

## Frontal behavioral and emotional symptoms in Spanish individuals with acquired brain injury and substance use disorders<sup>☆</sup>

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### Abstract

**INTRODUCTION:** Patients with acquired brain injury affecting the frontal cortex and individuals with substance use disorders share a range of behavioral problems, including apathy, poor self-control, and executive dysfunction. The Frontal Systems Behavioral Scale (FrSBe) is a self-report instrument designed to measure behavioral problems resulting from damage to the frontal–striatal neural systems, involved both in brain insult and addiction. The aim of this study was twofold: (1) to compare the scores from the Spanish version of the FrSBe with the norms collected for American, English-speaking population; and (2) to examine the ability of the FrSBe to discriminate between two clinical populations (acquired brain injury (ABI) and addiction) with putative frontal dysfunction, as compared to a group of healthy participants. **PATIENTS AND METHODS:** A total of 139 volunteers participated including 46 patients with frontal ABI (F-ABI), 57 abstinent substance abusers, and 36 healthy controls from the Spanish population. A Spanish version of the FrSBe was administered to all participants. We conducted multivariate analyses of variance to examine group differences across the three subscales: apathy, disinhibition, and executive dysfunction; and in the FrSBe total score. **RESULTS:** F-ABI and substance abusers had higher scores (i.e., greater impairment) than controls on the FrSBe total score; F-ABI patients scored significantly higher than substance abusers, and substance abusers significantly higher than controls. For specific subscales, F-ABI patients had higher scores than substance abusers and controls in the subscales of apathy, disinhibition and executive dysfunction, whereas substance abusers had greater executive dysfunction than controls. **CONCLUSIONS:** The Spanish version of the FrSBe is

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a useful instrument for the detection of behavioral problems associated with frontal systems dysfunction in two clinical samples of Spanish-speakers.

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*Keywords:* Addiction; Apathy; Acquired brain injury; Disinhibition; Executive dysfunction; Frontal Systems Behavioral Scale

## 1. Introduction

Patients with acquired brain injury (ABI) affecting the frontal cortex and substance abusers share a wide spectrum of behavioral problems, including apathy (e.g., loss of initiative, lack of energy and interest, reduced affective expression), poor inhibition (e.g., impulsive responses, inappropriate social behaviors) and executive dysfunction (e.g., poor planning and working memory, cognitive inflexibility, defective decision-making) (Levine et al., 2005; Verdejo-García, Bechara, Recknor, & Pérez-García, 2006). These behavioral problems have been associated with disrupted functioning of three anatomical and functional neural systems involving different sections of the frontal cortex and its projections to subcortical structures. Evidence from lesion neurological studies have linked apathy symptoms to alterations in the anterior cingulate–thalamic system, whereas disinhibition problems have been associated with alterations in the orbitofrontal–thalamic system, and declines of executive functioning have been associated with alterations in the dorsolateral prefrontal–thalamic system (Cummings, 1993; Tekin & Cummings, 2002). Several lesion studies have demonstrated cognitive–executive deficits after acquired brain damage affecting these frontal–subcortical systems (Stuss & Knight, 2002). In addition, recent neuropsychological and imaging studies indicate that the disruption of the same frontal–subcortical systems underlies the neurocognitive declines observed in substance use disorders (Garavan & Stout, 2005; Verdejo-García, López-Torrecillas, Orozco, & Pérez-García, 2004).

