-	0.22	-	0.22	1.90	0.46	4.10	0.001
Towards tolerance of failure from	-	-	-	0.08					0.001
Behavioral inhibition of the behavioral brain system	0.24	-	0.24		0.24	1.96	0.49	4.23	0.001
Towards tolerance of failure from	-	-	-	0.07					0.001
assertive behavior	0.23	-	0.23		0.23	1.98	0.47	4.21	0.001

Table 4 presents the direct, indirect, and total effects of the variables in the structural model. The behavioral activation system (BAS) and frustration tolerance jointly explained 44% of the variance in impulsivity. The behavioral inhibition system (BIS) together with frustration tolerance accounted for 48% of the variance in impulsivity, and assertiveness along with frustration tolerance explained 46% of the variance in impulsivity. In addition, BAS, BIS, and assertiveness explained 5%, 8%, and 7% of the variance in frustration tolerance, respectively. The direct effects indicated that BAS ($\beta = 0.21$, $p < .01$), BIS ($\beta = 0.23$, $p < .01$), and assertiveness ($\beta = 0.22$, $p < .01$) had significant positive effects on impulsivity. Frustration tolerance also showed a significant direct effect on impulsivity ($\beta = 0.58$, $p < .001$). Indirect effects were examined using the bootstrap method with 2000 resamples. The results showed that BAS ($\beta = 0.13$, $p < .01$), BIS ($\beta = 0.14$, $p < .01$), and assertiveness ($\beta = 0.14$, $p < .01$) had significant indirect effects on impulsivity through frustration tolerance. These findings confirm the mediating role of frustration tolerance in the relationships between BIS, BAS, assertiveness, and impulsivity. Overall, the significance of the standardized coefficients supports both the direct and indirect pathways proposed in the model, indicating that frustration tolerance functions as a meaningful mediator in explaining impulsive behavior.

Discussion

The aim of the present study was to examine the role of behavioral brain systems (BIS/BAS) and assertiveness in predicting impulsive behavior, with frustration tolerance as a mediating variable in individuals with ADHD. The findings demonstrated that both BIS and BAS activity were significantly associated with impulsive behavior, and frustration tolerance played a meaningful mediating role in these relationships. These results are consistent with recent studies indicating that dysregulation in motivational–behavioral systems contributes to impulsivity and self-regulation difficulties in individuals with ADHD (Arnett et al., 2013; Barkley, 1997; Shaw et al., 2014). In line with these findings, heightened BIS sensitivity and reduced BAS engagement have been shown to increase emotional reactivity, behavioral disinhibition, and difficulties in delaying responses—factors that collectively contribute to impulsive behavior. Individuals with ADHD often display reduced frustration tolerance, which further intensifies impulsive reactions when confronted with obstacles or unmet goals. This pattern is supported by recent evidence showing that frustration intolerance is a significant predictor of emotional dysregulation and impulsive responding in ADHD populations. Furthermore, the results indicated that assertiveness had both direct and indirect effects on impulsive behavior. Lower assertiveness has been associated with maladaptive coping, interpersonal conflict, and heightened emotional arousal, which may increase impulsive tendencies (Mikaeili et al., 2023). This finding aligns with recent research suggesting that deficits in assertive communication and self-expression contribute to behavioral dysregulation in youth with ADHD (Van stralen, 2016). Overall, the present study highlights the importance of frustration tolerance as a psychological mechanism linking behavioral brain systems and assertiveness to impulsive behavior. These findings underscore the need for interventions that strengthen frustration tolerance and self-regulation capacities in individuals with ADHD.

The findings of the present study indicated that motor impulsivity and cognitive impulsivity were positively and

significantly associated with assertive behavior in individuals with ADHD, whereas non-planning impulsivity showed no significant association. These results suggest that specific dimensions of impulsivity may differentially relate to interpersonal functioning. This finding is consistent with recent studies showing that impulsive action and rapid decision-making tendencies are linked to interpersonal expression and behavioral engagement, while non-planning impulsivity is more strongly tied to long-term self-regulation deficits rather than moment-to-moment social behavior (Puiu et al., 2018; Rosenthal et al., 2024).

Assertiveness is a core interpersonal skill that enables individuals to express their needs, emotions, and boundaries effectively. Individuals with low assertiveness often experience interpersonal anxiety, avoidance, and difficulty expressing emotions, which may contribute to maladaptive behavioral patterns. Reduced assertiveness in individuals with ADHD has been associated with social withdrawal, emotional distress, and impaired decision-making, all of which may exacerbate impulsive tendencies (Salmani et al., 2024). Conversely, higher assertiveness may facilitate more adaptive behavioral responses and reduce impulsive reactions in challenging social situations. These interpretations align with recent findings emphasizing the role of interpersonal competence in moderating impulsive behavior among youth with ADHD.

