

# Research Paper: The Reliability and Validity of Behavior Rating Inventory of Executive Functions Tool Teacher's Form Among Iranian Primary School Students



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## ABSTRACT

**Objectives:** Behavior rating scales have been developed to increase ecological validity in the measurement of executive functions. As the teachers have a lot of contact with the students in the school environment, behavioral rating scale teacher's form can provide useful information. The purpose of this study was to investigate the reliability and validity of the behavioral rating inventory of executive functions teacher's form among primary school students of Iran.

**Methods:** The statistical population consisted of primary school students of Jajarm city who were studying in the academic year 2016-2017. Students (n=360) were selected through sampling two-stage clusters. The behavioral rating inventory of executive functions (BRIEF) teacher's form for students was completed by their teachers, and the Wechsler's coding subscale was completed by the students.

**Results:** The results showed that the internal consistency of this inventory was 0.98 and for all subscales ranged 0.75 to 0.92. Also, subscales related to each other significantly. Regarding convergent validity, Wechsler's coding subscale had a significant correlation with the subscales of executive functions. Also, results showed that two-factor model with eight subscales were confirmed by confirmatory factor analysis.

**Discussion:** Given the satisfactory reliability and validity of BRIEF tool in the school environment and results of this study indicated the relationship of executive functions with academic problems; this tool could be used to examine students' executive functions.

## 1. Introduction

The term executive functions include a wide range of cognitive processes and behavioral competencies that consist of

verbal reasoning, problem-solving, planning, sequencing, ability to maintain attention, resistance to distracting factors, use of feedback, cognitive flexibility, multiple performance, and ability to deal with novelty [1]. These components are referred to as "cold component"

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of executive functions since these cognitive processes do not include emotional excitation and nearly are based on logic or machine. On the other hand, executive functions which are more emotional and attitudinal (such as experiences of reward and punishment, regulation of social behavior, and decision making), and personal and emotional interpretations, are considered as "hot component" [2]. Studies have shown that disturbance in both the cold and hot components of executive functions may have catastrophic effects on everyday life activities such as the ability to work, social relationships, education, and independent function [3].

Previous studies about executive functions were focused on neuropsychology based tests and were criticized as raw and non-specific [2]. The most troublesome problem in evaluating executive functions is that the task measuring executive functions is commonly trapping into other cognitive processes such as intelligence and language, not specified executive functions [4]. Another primary concern about neuropsychological tests is the lack of ecological validity, which is defined as the relationships between test results and real-world performance [2]. Although neuropsychological tests provide essential information about how a person works, there are less practical applications in the contextual school, and tasks that evaluate executive functions in clinical settings provide less information on how a student works in the classroom [5]. The classes, of course, filled with routines and distracting issues that require the student to apply multiple executive functions for success. Students performed test outside the classroom, less information is provided on how executive functions affect class behaviors and academic achievement.

The behavioral rating scales were developed to reduce the cited problems for assessing executive functions [6]. The behavioral rating scales are tools that list more specific behavioral features, and the person familiar with student evaluates frequencies of presented behaviors. School psychologists widely use these behavioral assessment scales, although these tools have some limitations. These tools have been criticized for undesirable variability that is attributed to the rater variance, the context variance, the time variance, and tool variance [7]. Other criticism of the behavioral rating scale includes the lack of useful information to select interventions that do not result in scientific conclusions because they are based on personal perception of behavior rather than actual behavior measurement [8].

Despite the limitations, the behavioral rating scales have the main utility as an evaluation tool. Rating scales

based on direct raters' assessments are inexpensive, easier to implement, and easy scoring [7]. Respondents are parents or teachers who have a regular contact with a student in their natural environment. Another benefit in using rating scales is that there is a normative data that helps to compare the student with his or her peers to determine the appropriate behavior with growth [5].

There are specific tools for measuring executive functions such as Behavioral Rating Inventory of Executive Functions (BRIEF) [9], Comprehensive Executive Function Inventory (CEFI) [8], and Barkley Deficits in Executive Function Scale (BDEFS). This study focused on BRIEF tool to rate executive functions as they are used commonly in school [10, 11]. BDEFS is not considered for this study because it does not have a teacher rating scale and also CEFI has less research support about reliability and validity [12].

