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Original Article

Response inhibition, cognitive flexibility and hypervigilance in adolescents with and without generalized anxiety disorder

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Abstract

The aim of this study was to compare response inhibition, cognitive flexibility and hypervigilance in adolescents with and without generalized anxiety disorder. The population consisted of 152 adolescents aged 16 to 22 years with/without generalized anxiety disorder who were referred to counseling and psychological service centers in Alborz province from 2022 to 2023. 74 of them were adolescents without generalized anxiety disorder and 78 of whom were adolescents with generalized anxiety disorder selected by convenience sampling. The data was collected using the General Anxiety Disorder Questionnaire, the Cognitive Flexibility Questionnaire, the Stroop Complex Word Test and the Continuous Performance Test and was analyzed by Multivariate analysis of variance through SPSS-22. The results showed that the group with generalized anxiety disorder had lower scores for response inhibition and cognitive flexibility and higher scores for hypervigilance. The results suggest that response inhibition, cognitive flexibility and hypervigilance are different in adolescents with and without generalized anxiety disorder, and these functions are impaired in people with generalized anxiety disorder.

Keywords

Generalized anxiety disorder
Response inhibition
Cognitive flexibility
Hypervigilance

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Introduction

Nowadays, the occurrence of psychological problems and behavioral disorders in children and adolescents is inevitable. Throughout their lives, adolescents may experience a wide range of mental and physical abnormalities and face countless challenges, one of which is the occurrence of symptoms of anxiety disorders. Today, the prevalence of anxiety disorders in children and adolescents continues to rise and is reported to be between 2 and 4% (Mendelson, 1995). One of the most common anxiety disorders in children and adolescents is generalized anxiety disorder. As defined by the Fifth Diagnostic and Statistical Manual of Mental Disorders, generalized anxiety disorder is a group of anxiety disorders characterized by feelings of excessive worry about multiple events, accompanied by related somatic symptoms, lasting for at least six months in most cases. This disorder is characterized by high chronic anxiety and difficulty controlling worry about a variety of activities and responsibilities, along with significant physical and cognitive symptoms (Szuhany & Simon, 2022). Worry is the main component of this disorder, which is a type of conceptual thinking focused on the future, and in fact a person cannot tolerate uncertainty. Often this feeling of worry persists because the person is unable to find the right solution to their problem. It can be said that their worry is extreme, uncontrollable and late (Dawson & Guare, 2018). The two main problems of young people with generalized anxiety disorder are an intolerance of uncertainty and a belief that worrying is useful and will solve problems. Evidence shows that all members of society worry in their lives, but their intensity is lower and their ability to control it is greater. In adolescents with generalized anxiety disorder, the outward manifestation of symptoms tends to focus on intense anxiety about homework, academic and athletic performance (Mendelson, 1995). There are several main approaches to explaining generalized anxiety disorder. According to the behavioral view, people with generalized anxiety respond to certain cues regardless of the stimulus. This is called stimulus anxiety; it can be said that these people are somehow conditioned to be afraid of stimuli that are present everywhere (Prochaska & Norcross, 2014). The cognitive approach sees anxiety as an inappropriate consequence of unreasonable thoughts and emphasizes that in order to get out of this situation, one must deal with the unreasonable thoughts

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that a person has about stimulating events. (Prochaska & Norcross, 2014). According to the Threat Magnification Vulnerability Model, people who have experienced an acute mental state of threat magnification vulnerability, in which a momentary danger is catastrophic, will show symptoms of anxiety, and the result will be a distortion in cognitive functions (Alvey & Riskind, 2016). Research shows that anxiety disorders affect different functions in people, and one of these is the executive function of people with the disorder, which is affected and leads to disruptions in their daily functioning. Executive functions are a set of high-level cognitive mechanisms and include a wide range of cognitive processes such as attention, memory, response inhibition, cognitive flexibility, vigilance, etc. (Micco et al., 2009).The attention control theory of Eysenck and colleagues, who investigated the negative effect of high anxiety on cognition in the context of high cognitive load, showed that anxiety impedes the efficiency of cognitive processing and thus reduces cognitive performance (Eysenck et al., 2007) .

