JEAS | Journal of Economics and Administrative Sciences
E-ISSN: 2148-1792 P- ISSN: 1302-2024
Volume 3, Supplement Issue 2
www.jeasweb.org

Examining the components of creative thinking of high school students based on the components of brain executive functions

*Nima Sabalani Talesh Mekaeil**
Master of Educational Psychology student, Islamic Azad University-Sarab Branch, Iran.
**Corresponding Author*

Parviz Abdoltajedini
Assistant Professor, Department of Psychology, Islamic Azad University, Sarab Branch, Sarab, Iran.

ABSTRACT
The purpose of this study was to investigate creative thinking based on executive functions of the brain among male and female second grade high school students in the city of Bileh Savar. The research method in the current study is applied in terms of purpose and correlational descriptive in nature. The statistical population in the present study is all female and male second grade high school students in Bileh Savar city, including 250 girls and 243 boys. Morgan table was applied to determine the sample size. Considering the population size, 218 students were selected as a sample by multi-stage cluster sampling method. The data collection tool was the questionnaires of the standard creative thinking and executive function of the brain. Data were analyzed using SPSS program at two levels of descriptive (demographic tables and graphs) and inferential (multivariate regression analysis). The obtained results indicated that: Creative thinking in both brain executive functions is predictable.
Keywords: Creative thinking, Brain executive function, High school.

Introduction

One of the factors that can play a significant role in emotional creativity and creative thinking is the executive functions of the brain. Although, researchers believe that the executive functions of brain have not yet been formally and basically defined, and it is a general term for high-level cognitive abilities. It has been mentioned as the ability to adopt and continue proper problem-solving skills to achieve the goal, which has sub-categories such as judgment, decision-making, planning and social behavior, cognition control and regulation (Ahrari et al., 2018). So, the question that the researcher faces is whether creative thinking and emotional creativity can be predicted based on the executive functions of the brain and emotional cognitive self-regulation or not, which has been answered during the research.

At large, there is no similar and acceptable definition of executive function among experts. In the provided definitions, some specific aspects of these functions have been emphasized. For instance, Pennington and Ozonov (1996) consider executive functions as particular areas of competence that include

organizing in space, selective deterrence, response preparation, purposefulness, planning, and flexibility. Barkley (1997) also considers executive functions as acts of self-regulation that are used for self-governance. He believes that in brief, executive functions can be considered as actions that a person accomplishes for himself, and for his regulation in order to perform self-control and goal-oriented behavior, and maximize future consequences. In fact, through this, one can control the behavior over a period of time, which occurs based on the perception of time, and correct and direct the final response to obtain a larger booster. Barkley (1997) believes that in the process of growth, self-commanding behaviors gradually become internal and implicit, and internal language or personal speech is an obvious example of these processes (Alizadeh, 2006).

Also, according to Debono, creative thinking is an intellectual and mental activity and means the capability to combine ideas in a unique way by creating connections between ideas or mental activity to create new ideas and novel and innovative ways and attitudes (Sharif, 2014). Creativity is the process of identifying problems, issues, information gaps, missing elements, awkward things, guessing and hypothesizing about these flaws and evaluating and testing these guesses and hypotheses, revising and retesting them and finally transferring the results.

In any case, being along and keeping up with the rapid changes in various fields, requires the capability of changing and intellectual flexibility and considering other solutions, evading to remain in the place and avoiding fixed methods and outdated and fruitless solutions in dealing with new issues or problems or having creative skills, also, processes such as goal setting, planning, prioritization, organization, flexibility, preservation and manipulation of information in working memory and self-monitoring have effects on students' success (Meltzer, 2010, cited in Ahrari et al., 2018). However, the relationship between creativity and executive functions of the brain has not been made so clear. And conducting various research studies in this field is of necessity. Emotional regulation refers to actions that are used to change or modify an emotional state and is a special form of self-regulation. Overall, it is assumed that emotion regulation is one of the basic factors of well-being and successful functioning and plays an important role in adapting to stressful life events. Successful emotion regulation is associated with good health consequences, academic achievement, and high work performance, and conversely, failure to regulate emotion is associated with mental, personality, and anxiety disorders. Neurocognitive executive functions are important structures that are related to the psychological processes responsible for controlling consciousness, thinking, and performance. Although executive functions have been examined primarily from a neurocognitive perspective, in recent years their evolution and pathology have been of interest to many specialists (Zlazoo and Müller, 2002).