The “Frontal Systems Behavioral Assessment Scale” (Grace & Malloy, 2001) is a self-report instrument that assesses behavioral problems resulting from dysfunction of the frontal–subcortical systems, thus including subscales for apathy, disinhibition and executive dysfunction. The instrument’s ability to detect and delineate behavioral problems linked to frontal dysfunction has been established in a variety of disorders including cortical dementias (Alzheimer), subcortical dementias (Parkinson and Huntington) (Cahn-Weiner, Grace, Ott, Fernandez, & F, 2002), multiple sclerosis (Goverover, Chiaravalloti, & DeLuca, 2005), schizophrenia (Velligan, Ritch, Sui, Dicocco, & Huntzinger, 2002) and substance abuse (Spinella, 2003). In addition, the FrSBe has shown significant ecological validity in terms of correlations with activities of daily living (Boyle et al., 2003; Spinella, Yang, & Lester, 2004), target symptoms for primary caregivers (Rymer et al., 2002), and measures of financial planning (Spinella et al., 2004). In turn, this ecological validity could aid the development of rehabilitation strategies. Furthermore, the instrument reveals moderate correlations with neuropsychological indices of executive functioning such as verbal fluency tests, the trail making test, the Wisconsin card sorting test, and N-back, go/no-go and continuous performance computer tasks (Velligan et al., 2002; Verdejo-García, Bechara, et al., 2006; Verdejo-García, Rivas-Pérez, López-Torrecillas, & Pérez-García, 2006).

In spite of increasing usefulness of the FrSBe, there are still few studies on specific populations with putative frontal dysfunction (Malloy & Grace, 2005). Another important limitation is that all previous studies to date have been conducted in English-speaking populations, thus limiting the potential generalizability both in the US (due to its increasing Hispanic population) but also outside the non-English speaking world. The goal of this study is to develop a valid translation of the scale and to apply it to groups with ABI involving the frontal cortex (F-ABI), abstinent substance abusers, and healthy volunteers all recruited from a Spanish sample. The aim of this study was twofold: (1) to compare the scores from the Spanish version of the FrSBe with the norms collected for American, English-speaking population; and (2) to examine the ability of the FrSBe to discriminate between two clinical populations with putative frontal dysfunction, as compared to a group of healthy participants. We hypothesized that the scores from the Spanish version of the FrSBe would be comparable to those from the American norms in the F-ABI and control groups (no norms are available for substance abusers). In a previous study conducted in the US we showed that abstinent polysubstance abusers had significantly greater scores than normal controls across all the subscales of the FrSBe (Verdejo-García, Bechara, et al., 2006; Verdejo-García, Rivas-Pérez, et al., 2006). However, polysubstance abusers’ scores were still lower than those previously reported for individuals with head injury (Stout, Ready, Grace, Malloy, & Paulsen, 2003; Stout, Wyman, Johnson, Peavy, & Salmon, 2003). Thus, we hypothesized that across the different subscales of the

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FrSBe F-ABI patients would score significantly higher than healthy controls, with substance abusers' scores falling in the middle of these two groups.

## 2. Methods

### 2.1. Participants

We examined three groups of participants: (1) Forty-six patients with acquired brain injury affecting the frontal lobes (F-ABI) (35 men, 11 women) aged 15–54 years old (mean =  $29.33 \pm 12.07$ ) and between 6 and 18 years of education (mean =  $10.63 \pm 3.19$ ). (2) Fifty-three substance abusers (50 men, 3 women) aged 19–53 (mean =  $31.09 \pm 7.01$ ) and 6–17 years of education (mean =  $9.74 \pm 2.59$ ). (3) Thirty-seven healthy control volunteers (35 men, 2 women) aged 18–50 (mean =  $33.14 \pm 7.69$ ) and 6–17 years of education (mean =  $10.65 \pm 2.41$ ). All were native Spanish speakers residing in Granada, Spain.