Response inhibition is one of our most important executive functions, involved in complex cognitive behaviors. According to Barkley (1997), response inhibition is a multidimensional construct and includes three processes: dominant response inhibition, pausing the response when deciding whether to respond or continue, and maintaining this pause (Barkley, 1997). Also Inhibition is a neurocognitive process that allows us to delay action. It also allows us to evaluate the situation and determine the impact of our behavior on the situation (Ansari & Iqbal, 2023). Research suggests that the relationship between response inhibition and generalized anxiety disorder is unclear (Shields et al., 2016). One group of researchers found that the amount of errors had a positive relationship with anxiety levels (Rosa-Alcázar et al., 2021). For example, Rosa-Alcázar and colleagues (2021) studied 95 adults with generalized anxiety disorder and obsessive-compulsive disorder and a control group and compared their response inhibition using the computerized Wisconsin Card Sorting Test and the Stroop Word and Color Test. They showed that the generalized anxiety disorder and obsessive-compulsive disorder groups had worse cognitive flexibility scores than the control group (Rosa-Alcázar et al., 2021). Zainal & Newman (2018) also found that deficits in response inhibition, attention, and working memory can predict symptoms of generalized anxiety disorder, as worry is a major component of the disorder. They followed the neuropsychological symptoms of a national sample of 2,605 community-dwelling adults for 9 years, during which time they conducted diagnostic interviews. After this time, they concluded that attention, working memory and response inhibition are associated with increased excessive and uncontrollable worry, which is the main symptom of generalized anxiety disorder (Zainal & Newman, 2022). As mentioned above, cognitive flexibility is also one of our executive functions and includes the ability to change behavior in response to environmental changes (Whiting et al., 2017). In most cases, high levels of cognitive flexibility predict low levels of anxiety in people. Studies show that cognitive flexibility is impaired in people with generalized anxiety disorder (Lee & Orsillo, 2014). In one study, Lee and Orsillo (2014) examined 66 people, 53 of whom had generalized anxiety disorder and 13 of whom were normal. They sought to investigate cognitive flexibility as a potential mechanism of mindfulness in generalized anxiety disorder. As a result of their research, it was found that the symptom of generalized anxiety disorder is visible with cognitive inflexibility. In other words, damage to cognitive flexibility has been identified in people with generalized anxiety disorder, and cognitive inflexibility is a potential feature of this disorder (Lee & Orsillo, 2014). Also, in a correlational study, Sepahund (2019) studied 300 students of Arak University using the available sampling method, and after taking the tests, he studied 70 students who scored high on the neuroticism index. His results showed that the component of cognitive flexibility predicted about 19% of the variance of generalized anxiety in neurotic individuals. As a result, it can be said that this study has shown that the components of cognitive inflexibility predict the generalized anxiety of neurotic people (Sepahvand, 2021). Another component of executive functioning is hypervigilance. Hypervigilance is the ability of a person to pay attention to a stimulus for a long period of time while waiting for the target stimulus to appear (Richards et al., 2014). The vigilance-avoidance model suggests that anxious people first orient to and then avoid threatening stimuli. Based on this, it can be said that people's anxiety symptoms will affect their executive function (Rosen et al., 2019). According to the threat magnification vulnerability model, by disrupting the mental control mechanisms used to deal with distressing thoughts, people with generalized anxiety disorder are more alert to threat-related information. Richards and colleagues (2014), in an article entitled 'Investigating the performance of selective attention and hypervigilance in anxiety', examined the eye movements of anxious people and concluded that anxious people listen louder, resulting in increased distraction and reduced eye movements in the presence of threats. Finally, they found that anxiety and hypervigilance are directly related and that people with anxiety disorders are more vigilant than the normal group (Richards et al., 2014).

According to the desired materials, it can be said that since generalized anxiety disorder can have a lot of direct and indirect costs for adolescents due to the damage it causes, the issue of timely identification and treatment of generalized anxiety symptoms and cognitive components affected by it is important. In reviewing the previous reports, it can be concluded that no comprehensive scientific research has been conducted on the executive functions of adolescents with generalized anxiety disorder, including response inhibition, cognitive flexibility and hypervigilance. It is also important to point out that the results of the present research are fruitful in the field of improving the mental health of adolescents, and various centers such as the Psychological and Counselling System Organization, the Welfare

Organization, the National Medical System Organization, educational and child care center such as schools, universities and correctional centers will benefit from the results of this research, and knowing that the various functions of adolescents with generalized anxiety disorder are affected, they can take steps in the direction of preventing this disorder and early diagnosis of this disorder. The aim of the present study is therefore to compare response inhibition, cognitive flexibility and hypervigilance in adolescents with and without generalized anxiety disorder.

Method

Participants

The present research is basic in terms of its purpose and descriptive in terms of the method of data collection. This study was conducted during 5 months from December 2022 to May 2023 in Alborz province. The ethics committee of Lahijan Islamic Azad University approved this study with the ethical code: IR.IAU.LIAU.REC.1402.008. The population of the current study includes all adolescents aged 16 to 22 years, boys and girls, without generalized anxiety disorder and with generalized anxiety disorder, who were referred to counselling and psychological service centers in Alborz province in 2022-2023. The sample size in the present study is 152 people, of whom 74 are adolescents without generalized anxiety disorder and 78 are adolescents with generalized anxiety disorder. The sampling method is convenience sampling.