Some research studies have been done in this area; Babakhani and Balvardi, (2015) in a study entitled the relationship between creativity and executive functions of the brain and emotional cognitive self-regulation in students have achieved the following results: that the executive functions of the brain have an inverse significant relationship with creativity. Contrarily, the results indicated that emotional cognitive self-regulation has a direct relationship with creativity. The results also displayed that emotional cognitive self-regulation has a direct relationship with the executive functions of the brain. Therefore, it can be concluded that creativity is related to brain executive functions and cognitive-emotional regulation.

Ahrari et al. (2015) in a study entitled predicting students' creativity based on the executive functions of the brain have attained the following results: The reasoning component has a positive relationship with total creativity ($r = 0.149$) and can predict 2.43% of its variance. Flexibility also has a significant relationship with reasoning ($r = 0.198$) and memory of inverse digits ($r = 0.156$). Therefore, due to the little research conducted on the relationship between brain functions and creative thinking, in this study, we examined the components of creative thinking in second-grade high school students based on the components of brain executive functions.

Methods

The research method in the present study is applied in terms of purpose and descriptive in nature and correlational predictive in terms of method. The statistical population in the current study is all male and female second-grade high school students in the city of Bileh Savar, whose number according to the official

statistics of education ministry is 250 girls and 243 boys. Morgan table has been used to determine the statistical sample, that based on the size of the population, 218 individuals have been selected as the sample, of which 109 will be girls and 109 will be boys. The sampling method used was multi-stage clustering.

Method of data collection: The data was gathered through using field data collection.

Data Collection tools

Creative Thinking Questionnaire: The creative thinking assessment questionnaire, known as the Abedi Creativity Test (CT), is based on Torrance's theory of creative thinking and was developed by Abedi in Tehran in 1984. This questionnaire has been revised several times and finally its 60-question form was advanced by Abedi in the University of California.

Brain Executive Function Questionnaire: This questionnaire was designed and standardized by Nejati in 2013. It includes 30 items and 7 components (memory, selective control and selective attention, decision making, planning, sustainable attention, social cognition and cognitive flexibility).

Validity and reliability of research tools

In this research, Cronbach's alpha method has been used to determine the reliability of the test. This method is used to calculate the internal consistency of a measuring instrument that assesses various properties. A questionnaire is valid if the Cronbach's alpha value is greater than 0.7 and the closer it is to 1, the higher the reliability of the questionnaire. Based on this test, the Cronbach's alpha value for all questionnaires was close to 1.

Procedure

After obtaining the required permits from the vice chancellor for research of the university, the questionnaires were referred to the general department of education and training of the province and applied for obtaining a permit. The research group, after reviewing the questions of the questionnaires, signed all the questionnaires with the signature of the research group and introduced them to the education and training department of Bileh Savar city to cooperate in conducting the research. Then, a copy of the letter along with signed questionnaires with the signature of the general office of education and training was sent to inform schools and security experts and make them cooperate in the research. After that, 109 students from girls 'schools and 109 students from boys' schools were selected in multi-stage clusters as a sample and filled in the above questionnaire.

Data analysis

In this study, after collecting the desired information, the data were entered into SPSS version 18 for analysis. Data analysis was done in two parts. In the first part, descriptive analysis of data including mean chart, etc., and in the second part, inferential analysis of data was performed, in which Pearson test and multiple regression were used in this part.

Results

Descriptive findings

Table 1: Descriptive information of the subjects' scores in the test of executive functions of the brain and creative thinking

Variable	Components	Mean	Std. deviation	Minimum score	Maximum score
Executive functions of the brain	Memory	3.68	0.6912	2.00	5.00
	Inhibitory control and selective attention	3.28	0.5447	2.33	4.83
	Decision making	3.39	0.6149	2.00	4.60
	planning	3.49	0.6182	2.00	4.67
	Sustainable attention	3.24	0.7250	1.67	4.67
	Social cognition	3.12	0.7649	1.00	4.67
	Cognitive flexibility	3.34	0.7588	2.00	5.00
	Executive performance (total)	3.36	0.3792	2.70	4.08
Creative Thinking	Fluency	56.12	4.69	43	63
	Elaboration	25.32	3.79	14	33
	Originality	39.13	4.20	28	48
	Flexibility	27.83	3.08	20	33
	Creative Thinking(total)	148.4	12.79	119	169

Inferential analysis of data

The research hypothesis was analyzed using multiple regression and Pearson correlation test.

Before entering the phase of testing the hypotheses and analyzing them, it is necessary to check the normality of the variables in order to use parametric or non-parametric tests based on whether the variables are normal or not. The use of nonparametric statistical tests does not need any specific presumptions, but parametric tests require specific presumptions and cannot be used if these presumptions are not met. One of the most important presumptions of the parametric test is the normality of the distribution of variable data.

