

Psychometric characteristics of the BRIEF scale for the assessment of executive functions in Spanish clinical population

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Abstract

Background: The Behavior Rating Inventory of Executive Functions (BRIEF) scale, completed by families, is widely known in the assessment of executive functions in children and adolescents. However, its application is limited to English-speaking population. **Method:** This study analyzes the preliminary results from its application in a Spanish clinical sample, comprising 125 participants aged 5-18 years. Internal structure and reliability of the translated scale were analyzed, as well as its relationship with other behavioral measures through the analysis of their correlations with the Assessment of Attention Deficit Hyperactivity Disorder Scale (EDAH). The results were compared with those from the original validation study. **Results:** The data revealed the presence of the same internal structure, as well as acceptable internal consistency and significant correlations with the Attention Deficit and Hyperactivity components of the EDAH scale. **Conclusions:** This study provides preliminary evidence of the utility of the BRIEF scale in cultural contexts different from the original, particularly in Spanish clinical population.

Keywords: BRIEF, Spanish, executive functions, family.

Resumen

Características psicométricas de la escala BRIEF para la evaluación de funciones ejecutivas en población clínica española. Antecedentes: la escala Behavior Rating Inventory of Executive Functions (BRIEF), cumplimentada por familias, es ampliamente conocida en la evaluación de las funciones ejecutivas en niños y adolescentes. Sin embargo, su aplicación está limitada a población de habla inglesa. **Método:** en este estudio se analizan los primeros resultados procedentes de su aplicación a una muestra clínica española, formada por 125 participantes de 5 a 18 años. Se analizó la estructura interna y fiabilidad de las puntuaciones de la escala traducida al español, así como su relación con otras medidas comportamentales a través del análisis de sus correlaciones con la escala de Evaluación del Déficit de Atención con Hiperactividad (EDAH). Los resultados se compararon con los del estudio de validación original. **Resultados:** los datos mostraron la presencia de una misma estructura interna de las puntuaciones, así como una aceptable consistencia interna y correlaciones estadísticamente significativas con los componentes de Déficit de Atención e Hiperactividad de la escala EDAH. **Conclusiones:** este estudio aporta evidencia preliminar sobre la utilidad de la escala BRIEF en contextos culturales diferentes al originario, concretamente en población clínica española.

Palabras clave: BRIEF, español, funciones ejecutivas, familia.

The term *executive functions* refers to a set of skills involved in the generation, supervision, regulation, execution, and readjustment of behavior to achieve complex goals, especially those that require a novel and creative approach (Verdejo-García & Bechara, 2010).

Executive functions comprise different processes, such as goal setting, hypothesis formulation, planning, focal attention, concentration, strategy generation, monitoring, response to feedback, the capacity to solve problems, abstract thinking, cognitive flexibility, working memory, and emotional control (Korzeniowski, 2011). Alterations in these processes during

childhood and adolescence cause difficulties in an extensive range of domains, including cognitive, behavioral, and social problems.

In this regard, many studies have shown the close relationship between the presence of executive deficits and specific problems in concrete areas such as reasoning, mathematics, reading, and writing (García, Rodríguez et al., 2013; Latzman, Elkovitch, Young, & Clark, 2010; Raghobar, Barnes, & Hecht, 2010; Stelzer & Cervigni, 2011; Van der Ven, Kroesbergen, Boom, & Leseman, 2013). Numerous studies have also shown how the inadequate development of these processes is related to difficulties in the individual's adaptation to the environment (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009; Garon, Bryson, & Smith, 2008; McClelland et al., 2007).

The study of the executive functions has also been particularly useful in the differential diagnosis of numerous childhood and adolescent disorders, mainly Attention Deficit with Hyperactivity Disorder (ADHD; Di Trani et al., 2011; Hale et al., 2011; Makris, Biederman, Monuteaux, & Seidman, 2009; Shimoni, Engel-Yeger,

& Tirosh, 2012), Autistic Spectrum Disorders (Han et al., 2011; Kenworthy, Black, Harrison, Della Rosa, & Wallace, 2009), and other clinical conditions (Donders, Den Braber, & Vos, 2010; Neri et al., 2012; Vințan, Palade, Cristea, Benga, & Muresanu, 2012; Wilson, Donders, & Nguyen, 2011).