Instrument

Computer Word Complex Stroop Test:

The Word and Color Stroop Test was proposed by Golden (1987) to measure the ability to inhibit a dominant verbal response, resistance to interference from external stimuli and selective attention. This software test has three phases. In the first stage, which is the preparatory stage, the subject is asked to respond by pressing the button corresponding to the color of the circles on the screen. In the second stage, which is the experimental stage, it is exactly the same as the main stage and its purpose is to practice and become familiar with the way of responding. In the third stage, which is the main stage, the names of the colors are displayed on the screen, but the written color word is different from the color itself (for example, blue is written as green). The subject is asked to ignore the words and present only the color on the screen. Qadiri and his colleagues (2006) obtained a reliability coefficient of 0.6 for reaction time in the first stage and 0.55 for the number of errors in the first stage, and in the second stage of the test, the reliability coefficient was calculated to be 0.83 for reaction time and 0.78 for the number of errors. And in the third stage, the reliability coefficient was 0.97 for reaction time and 0.79 for number of errors (Ghadiri et al., 2007). Özsoy and Ataman (2009) also reported a validity of between 0.80 and 0.90 with retesting (Özsoy & Ataman, 2009).

Continuous Performance Test (CPT):

The Continuous Performance Test was developed by Rozvold (1956). This test is used to assess sustained attention, alertness and impulsivity in a software form and requires maintaining attention during a continuous task and inhibiting impulsive responses. The test requires the subject to attend to a series of relatively simple visual stimuli and to respond by seeing the target stimulus. The approximate duration of the test is 10 minutes. This test includes three variables: response error, response omission and response time. In this test a total of 150 stimuli are presented, 20% of which are the target stimulus (containing a specific number or geometric shape). The duration of each stimulus is 200 thousandths of a second and the interval between two stimuli is 1 second. The subject first enters his or her personal details and then completes the trial phase of the test, after which the main phase begins. It is explained to the subject that whenever he sees the number 4 he must press the key with the label on the screen of the computer keyboard. The validity coefficients of the different parts of the test, which was carried out on 43 primary school boys with an interval of 20 days, ranged from 0.59 to 0.93. The calculated coefficients have a significant correlation at the 0.001 level. The validity of the test was established using the criterion validation method by comparing the normal group and the hyperactivity/attention deficit group, which showed a significant difference between the performance of the two groups (Hadianfard, Shekarkan, Mehrabizadeh & Najarian, 2000).

Cognitive Flexibility Scale (CFI):

This scale was created by Dennis & Vander (2010) and is a short self-report instrument with 20 items, each item in this scale is based on a 7-point Likert scale (1 = completely agree to 7=completely opposed) is scored. The lowest and highest scores in this questionnaire are 20 and 140, respectively. Dennis and Vander (2010) identified two factors of perception of different options (perception of justification of behavior) and perception of controllability, and the correlation of this questionnaire with the Beck Depression Inventory (BDI_II) (R = 0.39) and Martin's Cognitive Flexibility Scale (R =0.75) reported. These researchers found the internal consistency of this questionnaire by Cronbach's alpha method for the whole scale, perception of control and perception of different options to be 91.91, 0.0 and 0.84, respectively, and with the retest method, 0.75 and 0.81, respectively. 0 and 0.75 were obtained. (Dennis & Vander Wal, 2010). Shareh et al. (2013) reported the retest coefficient of the whole scale as 0.71 and Cronbach's alpha coefficient as 0.90 for the whole scale (Shareh et al., 2013).

Short Scale of Generalized Anxiety Disorder (GAD):

This questionnaire was created in 2006 by Spitzer and his colleagues and has seven main questions and one additional question to identify possible cases of generalized anxiety disorder and to check its severity in this questionnaire. You are asked to rate your level of discomfort with each question over the past two weeks. In this scale, the answer options include a 4-point range of not at all, several days, more than half of the days, and almost every day, each rated from 0 to 3. The total score of the test is the sum of the scores and ranges from 0 to 21. This scale is an important tool in the screening of generalized anxiety disorder in research and clinical practice. The scale has a validity of 0.92 and its retest reliability is 0.38 (Spitzer et al., 2006). Also, the Cronbach's alpha coefficient calculated in the research of Nainian et al. (2013) in Iran for this questionnaire is estimated to be 0.85 (Naeinian et al., 2011).