Patients with F-ABI were participating in a Holistic Rehabilitation Program in the “Hospital de Traumatología” in Granada, Spain. Selection criteria for candidates were: (1) being in the chronic phase after acquired brain damage (6–12 months after insult), (2) having lesions primarily affecting the frontal cortex, and (3) keeping basic skills to learn new information and independently perform activities of daily living. Individuals with alterations of self-awareness were excluded from the study due to its self-report method (Caracuel-Romero et al., 2005). The etiology of F-ABI was diverse, including traumatic brain injury in the 80.4% of cases, vascular accident in 15.2% and tumors and anoxia in 2.2%, respectively. All lesions were confirmed by radiologists' readings of computed tomography or MRI. Substance abusers were selected while they were following residential treatment in the therapeutic communities of “Proyecto Hombre” and “Cortijo Buenos Aires”, also in Granada, Spain. All participants were abstinent for at least 15 days before assessment. We used abstinent users for two reasons: (1) previous data indicate that FrSBe scores are elevated in retrospective assessments of the period of actual drug use but stabilize during abstinence (Verdejo-García, Bechara, et al., 2006; Verdejo-García, Rivas-Pérez, et al., 2006), (2) previous data indicate that self-report is much more reliable during abstinence than during actual drug use (Verdejo-García & Pérez-García, 2008). Random urine testing was conducted during the course of the study to confirm abstinence. Therefore, the determination of abstinence was based both on self-report and drug screens. The selected participants were polysubstance users of different drugs, including cannabis, stimulants and opioids. Although this fact clearly complicates interpretation, it is virtually impossible to find pure drug users in treatment settings, except for alcohol abusers. Mean duration of substance abuse in these participants was 9.21 years ( $SD = 4.98$ ), and the mean duration of abstinence was 17.87 weeks ( $SD = 22.78$ ; range 2–48 weeks, with the majority of the sample falling in the 1–6 months abstinence period—middle term abstinence or early partial remission). The control participants were selected by means of advertising posters located in telephone booths, recreation centers, adult education centers and fire stations in Granada. The inclusion criteria for the participation of controls in the study were: (1) not having abused drugs currently or in the past (i.e., participants did not meet DSM-IV abuse criteria for any substance); (2) not presenting neurological alterations (i.e., head injury with loss of consciousness, seizure disorders, fetal alcoholic syndrome, or systemic disease that may affect the CNS) or psychiatric diagnosis; (3) absence of a history of mental retardation or learning disability; and (4) not being on any medications. These data were obtained through a semi-structured interview. All participants signed an informed consent form before inclusion in the study.

### 2.2. Instrument

A Spanish version of the FrSBe (FrSBe-SA: Frontal Systems Behavioral Scale-Spanish Adaptation) (Grace & Malloy, 2001) was adapted and reproduced with special permission from the Editor (PAR: Psychological Assessment Resources, Inc.). The scale contains 46 items that assess behavioral problems linked to frontal systems dysfunction. The instrument is divided in three independent subscales: apathy, disinhibition, and executive dysfunction. We used the self-report version of the scale because it was difficult to reach and involve in the study to relatives or significant others. To endorse the reliability of self-report we excluded those F-ABI patients with deficits of self-awareness. In the case of substance abusers, we had previously demonstrated that FrSBe self-report scores are reliable when they are collected during abstinence from drugs (Verdejo-García & Pérez-García, 2008). The FrSBe was translated into Spanish and back-translated into English by individuals cognizant of both language and neuropsychological literature. Variations from the original scale were resolved by agreement of members of the research group. The final Spanish version was

approved by the authors and by PAR after a careful revision by its own commission, composed by English and Spanish speakers. The scale showed adequate internal consistency in this sample (Chronbach alpha = 0.91). Subscales also showed adequate internal consistency, with alpha values of 0.76, 0.77 and 0.82 for apathy, disinhibition and executive dysfunction, respectively.

2.3. Procedure

The FrSBe-SA was individually administered to both sets of patients as a part of a broader neuropsychological assessment routinely conducted in their treatment centers. Healthy participants were also individually tested using the FrSBe-SA. Each individual read, understood and signed an informed consent prior to individually completing the test. Statistical analyses were completed using SPSS software.

2.4. Variables and statistical analysis

The dependent variables were the self-report scores from the different groups (F-ABI, substance abusers and controls) on the three FrSBe-SA subscales: apathy, disinhibition and executive dysfunction.