Parametric tests are generally based on mean and standard deviation, and if the data distribution is not normal, these indicators do not reflect the true image of the data status.

Kolmogorov-Smirnov test was used to evaluate the normality of data distribution of research variables. In the Kolmogorov-Smirnov test, the zero assumption of the normality of data distribution is tested against the assumption that the data are not normal. If the significance level is greater than the test error value, the assumption that the data is normal is accepted.

According to the obtained results, the significance level of Kolmogorov-Smirnov test is greater than the error value of 0.05, so the normality test is not significant for the variables tested at the level of 0.05. So, it can be concluded that the studied data have normal conditions and they are ready to be used in "parametric" tests, and the mean can be used as a central indicator in statistical decisions. As a result, correlation and regression tests can be used to test the hypotheses.

Hypothesis test

The components of creative thinking of second-grade high school students can be predicted based on the components of executive functions of the brain.

- Fluency

The results of regression coefficients of the fluency component of the creative thinking based on the components of the executive functions of the brain indicate that 20% of the total variance of the fluency component of the creative thinking is explained based on the components of the executive functions of the brain.

The results of ANOVA test to examine the significance of the regression model indicate that the regression model of the fluency component of creative thinking based on the components of the executive functions of the brain is significant ($p < 0.000$; $F = 7.555$).

Table 2: Results of Regression Coefficients of Creative Thinking (Fluency) Based on Components of Brain Executive Functions

Criterion variable	Predictive variables	B	SEB	β	t	Sig
Creative thinking (Fluency)	Constant Value	2.708	0.141		19.144	0.000
	Memory	0.072	0.025	0.233	2.922	0.004
	Inhibitory control and selective attention	-0.110	0.032	-0.280	-3.400	0.001
	Decision making	-0.034	0.027	-0.099	-1.289	0.199
	planning	-0.029	0.026	0.084	-1.112	0.267
	Sustainable attention	-0.058	0.022	-0.198	-2.670	0.008
	Social cognition	-0.043	0.019	-0.154	-2.266	0.024
	Cognitive flexibility	0.143	0.028	0.511	5.177	0.000

The results of Table 2 demonstrate that among the components of brain executive function, the components of memory, inhibitory control, sustained attention, social cognition and cognitive flexibility predict the fluency component of creative thinking.

- Elaboration

The results of regression coefficients of the elaboration component of the creative thinking based on the components of the executive functions of the brain indicate that 23% of the total variance of the elaboration component of the creative thinking is explained based on the components of the executive functions of the brain.

The results of ANOVA test to examine the significance of the regression model display that the regression model of the elaboration component of the creative thinking is significant based on the components of the executive functions of the brain ($p < 0.000$; $F = 0.923$).

Table 3: Results of Regression Coefficients of Creative Thinking (Elaboration) Based on Components of Brain Executive Function

Criterion variable	Predictive variables	B	SEB	β	t	Sig
Creative thinking (Elaboration)	Constant Value	2.604	0.225		11.59	0.000
	Memory	0.088	0.039	0.177	2.259	0.025
	Inhibitory control and selective attention	-0.122	0.051	-0.193	-2.385	0.018
	Decision making	-0.101	0.042	-0.181	-2.396	0.018
	planning	0.135	0.041	0.242	3.260	0.001
	Sustainable attention	0.006	0.035	0.013	0.178	0.859
	Social cognition	0.048	0.030	0.107	1.610	0.109
	Cognitive flexibility	-0.157	0.044	-0.346	-3.573	0.000

The results of Table 3 indicate that among the components of executive function of the brain, the components of memory, inhibitory control, decision making, planning and cognitive flexibility predict the elaboration component of creative thinking.

- Originality

The results of regression coefficients of the originality component of creative thinking based on the components of the executive functions of the brain show that 14% of the total variance of the originality component of creative thinking is explained based on the components of the brain executive functions.

Also, the results of ANOVA test to examine the significance of the regression model indicate that the regression model of the originality component of creative thinking based on the components of the brain executive functions is significant ($p < 0.000$; $F = 5.212$).