Procedure

After making the necessary arrangements with the centers involved in the research and obtaining the necessary permissions, the research began. Firstly, the researcher went to a number of counselling, psychological and psychiatric centers in Alborz province that he was already familiar with, and after obtaining the consent of the officials of these centers, he collected data from people suffering from general anxiety who visited these centers. And they were asked to cooperate in carrying out the research. Also, to collect data from the group without generalized anxiety disorder, boys and girls referred to the educational centers where the researcher was active and matched in terms of age, education and socio-economic level were selected. There was no compulsion to take part in the research, and tests and questionnaires were given to those who were willing to take part in the research. First, they were asked to complete the Short Scale Questionnaire for Generalized Anxiety Disorder, and after confirming the diagnosis of Generalized Anxiety Disorder, each of the participants was given preliminary explanations about how to complete the cognitive flexibility questionnaire, and then they were asked to complete the questionnaires first, and after a short break, the explanations related to each of the computer tests were given, and they were asked to complete the computer tests according to the explained instructions. In general, the ethical considerations that were taken into account before, during and after the research were as follows obtaining participants' consent to the tests, reassuring people that their names would not be published in the research and that the principle of confidentiality would be respected, fully explaining the way in which the tests would be carried out, the time required to carry them out and the reason why they had been selected to carry them out, explaining the nature of the tests at the end of the presentation if participants wished to do so, and allowing participants to withdraw from the test if they wished to do so.

Data analysis

The data was analyzed at descriptive and inferential levels. At the descriptive level, mean and standard deviation were used to measure the research variables. The assumptions of the research included Box's test for coordinating variance matrices and Levine's test for homogeneity of variance. At the inferential level, multivariate analysis of variance (MANOVA) was used to compare variables. Data analysis was performed using SPSS 26 statistical software. In addition, a significance level of α=0.5 was considered for all hypotheses.

Results

The demographic information of the present study shows that 48.7% of adolescents are without generalized anxiety disorder and 51.3% of adolescents are with generalized anxiety disorder. At the level of descriptive statistics, the mean and standard deviation of generalized anxiety scores in adolescents without generalized anxiety disorder are 7.66 and 7.80, respectively. Also, the mean and standard deviation of adolescents with generalized anxiety disorder are 15.53 and 2.59, respectively.

According to the results in Table 1, the descriptive statistics related to the mean and standard deviation of the response inhibition scores are observed separately between adolescents without and with generalized anxiety disorder.

Table 1. Statistical description of response inhibition scores by group

	Without generalized anxiety disorder		With generalized anxiety disorder		Total	
Variable	M	SD	M	SD	M	SD
Consonant test time	192.19	26.995	182.32	46.91	187.13	35.15
consonant error	8.34	12.164	6.31	174.12	7.30	9.42
No consonant response	5.59	12.950	6.28	43.98	5.95	14.08
The correct answer is consonant	22.82	32.28	218.18	33.73	220.44	40.39
Consonant reaction time	802.95	113.35	712.56	17.84	782.23	148.60
Inconsistent test time	203.91	29.60	194.38	56.71	199.02	37.85
inconsistent error	23.43	39.91	20.67	184.22	22.01	36.77
No discordant answers	9.20	15.04	9.91	35.41	95.57	16.49
Incongruent correct answer	204.12	50.99	200.19	33.09	202.11	35.86
Anomalous reaction time	846.05	122.48	806.28	97.87	825.64	157.98

Interference score	18.70	39.69	17.99	35.41	18.34	37.43
Interference time	43.11	30.61	43.71	33.09	43.41	31.80
Sum of correct answers	426.95	75.56	418.37	97.87	422.55	87.54
Sum of wrong answers	31.77	45.17	26.97	35.63	29.31	40.49
Unanswered plural	14.80	27.61	16.19	32.40	15.51	30.07

Table 2 shows descriptive statistics related to the mean and standard deviation of cognitive flexibility scores separately for adolescents without generalized anxiety disorder and with generalized anxiety disorder.

Table 2. Statistical description of cognitive flexibility scores by group

group	Average	Standard deviation	Total
without generalized anxiety disorder	89.93	20.64	74
with generalized anxiety disorder	75.96	15.71	78
Total	82.76	152	19.51

In Table 3, the descriptive statistics related to the mean and standard deviation of hypervigilance scores are shown separately for adolescents without generalized anxiety disorder and with generalized anxiety disorder.

Table 3. Statistical description of hypervigilance scores by group

	without generalized anxiety disorder		with generalized anxiety disorder		Total	
Variable	Average	standard deviation	Average	standard deviation	Average	standard deviation
Error 50 first actuator	1.14	1.97	1.00	1.43	1.07	1.71
No response for the first 50 stimuli	1.04	1.49	0.71	1.20	0.87	1.36
The correct answer is the first 50 stimuli	48.82	3.22	48.29	2.42	48.07	2.84
Reaction time of the first 50 stimuli	50.67	65.40	500.22	76.29	521.40	70.97
Error 50 second drive	0.93	1.95	0.94	1.34	0.93	1.66
No response 50 second stimulus	1.45	2.17	1.16	1.83	1.32	2.00
Correct answer 50 second stimulus	47.62	3.70	47.84	2.88	47.85	3.30
50 second stimulus reaction time	52.08	67.85	524.74	59.97	522.67	63.73
Error 50 third actuator	0.82	1.45	0.67	1.28	0.74	1.36
No response 50 third stimulus	1.51	2.70	0/85	2.08	1.71	2.42
Correct answer 50 third stimulus	47.66	3.70	48.49	3.08	48.09	3.41
Reaction time of 50 third stimuli	48.58	94.61	494.85	103.58	488.39	99.21