The authors' BRIEF tool has considered various dimensions within the framework of executive functions that include inhibit, shift, working memory, emotional control, planning, and organizing of material, initiate, and monitor. In Parent and Teacher's Forms of BRIEF and with eight subscales exploratory factor analysis has revealed solution two factors in both clinical and normal samples [9]. Gioia et al. [10] have analyzed the BRIEF among children and adolescents of aged 5 to 18 years in the clinical sample, and have obtained the three-factors metacognition, emotional regulation, and behavioral regulation.

The metacognition factor consists initiate, working memory, planning/organization, an organization of material, monitor subscales. Emotional regulation factor includes shift and emotional control subscales, and behavioral regulation factor include self-monitor and inhibits subscales. Slick et al. [13] have found that the two-factor model had the best fit for children and adolescents with untamable epilepsy rather than of the one or three-factor model for the parent's form. In a sample of brain-damaged children, a two-factor structure with eight subscales was approved in the parent's form [14]. The present study has used the two-factor model with eight subscales to examine validity and reliability teacher's form of BRIEF.

The developers' BRIEF tool have found that collecting structured observations from parents and teachers has potential benefits [9]. Therefore, along helping parents, teachers, and clients, clinicians in various fields it is interested in contributing in interventions related to executive functions in particular neurodevelopment disorders. In this way, it is essential to evaluate the executive func-

tions in the non-laboratory clinical environment using a valid and reliable tool. Given the cited issues, it is essential that there will be valid and reliable tools to assess the students' executive functions in an educational environment. In general, due to the importance of the practical application of the BRIEF in examining the executive functions of primary students, the reliability and validity of BRIEF have not been investigated in Iran. Therefore, the aim of this study was to examine the psychometric properties of the Persian version of the BRIEF tool for primary school students in Iranian population.

## 2. Methods

The study was a descriptive-correlation type. The statistical population consisted of all primary school students of Jajarm city who were studying in the academic year 2016-2017. Two primary schools (a girls' school and a boys' school) were selected by sampling two-stage clusters and was selected a grade in each school. The sample size was 360 students and their 12 teachers (6 women and 6 men) completed BRIEF for them. The numbers of students in each grade were based on gender presented in Table 1.

### Instrument

#### The Behavioral Rating Inventory of Executive Functions (BRIEF)

Gioia et al. [9] have designed BRIEF for children aged 5 to 18 years. It has 86 questions and parent and teacher's forms. Questions were answered based on the three-point scale Likert (never, sometimes, and often). BRIEF has eight subscales, in which inhibit, shift and emotional control together constitute the behavioral regulation index; initiate, plan/organization, working memory, organization of material and monitor constitute metacognition index. The sum of these two indexes is global executive composite. The higher scores are an indicator of higher perceived score. The designers' BRIEF have standardized it among 1419 normal children and 852 of the clinical groups, and have confirmed two factors model that is metacognition and behavioral regulation in the factor analysis.

The internal consistency for parent's form was in the range of 0.80 to 0.98. The correlation of retest reliability for the parent's form in the normal sample was 0.81 (ranged 0.76 to 0.85), with a mean of two weeks interval, the test-retest correlation for behavioral regulation was 0.84, metacognition 0.88 and the total 0.86. The correlation of retest for the parent's form in the clinical sample

was 0.79 (ranged 0.72 to 0.84) and for the behavioral index was 0.80, metacognition index 0.83 and the total 0.81. The retest reliability of teacher's test form in three weeks interval was in the normal sample of 0.87 (ranged 0.83 to 0.92), and for the behavioral regulation, index was 0.92, metacognition 0.91 and total 0.91 [15].

Mahone et al. [16] reported the validity of BRIEF tool in children aged 6 to 16 years and found that both attention deficit hyperactivity disorder and Tourette syndrome groups were rated as more impaired than the control group on the subscales of BRIEF.

Lamer [12] studied the correlation of BRIEF and Conners 3 executive functioning scale among children and adolescents and found a correlation of 0.5 for total scores and the subscale in the range of 0.14 to 0.68. He obtained an internal consistency of between 0.80 to 0.98 for the form of parent and teacher in normal children and children with clinical problems, and interrater agreement for the forms of teacher and parent was in the range of 0.15 to 0.50, and the correlation among forms was 0.32.

### Wechsler's Coding Subscale

In this subscale, one must copy symbols as part of a code set, and the numbers and symbols must be paired. This subscale measures the psychomovement speed, the ability to follow the order, visual short-term memory, speed and accuracy, the ability to learn unfamiliar tasks, and flexibility. The scores of this subscale are reduced significantly in learning disabilities, brain damage, depression, anxiety, and obsession. In coding subscale, normal children were significantly different than children with clinical problems [17]. Reliability for this subscale has been reported 0.80 [18]. In this study, the internal consistency of coding subscale was 0.96.