Table 4: Results of Regression Coefficients of Creative Thinking (Originality) Based on Components of Brain Executive Function

Criterion variable	Predictive variables	B	SEB	β	t	Sig
Creative thinking (Originality)	Constant Value	2.464	0.180		13.692	0.000
	Memory	2.103	0.031	0.000	0.001	0.999
	Inhibitory control and selective attention	-0.151	0.041	-0.312	-3.670	0.000
	Decision making	-0.007	0.034	-0.016	-0.207	0.836
	planning	0.009	0.033	0.022	0.277	0.782
	Sustainable attention	0.013	0.028	0.037	0.481	0.631
	Social cognition	0.088	0.024	0.258	0.669	0.000
	Cognitive flexibility	0.044	0.035	0.128	1.258	0.210

The results of Table 4 display that among the components of brain executive function, the components of inhibitory control and social cognition predict the originality component of creative thinking.

-Flexibility

The results of the regression coefficients of the flexibility component of creative thinking based on the components of the brain executive functions show that 20% of the total variance of the creative thinking flexibility component is explained based on the components of the executive functions of the brain.

According to the ANOVA test to evaluate the significance of the regression model, the regression model of the flexibility component of creative thinking based on the components of the executive functions of the brain is significant ($p < 0.000$; $F = 7.694$).

Table 5: Results of regression coefficients of creative thinking (flexibility) based on the components of brain executive functions

Criterion variable	Predictive variables	B	SEB	β	t	Sig
Creative thinking (Flexibility)	Constant Value	3.100	0.204		15.179	0.000
	Memory	0.121	0.035	0.272	3.417	0.001
	Inhibitory control and selective attention	-0.125	0.047	-0.221	-2.683	0.008
	Decision making	-0.063	0.038	-0.126	-1.640	0.102
	planning	-0.023	0.038	-0.047	-0.620	0.536
	Sustainable attention	-0.084	0.032	0.199	-2.681	0.008
	Social cognition	-0.112	0.027	-0.279	-4.107	0.000
	Cognitive flexibility	0.170	0.040	0.417	4.240	0.00

The results of Table 4-30 indicate that among the components of brain executive function, the components of memory, inhibitory control, sustained attention, social cognition and cognitive flexibility predict the flexibility component of creative thinking.

Conclusion

The components of creative thinking of second-grade high school students can be predicted based on the components of brain executive functions. The results of this study indicate that among the components of brain executive function, the components of memory, inhibitory control, sustained attention, social cognition and cognitive flexibility predict the fluency component of creative thinking. Also among the

components of brain executive function, the components of memory, inhibitory control, decision making, planning and cognitive flexibility predict the elaboration component of creative thinking, and among the components of brain executive function, the components of inhibitory control and social cognition predict the originality component of creative thinking. Also among the components of brain executive function, the components of memory, inhibitory control, sustained attention, social cognition and cognitive flexibility predict the flexibility component of creative thinking. In explaining this hypothesis, the similarities between the components of creative thinking and the components of executive function of the brain can be pointed out. A review of the studies done in this field shows that the results of Babakhani and Balvardi (2018) entitled as the relationship between creativity and executive functions of the brain and emotional cognitive self-regulation in students, Ahrari et al. (2018) entitled as predicting students' creativity based on the executive functions of the brain, Camarda et al. (2017) entitled as the executive functions of the brain creatively all are in line with the results of the current study, and confirm the results of the present study. The results of the present hypothesis revealed that 20% of the total variance of the fluency component of creative thinking is explained based on the components of the brain executive functions. Also, 23% of the total variance of the elaboration component of creative thinking, 14% of the total variance of the originality component of creative thinking and 20% of the total variance of the flexibility component of creative thinking are explained based on the components of the brain executive functions.

References

[1] Ahrari, Gh; Badri Gargari, R.;Abdollahi,S; Parkar, P. and Yousefi (2018) Predicting students' creativity based on executive functions of the brain, Journal of Cognitive Psychology and Psychiatry, Volume 5, Number 3, pp. 66-80.

[2] Alizadeh, Hamid. (2006) Relationship between neurological executive functions and developmental disorders. Cognitive Science News, 8 (4), 70-57.

[3] Sharifi, Ali Akbar and Davari, Roghayeh. (2009). Comparison of the effect of three methods of fostering creativity in increasing the creativity of second grade guidance school students. Iranian Journal of Psychiatry and Clinical Psychology. Fifteenth year. No. 1. pp. 57-62.

[4] Zelazo, P. D., Müller, U. (2002). Executive Function in Typical and Atypical Development. Usha Goswami, Blackwell Handbook of Childhood Cognitive Development.

[5] Babakhani, Narges and Farahnaz Balvardi,2018, The Relationship between Creativity and Brain Executive Functions and Emotional Cognitive Self-Regulation in Students, 5th National Conference on School Psychology, Tehran, Iranian Educational Psychology Association.