Multivariate analysis of variance (MANOVA) was used to compare response inhibition in adolescents with and without generalized anxiety disorder. To test the assumption of normality, the skewness and kurtosis test was used, and the results showed that the coefficient of skewness and kurtosis is in the range of -3 to +3, so normality is true. In order to test the homogeneity of variances assumption, the Lune's test was used. The results showed that the assumption of homogeneity of variance of the variables was met, considering that the significance level of Lon's test is more than 0.01.

In order to investigate response inhibition in adolescents with and without generalized anxiety disorder, a multivariate analysis of variance test was used, the results of which are presented in Table 4.

Table 4. Results of multivariate variance analysis to compare response inhibition in the group with and without generalized anxiety disorder

Effect	Tests	Amounts	F	Effect degree of freedom	Error degree of freedom	Sig
Group	Pillai Trace	0.20	2.31	15	136	0.00
	Wilks Lambda	0.79	2.31	15	136	0.00
	Hotelling's Trace	0.25	2.31	15	136	0.00
	Roy's Largest Root t	0.25	2.31	15	136	0.00

As can be seen, the significance level of all four relevant multivariate statistics, namely Pillai's effect, Wilks' lambda, Hotelling's effect and the largest zinc root, is less than 0.05 (P<0.05). Thus, it is clear that there is a significant difference between the response inhibition of two groups of adolescents with and without generalized anxiety disorder.

In order to compare two groups on each of the components of response inhibition, the test of between-subject effects was used, the results of which are presented below.

According to Table 5, considering that the significance level obtained for a number of variables, including consonant test time (Sig = 0.00) and consonant reaction time (Sig = 0.00) is less than 0.05, the null hypothesis is rejected and the research hypothesis is confirmed. That is, there is a significant difference between the two groups in terms of response inhibition. In the remaining variables, there is no significant difference in terms of response inhibition; because their significance level is greater than 0.05.

Table 5. Test of inter-subject effects to compare response inhibition components in the group with and without generalized anxiety disorder

Source	The dependent variable	sum of squares	DF	mean square	F	Sig
group	Consonant test time	166.01	1	166.01	7.87	0.00
	consonant error	7.84	1	7.84	0.30	0.58
	No consonant response	9.40	1	9.40	1.22	0.27
	The correct answer is consonant	3.80	1	3.80	0.10	0.74
	Consonant reaction time	2922.76	1	2922.76	7.33	0.00
	Inconsistent test time	107.11	1	107.11	2.36	0.12
	inconsistent error	770.03	1	770.03	3.54	0.06
	No discordant answers	3.37	1	37.3	0.13	0.71
	Incongruent correct answer	179.00	1	179.00	2.82	0.09
	Anomalous reaction time	14034.92	1	14034.92	2.51	0.11
	Interference score	0.06	1	0.06	0.00	0.95
	Interference time	15.89	1	15.89	0.02	0.87
	Sum of correct answers	181.24	1	۱۸۱/۲۴	0.97	0.32
	Sum of wrong answers	6.64	1	6.64	0.06	0.80
	Unanswered plural	0.08	1	0.08	0.00	0.97
error	Consonant test time	32881.64	150	219.21		
	consonant error	3927.52	150	26.18		
	No consonant response	1156.17	150	7.70		
	The correct answer is consonant	5334.16	150	35.56		
	Consonant reaction time	59764.50	150	3984.29		
	Inconsistent test time	48759.96	150	325.06		
	inconsistent error	4538.98	150	30.260		
	No discordant answers	364.13	150	24.27		
	Incongruent correct answer	9509.38	150	63.29		
	Anomalous reaction time	836651.02	150	557.67		
	Interference score	2718.93	150	18.126		
	Interference time	92566.94	150	617.11		
	Sum of correct answers	2781.69	150	185.54		
	Sum of wrong answers	16018.82	150	106.69		
	Unanswered plural	11389.54	150	75.93		
Total	Consonant test time	5611029.00	152			
	consonant error	9170.00	152			
	No consonant response	2486.00	152			
	The correct answer is consonant	8152286.00	152			
	Consonant reaction time	97958074.00	152			
	Inconsistent test time	6406208.11	152			
	inconsistent error	14041.00	152			
	No discordant answers	9408.0	152			
	Incongruent correct answer	7857540.00	152			
	Anomalous reaction time	11022404.00	152			
	Interference score	5159.00	152			
	Interference time	335383.00	152			
	Sum of correct answers	32439169.00	152			
	Sum of wrong answers	372231.00	152			
	Unanswered plural	25471.00	152			