However, although nowadays the relevance of the executive functions is clear in research, their assessment is often complex. This complexity is partially due to the type of measurement instruments employed, as most of them are performance-based. For some authors, this type of measures, such as the Stroop Test, the Tower of Hanoi or the Wisconsin Card Sorting Test, present low ecological validity and are not representative of the individual's functioning in real life settings (Gioia, Kenworthy, & Isquith, 2010; Henry & Bettenay, 2010; Lezak, Howieson, Bigler, & Tranel, 2012; Toplak, Bucciarelli, Jain, & Tannock, 2009; Verdejo-García & Bechara, 2010). These tasks, which are excessively structured and based on quantitative criteria, disregard much relevant information about children and adolescents' daily functioning, such as the type of strategies they employ to solve problems, their capacity to plan and to recall certain rules or guidelines, to inhibit behaviors or impulses, or to adapt to new settings or situations.

An alternative to this type of measures is the use of questionnaires based on the observation of the behavior, such as the BRIEF (*Behavior Rating Inventory of Executive Function*; Gioia, Isquith, Guy, & Kenworthy, 2000). There are several hetero-report versions of this questionnaire. The most frequently employed is based on information provided by the family. It is applicable from ages 5 to 18 years and it assesses the frequency with which children and adolescents display certain problematic behaviors related to deficits in executive functions at home and/or in school. For this purpose, it uses a Likert-type response format ranging from 1 to 3, where 1 is never, 2 is sometimes, and 3 is often. The scale is made up of 86 items (72 computable items and 14 additional ones). The latter do not contribute to the score but are useful to orient possible interventions. The remaining 72 items form 8 scales: Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor, which in turn are grouped into two main indexes: the *Behavioral Regulation Index* (BRI), made up of the first three scales, and the *Metacognition Index* (MI), made up of the remaining five. Both indexes made up the *Global Executive Composite* (GEC) score. High scores in these scales and indexes indicate executive deficit. It also includes two validity scales to identify problematic response styles. These scales are based on the analysis of the excessive frequency assigned to certain items (Negativity) or the correspondence between pairs of items (Inconsistency) and are not submitted to statistical analysis.

This instrument has shown its utility for the assessment of executive functions in a broad range of clinical conditions (Anderson & Reidy, 2012; Lee et al., 2011; Toplak et al., 2009; Wilson et al., 2011), especially in ADHD (Jarratt, Riccio, & Siekierski, 2005; McCandless & O'Laughlin, 2007; Toplak et al., 2009). In this regard, numerous studies have analyzed the executive profile in ADHD and its subtypes, as well as in comorbidity with other disorders such as Reading Difficulties (RD). These studies have pointed to response inhibition and working memory as key issues in the differentiation of ADHD, finding greater impairment of response inhibition in groups with hyperactivity/impulsivity and more impairment of working memory in groups with

inattention (García et al., in press; Gioia et al., 2000; McCandless & O'Laughlin, 2007; Riccio, Homack, Jarratt, & Wolfe, 2006), as well as differential executive profiles in groups with ADHD and ADHD with associated RD. Specifically, García et al. (2013) found greater executive deficit in the group with ADHD and associated RD than in the group with isolated ADHD, mainly in working memory and plan, coherent with previous studies carried out by Pratt (2000) with the BRIEF scale, as well as by Bental and Tirosh (2007), Van De Voorde, Roeyers, Verté and Wiersema (2010), and Willcutt et al. (2010) with performance-based tests.

However, despite being one of the most extensively employed scales, its use has been limited to English-speaking countries, except for a new version available in Dutch (Huizinga & Smidts, 2011; Smidts & Huizinga, 2009). Therefore, to determine its potential utility beyond its original context, we translated the scale into Spanish.

This aim of this work is to address the first analysis of the internal structure of the BRIEF scores, and also to obtain evidence of their reliability and the degree of its association with other behavioral measures, specifically the scale "Evaluación del Déficit de Atención con Hiperactividad" (EDAH; Farré & Narbona, 1997; in English, Attention Deficit with Hyperactivity Assessment). For this purpose, we conducted a non normative study with a heterogeneous clinical sample of 125 Spanish children and adolescents, aged from 5 to 18 years, whose families completed the translated scale. The results obtained were contrasted with those of the original validation study in a clinical sample (Goia et al., 2000).