The study also demonstrated a significant relationship between behavioral brain systems (BIS/BAS) and frustration tolerance. This finding is partially consistent with previous research (Alizadeh, 2005) and aligns with contemporary evidence indicating that BIS sensitivity is associated with avoidance tendencies, heightened threat perception, and negative interpretation of ambiguous situations. Given the close association between motivational systems and emotional regulation capacities, BIS/BAS functioning appears to be an important predictor of frustration tolerance. Individuals with heightened BAS activity tend to pursue immediate rewards and may exhibit lower tolerance for delayed gratification, whereas those with higher frustration tolerance demonstrate reduced sensitivity to previously rewarding cues. These patterns are consistent with recent studies highlighting the interplay between motivational systems, reward processing, and frustration tolerance in ADHD (Graziano & Garcia, 2016). Overall, the findings underscore the importance of considering both motivational–behavioral systems and interpersonal competencies when examining impulsive behavior in individuals with ADHD. Frustration tolerance emerges as a key regulatory mechanism that may help explain how BIS/BAS activity and assertiveness contribute to impulsive responding.

Another finding of the present study indicated that assertive behavior was significantly associated with frustration tolerance in individuals with ADHD. This result is consistent with previous research showing that interpersonal competence and assertive communication are linked to greater emotional resilience and tolerance of failure (Corr, 2004; Muris, 2021). These findings suggest that individuals with higher levels of assertiveness are better able to cope with setbacks and are less likely to experience avoidance, embarrassment, or social withdrawal in challenging situations. Individuals with low frustration tolerance often display heightened social anxiety, avoidance of interpersonal encounters, and difficulty expressing their needs or opinions. Such patterns may reduce their willingness to engage in social interactions and undermine their confidence in managing failure. In contrast, assertive individuals tend to express their thoughts and emotions clearly, maintain a balanced sense of self-worth, and demonstrate greater psychological flexibility when confronted with obstacles. These characteristics may enhance their ability to tolerate frustration and reduce the likelihood of maladaptive emotional responses. Assertiveness training has been shown to improve adolescents' awareness of their rights, strengthen their ability to respond effectively to bullying, and enhance interpersonal problem-solving skills. Interventions targeting assertiveness often emphasize empathy, conflict resolution, and adaptive coping strategies, which collectively contribute to improved frustration tolerance. By learning to express themselves directly and respectfully, individuals develop a stronger sense of agency and self-efficacy, which may buffer against the negative emotional impact of failure. Overall, the present findings highlight the importance of assertiveness as a protective interpersonal factor that contributes to greater frustration tolerance in individuals with ADHD. These results align with contemporary research emphasizing the role of social–emotional competencies in moderating behavioral and emotional difficulties in this population.

The final finding of the present study indicated that frustration tolerance mediates the relationship between behavioral brain systems, assertive behavior, and impulsive behavior in individuals with ADHD. This result is consistent with recent interpretive work highlighting the central role of frustration tolerance in emotional and behavioral regulation (Seymour & Miller, 2017). According to frustration-based models, repeated exposure to obstacles or blocked goals increases the likelihood of impulsive or aggressive responses, particularly when regulatory capacities are limited. For individuals with ADHD, frequent experiences of academic difficulty, peer conflict, and attentional challenges may heighten emotional arousal and reduce impulse control, making frustration tolerance a key mechanism linking BIS/BAS activity and assertiveness to impulsive behavior. Individuals with higher BAS sensitivity may react more strongly to blocked rewards, whereas those with greater frustration tolerance demonstrate higher resilience and reduced impulsive responding. Assertiveness also contributes to frustration tolerance by enabling individuals to express needs clearly, manage interpersonal conflict, and maintain a balanced sense of self-worth. Assertive individuals are better equipped to navigate challenging situations without resorting to impulsive or aggressive behaviors, thereby preventing frustration from escalating into maladaptive responses. Overall, these findings underscore the importance of motivational systems and interpersonal competence in shaping behavioral outcomes in ADHD.

Conclusion

The findings of the present study indicate that frustration tolerance functions as a partial mediator in the relationship between behavioral brain systems, assertive behavior, and impulsive behavior in individuals with ADHD. Although the inclusion of frustration tolerance reduced the magnitude of the direct effects, the predictive paths from behavioral inhibition and assertiveness to impulsive behavior remained significant, supporting a partial—rather than full—mediation model. Overall, the results suggest that behavioral activation, behavioral inhibition, and assertive behavior each exert direct predictive effects on impulsive behavior, while frustration tolerance contributes additional explanatory power by shaping how these variables influence impulsive responding. This pattern underscores the importance of both motivational systems and interpersonal competencies in understanding impulsivity among individuals with ADHD. The study's limitations include reliance on self-report measures, a cross-sectional design that restricts causal inference, and a geographically limited ADHD sample. Uncontrolled factors such as medication use and comorbidities may also have influenced the findings. Future research should use longitudinal and intervention-based designs, diverse samples, and multi-method assessments to clarify the mechanisms linking BIS/BAS activity, assertiveness, frustration tolerance, and impulsivity. Practically, strengthening frustration tolerance and assertiveness through school, parent, and clinical programs may help reduce impulsive behavior in students with ADHD.

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