The Multivariate Analysis of Variance (MANOVA) test was used to compare hypervigilance in adolescents with and without generalized anxiety disorder. To test the assumption of normality, the skewness and kurtosis test was used and the results showed that considering that the coefficient of skewness and kurtosis is in the range of -3 to +3, therefore normality is true. In order to test the assumption of homogeneity of variances, Lune's test was used. Considering that the significance level of Levene's test is more than 0.01, the assumption of homogeneity of variance of the variables is fulfilled. In order to verify the above hypothesis, the multivariate analysis of variance test was also used, considering that the significance level of Levene's test is more than 0.01, therefore the assumption of homogeneity of variance of the variables has been met.

In order to investigate the components of hypervigilance in adolescents with and without generalized anxiety disorder, the multivariate analysis of variance test was used, the results of which are shown in Table 6.

As can be seen, the significance level of all four relevant multivariate statistics, namely Pillai's effect, Wilks's lambda, Hotelling's effect and the largest zinc root, is less than 0.05 ($P<0.05$). In this way, it is clear that there is a significant difference between the two groups of adolescents with generalized anxiety disorder and without generalized anxiety disorder.

In order to compare two groups in each of the hypervigilance components, the test of inter-subject effects was used, the results of which are presented below.

Table 6. Results of multivariate analysis of variance to compare the amount of hypervigilance in the group with and without generalized anxiety disorder

Effect	Tests	Amounts	F	Effect degree of freedom	Error degree of freedom	Sig
Group	Pillai Trace	0.29	5.24	11	140	0.00
	Wilks Lambda	0.70	5.24	11	140	0.00
	Hotelling's Trace	0.41	5.24	11	140	0.00
	Roy's Largest Root t	0.41	5.24	11	140	0.00

According to Table 7, considering that the significance level obtained for a number of variables, including the error of 50 second stimuli (sig = 0.00) and no response of 50 second stimuli (sig = 0.02) and the reaction time of 50 third stimuli (sig = 0.00) is less than 0.05, the null hypothesis is rejected and the research hypothesis is confirmed. This means that there is a significant difference between the two groups in terms of the level of hypervigilance. In the rest of the variables, there is no significant difference in terms of sound; because their significance level is greater than 0.05.

In order to compare flexibility in adolescents with and without generalized anxiety disorder, the Mann-Whitney test was used. To examine the mean ranks and total ranks of cognitive flexibility of adolescents with and without generalized anxiety disorder, the Yeoman-Whitney test was used, the results of which show that the mean ranks and total ranks for the group without generalized anxiety disorder are 90.51 and 6697.50, respectively, and for the group with generalized anxiety disorder they are 63.21 and 4930.50, respectively.

Table 7. Test of inter-subject effects to compare the amount of hypervigilance in the group with and without generalized anxiety disorder

Source	The dependent variable	sum of squares	DF	mean square	F	Sig
group	Error 50 first actuator	0.02	1	0.02	0.07	0.78
	No response for the first 50 stimuli	1.83	1	1.83	3.58	0.06
	The correct answer is the first 50 stimuli	1.57	1	1.58	3.12	0.07
	Reaction time of the first 50 stimuli	2824.48	1	2824.48	0.07	0.39
	Error 50 second drive	52.98	1	52.98	29.30	0.00
	No response 50 second stimulus	2.42	1	2.42	5.40	0.02
	Correct answer 50 second stimulus	0.11	1	0.11	0.01	0.90
	50 second stimulus reaction time	3365.40	1	3365.44	1.54	0.21
	Error 50 third actuator	0.03	1	0.03	0.11	0.73
	No response 50 third stimulus	0.00	1	0.00		
	Correct answer 50 third stimulus	0.00	1	0.00	0.00	0.94
	Reaction time of 50 third stimuli	12011.54	1	1201154.54	8.62	0.00
Error	Error 50 first actuator	49.94	150	0.33		
	No response for the first 50 stimuli	36.77	150	0.50		
	The correct answer is the first 50 stimuli	74.04	150	3874.77		
	Reaction time of the first 50 stimuli	581216.01	150	1.80		
	Error 50 second drive	271.22	150	0.64		
	No response 50 second stimulus	67.25	150	7.15		
	Correct answer 50 second stimulus	1073.64	150	2178.61		
	50 second stimulus reaction time	326791.58	150	0.27		
	Error 50 third actuator	41.64	150	0.35		
	No response 50 third stimulus	0.00	150	0.00		
	Correct answer 50 third stimulus	53.86	150	0.51		
	Reaction time of 50 third stimuli	209023.30	150	1393.48		
Total	Error 50 first actuator	86.00	152			
	No response for the first 50 stimuli	107.00	152			
	The correct answer is the first 50 stimuli	370637.00	152			
	Reaction time of the first 50 stimuli	3835850.00	152			
	Error 50 second drive	427.00	152			
	No response 50 second stimulus	101.00	152			
	Correct answer 50 second stimulus	351858.00	152			
	50 second stimulus reaction time	40488977.00	152			
	Error 50 third actuator	55.00	152			
	No response 50 third stimulus	0.00	152			
	Correct answer 50 third stimulus	374276.00	152			
	Reaction time of 50 third stimuli	3706010.00	152			