### Procedure

At The first, English version of BRIEF was translated into Persian and accuracy translation was checked by several translators and then reverse translation was carried out to ensure the conformity of the Persian version with the English version. The Persian version was matching with the English version. The sample was selected using a two-stage cluster sampling. In the first stage, two schools (a girls' school and a boys' school) were chosen randomly from among elementary schools, and in the second stage, a class of each grade was selected.

After obtaining a license from the Education Office, a booklet of BRIEF was completed by teachers, and for

completing each, the questionnaire was paid 20,000 Rials to teachers. Wechsler’s coding subscale was given to the students, as this subscale was performed in 120 seconds, students were encouraged to answer quickly, and financial support was not provided. The completed questionnaires were analyzed through correlation and Cronbach’s alpha test in SPSS 23 software and the confirmatory factor analysis through AMOS 23 software.

### 3. Results

Mean and standard deviation of variables is presented in Table 2. The relationships among sub-scales of BRIEF are significant. Also, the exception of working memory and organization of material, and other subscales of BRIEF have a significant correlation with coding. Table 2 shows that all factors of BRIEF have satisfactory of internal consistency reliability measured through Cronbach’s Alpha test. The lowest reliability is in the initiate factor, and the highest reliability is in the plan/organization factor.

The confirmatory factor analysis was used to examine the validity of the BRIEF tool. At first, the validity of subscales was considered separately to assure items related to subscales significantly. In this analysis, each of the subscales was considered as a single-factor model in which its items were observed variables. After that, the validity of the two-factor model of the BRIEF tool was examined including metacognition factor with five subscales as observed variable and behavioral regulation factor with three subscales as an observed variable. The two-factor model of BRIEF is shown in Figure 1. The results of confirmatory factor analysis are presented in the Tables 2 and 3.

Table 3 shows standardized direct effects. In this manner that paths of working memory factor to related items are ranged 0.26 to 0.74; paths inhibit factor to its items are ranged 0.52 to 0.79; paths of initiate to its items are ranged 0.27 to 0.73; paths of monitor to its items are ranged 0.44 to 0.79; paths of organization of material to its items are ranged 0.55 to 0.73; paths of shift to its items are ranged 0.46 to 0.80; paths of emotional control to its items are ranged 0.50 to 0.84; paths of plan/organization to its items are ranged 0.55 to 0.84. In general all items significantly related to its factors. Also, Table 3 shows that in the two-factor model the subscales of inhibit, emotional control and shift related to the behavioral regulation index; subscales of the initiate, working memory, plan/organization, an organization of material and monitor pertaining to metacognition index. Table 4 shows that the indexes of best fit model in all subscales are acceptable. Also, in the solution two-factor model, the total model is confirmed through confirmatory factor analysis. The results show that indexes of the goodness of fit are acceptable for this model.

### 4. Discussion

Processes as executive functions are considered including the ability to regulate behavior and monitoring and evaluation of thoughts, emotions, and behavior. Executive functions are measured through a questionnaire based on the performance and multiple related routine aspects were reported [19]. The present study aimed to examine the reliability and validity of BRIEF among primary school students. The results showed that internal consistency of BRIEF subscales was in the range of 0.75 to 0.98 among primary school students.

Table 1. Demographic characteristics of the participants

Grade	Girl		Boy		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	25	6.94	26	7.22	51	14.16
2	31	8.61	30	8.34	61	16.95
3	33	9.17	32	8.89	65	18.06
4	30	8.34	29	8.05	59	16.39
5	34	9.44	33	9.17	67	18.61
6	28	7.78	29	8.05	57	15.83
Total	181	50.28	179	49.72	360	100