To compare the results obtained on the FrSBe-SA with the normative scores from the original version (Hypothesis 1) we ran four ANOVAs, one for each subscale and one for the total score, comparing the control group of the present study with their equivalent group in the original standardization sample. Since most of the healthy controls that participated in this study were men, we restricted our comparison to the male subgroups from our control group (n = 35) and from the equivalent group of the original sample (n = 32).

To examine possible differences between groups on the extent of frontal systems dysfunction related problems (Hypothesis 2), we conducted a multivariate analysis of variance (MANOVA) and post hoc Bonferroni tests on the scores of the three groups (F-ABI vs. substance abusers vs. controls) across the three subscales of the FrSBe-SA (apathy, disinhibition and executive dysfunction). Additionally, we run a one-way ANOVA to examine possible differences between the groups on the total scores of the scale.

3. Results

3.1. Preliminary analysis

First we conducted two one-way ANOVAs to examine possible differences between groups (F-ABI, substance abusers and controls) on gender, age and years of education. There were no significant differences between groups on age and education (Table 1). However, groups differed in gender composition; there were significantly more women in the F-ABI group, although substance abusers and controls were well matched. Therefore, we conducted Spearman bivariate correlation analysis to analyze the relationship between gender and the dependent variables (FrSBe subscales and total scores) for each of the three groups independently. Results showed no significant correlations between gender and FrSBe scores. Thus, we did not include gender as a covariate in subsequent analyses.

3.2. Comparison between the Spanish adaptation (FrSBe-SA) and the original version of the FrSBe (Hypothesis 1)

We contrasted the scores from male normal controls included in the published norms of the FrSBe (Grace & Malloy, 2001) with the scores from male normal controls in our sample. Results showed significant differences between the

Table 1  
Participant demographics

	Substance abusers, N = 53	F-ABI patients, N = 46	Healthy volunteers, N = 37	F/ $\chi^2$	p
Age	31.09 (7.01)	29.33 (12.07)	33.14 (7.69)	1.761	0.176
Education	9.74 (2.59)	10.63 (3.19)	10.65 (2.41)	1.727	0.182
Gender (M–F)	94.3–5.7%	76.1–23.9%	94.6–5.4%	9.884	0.007

Note: F-ABI, frontal acquired brain injury patients; M, male; F, female.

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Table 2  
Differences between the original American control sample and the Spanish sample (males only)

	Spanish controls (1) Mean (SD), <i>n</i> = 35	American controls (2) Mean (SD), <i>n</i> = 32	<i>F</i>	<i>p</i>	Cohen's delta ( $\delta$ )
Apathy	25.17 (5.80)	28.7 (4.7)	7.41	0.008	0.67
Disinhibition	27.40 (6.55)	30.8 (6.0)	4.88	0.030	0.54
Executive Dys.	32.91 (6.65)	34.4 (5.4)	1.01	0.320	0.24
Total	85.49 (16.60)	93.9 (11.8)	5.61	0.021	0.59

Note: Executive Dys., executive dysfunction; SD, standard deviation; (1) control subjects, males with a mean of age of 32.8 years and a mean number of years of education of 10.68; (2) control subjects, males, between the ages of 18–39 and less than 12 years of education, from Table 7, p. 38 of the manual (Grace & Malloy, 2001).

two samples on the subscales of apathy and disinhibition, and also in the total score. For all measures, the Spanish sample scored lower than the original English-speaking sample (Table 2).

In order to perform a more precise analysis of the statistical relevance of the findings, the size effects of the previous analyses were calculated using the Cohen's delta statistic. The results showed that the differentiation between both control samples was of moderate size, ranging from 0.24 (for executive dysfunction) to 0.67 (for apathy) (Table 2).