Table 8 shows the results of the Yeoman-Whitney test to compare the level of cognitive flexibility in the two groups. According to the results presented in Table 8, the obtained statistic value is equal to 0.000 and its significance level is less than 0.05 (P<0.05). As a result, the null hypothesis is rejected and the research hypothesis is confirmed. That is, there is a significant difference between the two groups in terms of cognitive flexibility. In other words, considering that the average of the group without generalized anxiety disorder is higher than the average of the group with generalized anxiety disorder in terms of cognitive flexibility, this difference is significant in favor of the group without generalized anxiety disorder.

Table 8. The results of the Mann-Whitney test to compare the rank of people in cognitive flexibility

Test	The amount of
Yeoman Whitney	1849.50
Will Coxon	4930.50
Significance level	0.000

Discussion

Generalized anxiety disorder is a chronic condition of excessive worry that is difficult to control. As this disorder covers a wide range of patients with mental disorders and affects different functions of people, it is important to address it. So the aim of the present study was to compare response inhibition, cognitive flexibility and hypervigilance in adolescents with and without generalized anxiety disorder.

The results of the present study showed that there was a difference between response inhibition in the two groups of adolescents with and without generalized anxiety disorder. This finding is in line with the research results of (Zainal & Newman, 2022), (Hallion et al., 2017) and (Matinfar et al., 2021). They have shown that there is a difference between response inhibition in adolescents with generalized anxiety disorder and without generalized anxiety disorder. For example, in one study, Zainal and Newman (2018) observed a national sample of 2605 adults living in the community for nine years and examined their neuropsychological symptoms, during which time they also conducted diagnostic interviews. After this period, they concluded that the executive functions of response inhibition, attention and working memory are associated with increased excessive and uncontrollable worry, which is the main symptom of generalized anxiety disorder, and that deficits in these functions are strong predictors of the generalized anxiety disorder (Zainal & Newman, 2022). In their research, Hellion and his colleagues (2017) studied 35 adults with generalized anxiety disorder and 21 healthy adults, using the Stroop test to assess their level of inhibition. They showed that people with generalized anxiety disorder have a deficit in inhibition compared to healthy people, so as the intensity of worry increases in these people, so does their inhibitory function (Hallion et al., 2017). The results of the present study are inconsistent with the results of (Rosa-Alcázar et al., 2020) and (Matinfar et al., 2021). In their research, they studied 95 adults with generalized anxiety disorder and obsessive-compulsive disorder, and a control group, and using the computerized Wisconsin Card Sorting Test and the Stroop Word and Color Test to assess response inhibition and cognitive flexibility in these people. The results showed that the generalized anxiety disorder and obsessive-compulsive disorder groups scored lower on cognitive flexibility than the control group, but there was no difference in response inhibition. This means that people's flexibility is affected by anxiety and obsession, but their response inhibition is not (Rosa-Alcázar et al., 2020). To explain the results, it can be said that people with suffering from generalized anxiety disorder, as mentioned in the previous research, have defects in the response inhibition function compared to normal people. The attention control theory of Eysenck and colleagues (2007) can be used to explain the findings in this area. The theory of attentional control outlines two important mechanisms: First, the theory suggests that, in the context of anxiety and worry, working memory and inhibitory functions may only be impaired during high cognitive load tasks. Second, the theory asserts that "in theory, high anxious individuals typically use more processing resources than low anxious individuals to achieve comparable levels of performance". In fact, Eysenck and his colleagues (2007) showed that people have difficulty with response inhibition due to anxiety (Eysenck et al., 2007). Finally, according to the theoretical and research bases discussed earlier, it can be stated that the level of response inhibition is different in adolescents with and without generalized anxiety disorder, and high response inhibition plays an important role in reducing the symptoms of generalized anxiety disorder (Lee & Orsillo, 2014).