Table 2. Statistical descriptive and correlation among variables

Variables	M	SD	α	1	2	3	4	5	6	7	8	9	10	11
Inhibit	15.51	5.08	0.90	1										
Shift	12.43	3.63	0.85	0.81**	1									
Emotional control	11.81	3.76	0.88	0.86**	0.84**	1								
Initial	11.65	3.39	0.75	0.81**	0.79**	0.82**	1							
Working memory	15.37	4.21	0.84	0.87**	0.86**	0.87**	0.81**	1						
Plan	19.35	5.82	0.92	0.90**	0.87**	0.88**	0.80**	0.89**	1					
Organization	8.75	2.65	0.82	0.83**	0.83**	0.88**	0.85**	0.85**	0.86**	1				
Monitor	12.29	3.79	0.87	0.89**	0.85**	0.86**	0.79**	0.85**	0.91**	0.85**	1			
BRI	38.09	11.25	0.95	0.95**	0.93**	0.95**	0.85**	0.91**	0.93**	0.89*	0.92**	1		
MI	67.31	18.75	0.97	0.92**	0.90**	0.92**	0.89**	0.93**	0.96**	0.93**	0.94**	0.97*	1	
GEC	105.52	29.68	0.98	0.94**	0.92**	0.94**	0.89**	0.94**	0.96**	0.92**	0.94**	0.97**	0.99**	1
Coding	47.89	14.44	0.96	-0.12*	-0.14*	-0.13**	-0.13**	-0.10	-0.17**	-0.10	-0.16**	-0.16**	-0.15**	-0.15**

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\* P<0.05; \*\* P<0.01; α: Cronbach’s Alpha; BRI: Behavioral Regulation Index; MI: Metacognition Index; GEC: Global Executive Composite

The lowest reliability of 0.75 was related to initiate, although it is an acceptable range but cautions must be taken before using this sub-scale in a clinical settings. This finding is in agreement with the study of Lamer [12], which showed that the internal consistency was ranged 80 to 0.98 for the forms of parent and teacher in normal children and children with clinical problems. The high internal consistency implies that all relevant items to a subscale measure the same subscale and not the other.

Also, the present study showed that all subscales of the BRIEF tool have high significant correlation together with indicating these subscales measure a conventional structure. These findings are consistent with the study of Ebrahimi et al. [20].

In this study, confirmatory factor analysis was performed to examine the structural validity of subscales which indicated all models of subscales had acceptable indexes of the goodness of fit. Also, in the present study,

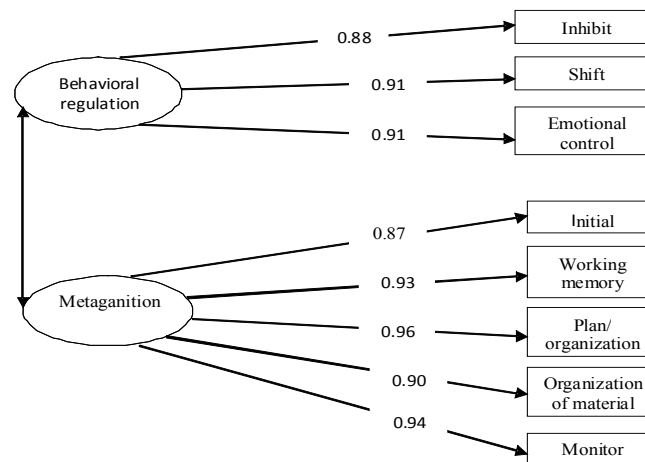


Figure 1. Results of confirmatory factor analysis for the two-factor model of BRIEF

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**Table 3.** Standardized regression weight of paths

Path	Standardized Re- gression Weight	Path	Standardized Re- gression Weight	Path	Standardized Re- gression Weight
2	WM	0.64	38	IN	0.79
9	WM	0.58	41	IN	0.78
17	WM	0.26	43	IN	0.52
19	WM	0.44	44	IN	0.78
24	WM	0.64	49	IN	0.73
27	WM	0.74	54	IN	0.77
32	WM	0.53	55	IN	0.53
33	WM	0.60	56	IN	0.62
37	WM	0.70	59	IN	0.67
57	WM	0.73	65	IN	0.66
3	INI	0.42	14	M	0.53
10	INI	0.27	21	M	0.62
16	INI	0.48	31	M	0.66
47	INI	0.66	34	M	0.79
48	INI	0.33	42	M	0.44
61	INI	0.69	52	M	0.73
66	INI	0.62	60	M	0.77
71	INI	0.73	63	M	0.70
4	OM	0.55	5	S	0.50
29	OM	0.68	6	S	0.46
67	OM	0.67	8	S	0.73
68	OM	0.73	12	S	0.70
69	OM	0.69	13	S	0.58
72	OM	0.68	23	S	0.60
S	BR	0.88	30	S	0.80
EC	BR	0.91	39	S	0.80
IN	BR	0.91			