Method

Participants

We used a non probabilistic clinical sample, made up of 125 participants (*range* = 5-18, *M* = 12.68, *SD* = 5.22), 54 females (43%) 71 and males (57%). The main clinical groups were: ADHD (*N* = 112, 89%), Intellectual Disability (*N* = 27, 21.6%), RD (*N* = 63; 50.4%), Anxiety (*N* = 49, 39.5%), and Emotional Maladaptation (*N* = 12, 9.6%). The participants were initially identified by the Pediatric Unit following the criteria of the *Diagnostic and Statistical Manual of Mental Disorders-IV-TR* (American Psychiatric Association [APA], 2002), and referred to a clinic for more extensive assessment. The final diagnosis was based on the information provided by the interviews, behavior rating questionnaires administered to the families and children, as well as diverse psychometric and neuropsychological tests. Assessment included the semi-structured *Diagnostic Interview Schedule for Children* (DISC-IV; Shaffer, Fisher, Lucas, Dulcan, & Schwab, 2000) adapted to Spanish, and also data from the developmental history, direct observation of the child, and the prior neuropsychiatric examination.

The IQ of the sample, assessed with the Wechsler Intelligence Scale for Children (WISC-IV; Wechsler; 1974/2005), included scores ranging from 54 to 125 (*M* = 92.58, *SD* = 13.75). Some participants presented various associated disorders. No participant was receiving medication at the time of assessment.

Instruments

The main assessment instrument and object of research was the BRIEF scale (Gioia et al., 2000) in its form for families translated

into Spanish (hereafter, BRIEF-E). In view of the importance of adapting linguistic and cultural aspects during the translation process, and following the guidelines on the use of psychological and educational tests (Elosúa, 2003) and those of the International Test Commission (ITC), described by Muñiz, Elosua, and Hambleton (2013), this process began with two independent translations carried out by members of the research team. The translations were then reviewed by a committee consisting of three translators specialized in the field of Psychology and assessment. After reviewing the translated version and making some linguistic corrections, prior to the study, the scale was administered to a reduced sample of families to verify their comprehension of the statements.

We also used the "Evaluación del Déficit de Atención con Hiperactividad" (EDAH) scale (Farré & Narbona, 1997). This scale assesses the presence of a series of behaviors related to the symptoms of hyperactivity and attention deficit. Like the BRIEF, it was administered in the family form.

Procedure

The study was conducted according to The Helsinki Declaration of the World Medical Association (available in Williams, 2008), which presents the ethical principles for research with human beings. All the participants' families gave written informed consent after receiving a complete description of the study. After an initial interview, the families completed the EDAH and BRIEF scales. The children and adolescents underwent a broad psychoeducational assessment, performed at a specialized clinical center, during two 30-minute sessions that took place in the afternoon. Participation in the study was voluntary, and the anonymity and ethical treatment of the data were guaranteed. The participants did not receive any incentive for their collaboration.

Administration of the BRIEF scale was supervised by a member of the research team, and these scores were not taken into account to establish the diagnosis. After obtaining the data, they were analyzed and compared with the results provided by the study with the original English version of the test. Following the authors' recommendations, scales with more than two missing values on the same subscale were excluded from the study, whereas the remaining missing values were substituted by the value 1 (Gioia et al., 2000, p. 7). Although in the original work, the authors' recommend treating reports with scores higher than 7 on the Negativity scales and higher than 9 on Inconsistency with caution (Gioia et al., 2000, pp. 10-15), they were also eliminated from this study.

Data analysis

Firstly, to obtain evidence of the internal structure of the questionnaire scores, as in the original study, we carried out Principal Component Analysis (PCA), selecting the components with Eigenvalues higher than 1. In view of the probability of correlations among components, we used direct Oblimin as the rotation method (Ferrando & Anguiano-Carrasco, 2010). Next, we analyzed the internal consistency of the scores for each subscale and index with Cronbach's alpha. Lastly, to explore convergent validity with other variables, we calculated the Pearson correlations among the subscales and indexes of the BRIEF scale and the EDAH (Farré & Narbona, 1997). All the analyses were performed with the SPSS-17.0 software.

Results

Analysis of the internal structure

Table 1 presents the results of the analyses of the internal structure of the scores carried out with the original version of the BRIEF scale and with the version of the present study (BRIEF-E).

In both studies, the same two-component structure was obtained: the first component (Metacognition) is made up of Initiate, Working Memory, Plan/Organizing, Organization of Materials, and Monitor, and the second one (Behavioral Regulation) is made up of Inhibit, Shift, and Emotional Control. These components explain 76% of the cumulative variance in the BRIEF, versus 62.48% in the BRIEF-E. Although in the original study with the BRIEF, these data were not provided, in this study with the BRIEF-E, the first component explained 43.35% of the variance, and the second one explained 19.13%. The correlations between the components were .74 in the BRIEF versus .35 in the BRIEF-E.