### 3.3. Group differences on severity of frontal alterations (Hypothesis 2)

Results showed that there were significant differences between the groups on the three subscales of the FrSBe-SA, and in the FrSBe-SA total score (see Table 3). Post hoc pair wise tests for multiple comparisons (Bonferroni) showed that F-ABI patients scored significantly higher (i.e., greater impairment) than substance abusers and controls on apathy and disinhibition. For apathy, no differences emerged between substance abusers and controls. For disinhibition, there was a trend for substance abusers to score higher than controls, but it did not reach statistical significance ( $p = 0.08$ ). For executive dysfunction, there were significant differences between the three groups; F-ABI patients had higher scores than the other two groups, and substance abusers had increased scores compared to controls. Finally, for the total scores of the FrSBe-SA, there were also significant differences between the three groups, with F-ABI patients scoring significantly above the other two groups, and substance abusers scoring significantly above healthy participants (Table 3).

A close inspection of the confidence intervals (CI) presented in Table 3 reveals no overlap between the scoring distributions of the three groups on the total scores of the FrSBe-SA. Hence, the CI of the F-ABI group did not overlap with the other two groups in the subscales of apathy and executive dysfunction. For disinhibition, there was minimal overlap between the upper limit of the CI of substance abusers and the lower limit of CI of F-ABI patients.

## 4. Discussion

This is the first study to assess behavioral alterations associated with frontal systems dysfunction using clinical groups and healthy participants in a Spanish-speaking population. Patients with F-ABI showed significantly elevated scores (i.e., greater impairment) relative to substance abusers and controls on the total score and the three subscales of the FrSBe-SA: apathy, disinhibition and executive dysfunction. These results suggest that the FrSBe-SA is a useful instrument to detect and measure behavioral problems linked to frontal systems dysfunction in Spanish-speaking individuals. These results are in agreement with those of recent studies indicating that the analysis of behavioral profiles can be as useful as the assessment of cognitive performance in characterizing the neuropsychological deficits resulting from frontal-subcortical damage (Cahn-Weiner et al., 2002; Goverover et al., 2005). In fact, previous studies have demonstrated that the subscales of apathy and executive dysfunction are especially sensitive in determining neuropsychological profiles associated with diverse disorders such as cortical and subcortical dementias, mainly in Alzheimer and Parkinson's disease. Furthermore, psychometric studies have shown that the scores in the apathy and executive dysfunction subscales are robust in differentiating a variety of pathologies (Cahn-Weiner et al., 2002; Stout, Ready, et al., 2003; Stout, Wyman, et al., 2003). The disinhibition subscale has shown sensitivity in discriminating

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Table 3  
Results on the frontal systems behavioral scale-Spanish adaptation for brain injured, substance abusers and healthy controls

	Substance abusers Mean (SD) [CI]	F-ABI patients Mean (SD) [CI]	Healthy controls Mean (SD) [CI]	Wilks-lambda (3,131)	F (2,133) p	Bonferroni
Apathy	28.87 (7.97) [26.72–31.02]	39.04 (9.26) [36.74–41.35]	25.32 (5.68) [22.75–27.90]	12.38 ( $p=0.000$ )	35.01	F-ABI > (SA = HC)
Disinhibition	30.92 (7.4) [28.89–32.97]	34.67 (8.45) [32.48–36.87]	27.32 (6.38) [24.88–29.77]		9.85	F-ABI > (SA = HC)
Executive Dys.	38.21 (10.53) [35.61–40.80]	49.11 (10.40) [46.32–51.90]	32.95 (6.47) [29.84–36.05]		31.77	F-ABI > SA > HC
Total	98 (22.95) [91.67–104.33]	122.83 (21.14) [116.55–129.10]	85.59 (16.14) [80.21–90.97]		35.79	F-ABI > SA > HC

Note: Executive Dys., executive dysfunction; SD, standard deviation; CI, confidence interval; F-ABI, frontal acquired brain injury; SA, substance abusers; HC, healthy controls.