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WM: Working Memory; IN: Inhibit; INI: Initiate; M: Monitor; OM: Organization of Material; S: Shift; EC: Emotional Control; P: Plan/organization; MC: Metacognition; BR: Behavioral Regulation

the two-factor model of BRIEF with adequate indexes for the goodness of fit was confirmed through confirmatory

factor analysis. This model consists metacognition and behavioral regulation factors. The behavioral regulation

Table 4. Significant indexes in the models

Model	X <sup>2</sup>	df	X <sup>2</sup> /df	P	RMSEA	CFI	TLI	IFI	RFI	NFI	GFA	AGFI
Inhibit	15.18	19	0.80	0.71	0	1	1	1	0.98	0.99	0.99	0.98
Shift	17.62	13	1.35	0.17	0.027	1	0.99	0.99	0.97	0.99	0.99	0.98
Emotional control	23.13	15	1.54	0.08	0.033	1	0.99	0.99	0.98	0.99	0.99	0.97
Initiate	18.94	12	1.54	0.10	0.033	0.99	0.99	0.99	0.96	0.98	0.99	0.97
Working memory	29.39	20	1.47	0.08	0.031	0.99	0.99	0.99	0.96	0.98	0.99	0.97
Plan/organization	41.78	37	1.29	0.27	0.016	1	1	1	0.98	0.99	0.99	0.97
Organization of material	5.88	4	1.47	0.21	0.031	1	0.99	1	0.98	0.99	1	0.98
Monitor	21.36	14	1.52	0.09	0.032	0.99	0.99	0.99	0.98	0.99	0.99	0.97
Total model	4.46	6	0.77	0.59	0	1	1	1	1	1	1	0.99

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factor reflects the ability for cognitive, emotional and behavioral modification, and to impose appropriate inhibitor controls. The metacognition factor measure working memory, the ability to start, plan and organize problem-solving as well as behaviors of self-monitor [10].

This result indicates that two-factor structure BRIEF was confirmed in the present study. This finding is consistent with the study of Gioia et al. [9] that revealed solution of two-factor of a BRIEF tool for parent and teacher's forms in both children with clinical problems and normal samples by the exploratory analysis factor. Similarly, Donders et al. [14] confirmed the two-factor model of BRIEF in a sample with brain-damaged children.

Studies on convergent validity have used other-report behavioral scales. We used the Wechsler's coding subscale to examine the convergent validity that showed a significant correlation between BRIEF and Coding, which indicates that BRIEF tool measures characteristics that are similar to coding. The coding subscale is used to measure the speed of processing information, attention processes, memory function and perceptual organization and performance speed [21], although coding correlates with all the subscales of executive functions, but with working memory sub-scale and organization of material did not relate significantly.

Given that all symbols are written alongside the numbers at the top of the screen, and child can look at and copy symbols continuously, him/her only uses short-term memory and does not require complicated processing such as working memory. Also, because of the simplicity of the coding, it does not engage the processes

of organizing thoughts and behavior. As in coding one quickly need to start and to find the related symbol to numbers it is related to the initiate. Since one is necessary to pay attention only to the specific symbol among similar symbols and to choose it, it is correlated with inhibition. Coding related to emotional control because one must copy symbols correctly and quickly, therefore he/she must control the negative emotions to focus. It is related to shifting, since each time the number changes its symbol also changes. At the end, in coding subscale one have to monitor his/her answers and to correct wrong answers, therefore related to monitoring.

This study has some limitations. First, in the present study the normal group was not compared with the clinical problem group. Second, because of the polarity of teachers at secondary and high school levels and their low familiarity with students, the sample of the study was limited to the primary school students. Third, the present study was conducted in Jajarm city and should be cautious in generalizing the results to the other cities. Considering the limitations of this study, it is recommended to examine the reliability and validity of BRIEF tool in Iranian clinical samples. It is also recommended that in the future studies the parent and teacher's forms of BRIEF should be used in the adolescent group. To investigate convergent validity, other behavioral assessment questionnaires of executive functions should be used, and it is suggested that this study should be carried out in other geographic regions of Iran. Given proper reliability and validity of BRIEF tool in the present study, it is recommended to use in intervention and diagnosis in an educational environment.

## 5. Conclusion

This study indicates that BRIEF tool is a reliable and valid inventory to rate executive functions in children and adolescents. As students are observed by teachers every day in an educational environment, teachers possess wealth information about students' behaviors that help to understand executive functions of students. Therefore, BRIEF of teacher's form can become the main part of assessing students in school and clinical settings and can be helpful for interventions based educational planning in children with executive functions problems.

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## Conflict of Interest

The authors declare no conflict of interest.

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