Regarding the weight of each subscale on its component, a similar pattern was obtained although some differences between the studies were also found. Thus, in both scales, Plan/Organizing and Working Memory were the subscales with the highest weight on the Metacognition component (for Plan/Organize, .96 in the BRIEF versus .87 in the BRIEF-E, and for Working Memory (.81 versus .82, respectively). Regarding the Behavioral Regulation component, the variable with the highest weight on the BRIEF was Emotional Control (.93), whereas Inhibit (.90) obtained the highest weight on the BRIEF-E, followed by Emotional Control (.89).

Analysis of internal consistency

The internal consistency coefficients (Cronbach's alpha) for the subscales and indexes of the BRIEF and BRIEF-E are presented in Table 2. The coefficients were generally higher in the BRIEF,

Subscales and indexes	BRIEF		BRIEF-E	
	Component 1	Component 2	Component 1	Component 2
Inhibit		.68		.90
Shift		.77		.56
Emotional control		.93		.89
Initiate	.71		.78	
Working memory	.81		.82	
Plan/Organize	.96		.87	
Organization of materials	.68		.54	
Monitor	.58		.70	
Correlation between factors	.71		.35	
% Explained variance			43.35	19.13
% Cumulative variance	76%		62.48%	

Note: Component 1 = Metacognition; Component 2 = Behavioral Regulation. Clinical Sample: BRIEF (N = 852), BRIEF-E (N = 125)

albeit following the same tendency. Thus, Initiate obtained the lowest values in both cases ($\alpha = .82$ in BRIEF versus $.57$ in BRIEF-E), and the highest values were found in the GEC ($\alpha = .98$ versus $.92$, respectively).

The alpha coefficients obtained were very similar to those of the original study for Emotional Control and Organization of Materials ($\alpha = .92$ in the BRIEF versus $.89$ in the BRIEF-E for Emotional Control, and $.88$ versus $.85$, respectively, for Organization of Materials).

Regarding the main indexes (BRI and MI) and the GEC, the Cronbach alpha coefficients of the BRIEF-E were high, around $.90$ in all cases, although lower than those of the BRIEF.

Convergent validity with other variables (EDAH Scale)

Although, in the original study, the ADHD Rating Scale-IV (ADHD-IV; DuPaul, Power, Anastopoulos, & Reid, 1996) was used, in this case, we administered the EDAH scale (Farré & Narbona, 1997). However, both scales assess behavioral problems related to attention deficit and hyperactivity.

As seen in Table 3, in both studies, statistically significant correlations were found between the BRIEF and BRIEF-E subscales and the ADHD-IV and EDAH scales, respectively, although with some differences.

Firstly, in the case of BRIEF-E, Inhibit, Shift, Emotional Control, and the BRI were significantly related only to the Hyperactivity subscale of the EDAH, whereas in the original study, they were related to both the ADHD-IV subscales, although more so to Hyperactivity. In both studies, the Inhibit subscale had the highest correlation with Hyperactivity ($.73$ in the BRIEF versus $.71$ in the BRIEF-E), followed by the BRI ($.70$ versus $.68$, respectively).

Secondly, Initiate, Working Memory, Plan/Organize, Organization of Materials, Monitor, and the MI all correlated significantly with both subscales, although more so with Attention Deficit in both studies. Organization of Materials was the only variable that correlated exclusively with Attention Deficit in the BRIEF, whereas in the BRIEF-E while in this study was initiate

Table 3
Correlations of the BRIEF and BRIEF-E scales with the ADHD rating scale-IV and the EDAH scale

Subscales and indexes	BRIEF – ADHD-IV		BRIEF-E - EDAH	
	Attention deficit	Hyperactivity	Attention deficit	Hyperactivity
Inhibit	.42**	.73**	.05	.71**
Shift	.39**	.59**	.07	.34**
Emotional control	.39**	.56**	.12	.59**
Initiate	.55**	.36**	.47**	.12
Working memory	.60**	.44**	.47**	.21*
Plan/Organize	.63**	.33**	.55**	.22*
Organization of materials	.49**	.15	.26**	.29**
Monitor	.54**	.45**	.39**	.39**
BRI	.44**	.70**	.10	.68**
MI	.67**	.38**	.62**	.32**
GEC	.63**	.60**	.47**	.58**

Note: BRI = Behavioral Regulation Index; MI = Metacognition Index; GEC = Global Executive Composite. Clinical Sample. BRIEF (N = 100), BRIEF-E (N = 125)
* $p < .05$; ** $p < .01$.

which showed an exclusive correlation with this variable. In both studies, Plan/Organize and Working Memory obtained the highest correlations with the Attention Deficit subscales ($.63$ and $.60$, respectively, in the original study versus $.55$ and $.47$ in this study).