Furthermore, the results of the present study showed that there was a difference between the cognitive flexibility of the two groups of adolescents with and without generalized anxiety disorder. This finding is consistent with the findings of Rosa-Alcázar & et al. (2021) and Lee & Orsillo (2014), both of which showed that there is a difference between the cognitive flexibility of adolescents with generalized anxiety disorder and those without generalized anxiety disorder. For example, Rosa-Alcázar & et al (2021) used accessible sampling in a pilot study of 89 adults diagnosed with generalized anxiety disorder, obsessive-compulsive disorder and social anxiety disorder. The results showed that there was a significant difference between the groups on the variables of cognitive flexibility and working memory. Therefore, it can be said that cognitive functions, including cognitive

flexibility and working memory, are affected by anxiety (Rosa-Alcázar et al., 2020) & (Lee & Orsillo, 2014). According to the results of previous research, it can be said that people who suffer from generalized anxiety disorder have defects in the function of cognitive flexibility compared to normal people, and cognitive inflexibility is a basic feature of generalized anxiety disorder. To explain this finding, it can be said that people with generalized anxiety disorder use a form of dry thinking due to chronic worry, and as a result they have debilitating beliefs about their worries. As a result, these people suffer from a weakness in cognitive flexibility. They show this weakness as a deficiency in interpretive methods, a deficiency in flexible thinking, and a repetitive thinking style about worry (Sepahvand, 2021). In general, cognitive inflexibility is one of the possible features of generalized anxiety disorder, and this executive function is weak in adolescents with this disorder.

Finally, the results of the present study showed that there is a difference between hypervigilance in adolescents with and without generalized anxiety disorder. These findings are consistent with the research findings of (Weinberg & Hajcak, 2011) and (Richards et al., 2014), all of which showed a difference between hypervigilance in people with and without generalized anxiety disorder. For example, by examining the eye movements of anxious individuals, Richards and colleagues (2014) concluded that anxious individuals become more vigilant by focusing extensively on threats, resulting in increased distraction and reduced eye movements in the presence of threats. Finally, they stated that there is a direct relationship between anxiety and hypervigilance, and that people with anxiety disorders are more hypervigilant than the normal group (Richards et al., 2014). The explanation for this finding is probably that people with generalized anxiety disorder are more alert to threats than the group without generalized anxiety disorder because they are constantly worrying. As mentioned above, people with generalized anxiety disorder are constantly worried, so it can be said that people feel safe when there are no anxiety symptoms, but when there is no feeling of safety, people experience chronic anxiety. Therefore, the lack of a sense of security explains why people with generalized anxiety disorder feel constantly hyper vigilant and worried about possible events, and this makes them more anxious. Finally, on the basis of the theory and research we discussed earlier, it can be said that hypervigilance is different in adolescents with and without generalized anxiety disorder, and in people with generalized anxiety disorder, when faced with events they are more alert than normal people.

The current research has limitations: people with generalized anxiety disorder were tested in psychological and counselling center, and there was a time and place limitation, so generalization of the results should be done with caution. The current research was causal-comparative in nature, which did not allow for selection and manipulation of variables in the experimental conditions, causal explanation of findings, and control for confounding variables. Also, due to the small sample size in the present study and the selection of the sample only from Alborz province, the generalization of the results to the society should be done with great caution. Finally, the current research was conducted at a time when all age groups in the society were under a lot of psychological, social and economic pressure and there may have been a lot of anxiety among them, based on this, the generalization of the results to the society should be done with caution. On a theoretical level, it is suggested that more research should be done in this area as there is little research on the level of hypervigilance in generalized anxiety disorder in different age groups. It is suggested that future research should be conducted as longitudinal research because, as mentioned in the course and prognosis of generalized anxiety disorder, this disease has a chronic course and it is not possible to explain the causes of the phenomena by using cross-sectional research. It is also suggested that future research should investigate other cognitive functions in generalized anxiety disorder, such as types of attention, memory, planning, etc. Because the software tests took longer than the paper-pencil tests, the initial assessment and separation of the group with and without generalized anxiety disorder was done by administering the tests with a break; based on this, it is suggested that further research should be done using other tools that take less time to administer, so that the time interval between the diagnosis of symptoms in the disordered group and the administration of the tests is reduced. At the practical level, it is suggested that schools and educational center use qualified counsellors and psychologists to identify the symptoms of generalized anxiety disorder in adolescents, and early diagnosis can prevent them from cognitive and psychological damage. It is also suggested that parents should consult a psychologist as soon as they notice signs of constant worry and anxiety in their adolescents, so that they can reduce the cognitive damage. Finally, it is suggested that workshops on the ability to control anxiety and its consequences be held free of charge for adolescents in educational and cultural centers so that a wide range of adolescents can benefit from them and gain the ability to control their anxiety. This is to prevent the signs of a decline in their cognitive functions.

Conclusion

The present study compares response inhibition, cognitive flexibility and hypervigilance in adolescents with and without generalized anxiety disorder. The results of the research indicate that the levels of response inhibition, cognitive flexibility and hypervigilance are different in adolescents with and without generalized anxiety disorder, and that these functions are lower in the group with generalized anxiety disorder than in the group without generalized anxiety disorder.

Disclosure Statement

The authors declare that there was no commercial or financial relationship that could be construed as a potential conflict of interest in their research.

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