Lastly, in both studies, the GEC had statistically significant correlations with both subscales, but its correlation was higher with Attention Deficit than with Hyperactivity in the BRIEF ($.58$ and $.47$, respectively), and they were practically the same in the BRIEF-E ($.60$ and $.63$, respectively).

Discussion and conclusions

The goal of this study was to obtain preliminary data in a convenience clinical sample of 125 Spanish children and adolescents about the potential utility of the BRIEF scale as an instrument to assess executive functions. For this purpose, the internal structure and consistency of its scores were analyzed, as well as its convergent validity with behavioral variables by analyzing its correlations with the EDAH scale (Farré & Narbona, 1997). The results were compared with those obtained in the original validation study with a clinical sample (Gioia et al., 2000).

In general terms, the results obtained suggest good, albeit improvable, psychometric properties of the scale, coinciding to a great extent with those obtained in the original study. For instance, we obtained the same factor structure, made up of two components (Metacognition and Behavioral Regulation), each one in turn, comprising the same subscales.

Regarding reliability of the scores, the internal consistency coefficients were generally higher in the original study. Nevertheless, in both studies, a similar pattern was obtained, with Initiate being the subscale with the lowest coefficients, and the GEC presenting the highest. The BRI and MI scores presented high internal consistency, very similar to that of the original study.

Table 2
Internal consistency coefficients (Cronbach's alpha) of the subscales and indexes of the BRIEF and BRIEF-E scales

Subscales and indexes	Alpha coefficient		Elements
	BRIEF	BRIEF-E	
Inhibit	.94	.85	10
Shift	.88	.72	8
Emotional control	.92	.89	10
Initiate	.82	.57	8
Working memory	.92	.81	10
Plan/Organize	.91	.68	12
Organization of materials	.88	.85	6
Monitor	.85	.60	8
BRI	.96	.91	28
MI	.96	.89	44
GEC	.98	.92	72

Note: BRI = Behavioral Regulation Index; MI = Metacognition Index; GEC = Global Executive Composite. Clinical Sample: BRIEF (N = 852), BRIEF-E (N = 125).

Lastly, evidence of convergent validity with other behavioral variables was obtained, with statistically significant correlations found between the components of the BRIEF-E scale and the Hyperactivity and Attention Deficit subscales of the EDAAH scale. These results coincide with those obtained by Gioia et al. (2000) in the original study, although the results of the present study suggest a higher discriminatory capacity of the Behavioral Regulation component, which only correlated with Hyperactivity. Similar results were found by McCandless and O'Laughlin (2007) using the Behavior Assessment System for Children (BASC: Reynolds & Kamphaus, 1992).

However, although these results provide preliminary data supporting the potential utility of the BRIEF scale in different cultural settings from the original one, some aspects of the study, as well as of the instrument itself, should be taken into account.

One of them is the small sample size and the broad age range used in this study, as well as the heterogeneity of the clinical groups that make up the sample, and the high rate of ADHD in the groups. All this makes it necessary to perform new studies, with larger and more representative samples. This would allow analysis by age group, thereby obtaining a developmental profile of deficits in executive functioning. Also, in view of the diversity of the cognitive and behavioral manifestations of these disorders, it would be interesting to establish differences among them, thereby providing new data about the utility of the scale. In this sense, two prior studies were carried out with Spanish samples (García et al.,

2013; García et al., in press), providing evidence of the existence of differential profiles of the ADHD subtypes, as well as of their comorbidity with RD.

The large number of items that make up the scale should also be taken into account. Lejeune et al. (2010) recently conducted a study with a brief version of the scale, made up of 24 items. Although in view of its recent appearance, there are still no data about its diagnostic capacity, a shorter questionnaire would be particularly useful in cases where families are requested to complete a broad range of reports or when administering it for epidemiological studies.

Although our results contribute preliminary evidence of the utility of the BRIEF scale in a Spanish clinical sample, following Muñiz et al. (2013), if the final goal is to achieve maximum correspondence and adequacy between both instruments, it is necessary to continue to analyze and to study in more depth the adequacy of the methodological, cultural, linguistic, conceptual, and metric aspects of the scale. This would open up new lines of research in this direction.

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