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different degrees of severity of cortical dementias, and in the differential diagnosis of subcortical dementias (Huntington vs. Parkinson) (Stout, Rodawalt, & Siemers, 2001). Furthermore, the disinhibition subscale is useful in the quantification of behavioral problems resulting from brain surgery in Parkinson's disease (Saint-Cyr, Trepanier, Kumar, Lozano, & Lang, 2000). In addition, this subscale is associated with the severity of drug use in substance abusers, and with positive symptoms and poorer adaptive functioning in schizophrenia (Spinella, 2003; Velligan et al., 2002). The fact that previous studies had identified a relationship between drug use severity and the disinhibition dimension (Spinella, 2003; Verdejo-García, Rivas-Pérez, et al., 2006) is somehow conflictive with the fact that here we did not find significant differences between substance abusers and controls. However, it is important to consider that the discrepancy between the groups was marginally significant in the expected direction, showing a moderate effect size ( $d = 0.46$ ). Another interpretation issue is that of the heterogeneity of the sample, which was composed of polysubstance abusers. However, this is a common limitation in the human drug use neuropsychology literature, because it is very unusual to find pure users of any substances. Furthermore, it is unlikely that polysubstance use may have diluted differences between the groups, since this pattern has been related to more severe neuropsychological impairment (Selby & Azrin, 1998). The drug use group was significantly impaired in the executive dysfunction domain, supporting our previous findings in an US polysubstance abuser sample (Verdejo-García, Bechara, et al., 2006; Verdejo-García, Rivas-Pérez, et al., 2006).

The results of the present study have important implications for the development of functionally oriented and ecologically useful rehabilitation strategies with Spanish-speaking clinical populations. Several studies have reported that FrSBe scores have significant correlations with indices of basic and instrumental activities of daily living in patients with dementia of the Alzheimer type (Boyle et al., 2003; Norton, Malloy, & Salloway, 2001; Stout, Wyman, et al., 2003), as well as with levels of needs of primary caregivers of patients with ABI (Rymer et al., 2002). Therefore, individual item-analysis of problem-behaviors in this scale could aid treatment interventions in both F-ABI and substance abusers.

Relative to the American sample of the scale (Grace & Malloy, 2001), there are apparent differences suggesting the influence of cultural variables (Ardila, Rosselli, & Puente, 1992; Puente & Pérez-García, 2000). The influence of culture in executive functions is relevant as it relates to the understanding and measurement of a wide range of social and emotional behaviors that are often unique to different cultures. In the clinical samples, the patients with F-ABI scored approximately less than 0.1 standard deviations in the total scale and in the subscales of disinhibition and executive dysfunction when compared to the US clinical samples. Similarly, for the apathy subscale, the F-ABI group scores were approximately 0.2 standard deviations below the US sample. Furthermore, scores of substance abusers in this sample were very similar to those obtained in our previous study in a US sample of polysubstance abusers (Verdejo-García, Bechara, et al., 2006; Verdejo-García, Rivas-Pérez, et al., 2006). Conversely, the Spanish healthy control subjects in the present study exhibited significantly lower scores than those obtained with US healthy participants. Nonetheless, these differences were of moderate size and their clinical relevance is questionable; they could just reflect fluctuations within adaptive personality or cultural approach. Overall, our results indicate that cultural factors are more influential for scores of healthy participants than for those of clinical populations.

Certain limitations must be addressed. First, the limited number of subjects made the replication of the results necessary. Second, the participants of this study were mainly males, with lesser number of women. Groups were not matched on gender composition due to the fact that we maintained the male/female proportion of substance abusers found in the therapeutic communities and the higher prevalence of males found in the rehabilitation program for frontal acquired brain injury. This higher rate of males in both groups is consistent with that referred by the Spanish national statistics (Ministerio de Sanidad y Consumo, 2004; Instituto Nacional de Estadística, 1999). Nonetheless, correlations failed to show an association between gender and FrSBe scores, thus we do not believe this is an overriding variable in explaining the present results.

In summary, the results of our study indicate that the Spanish version of the Frontal Behavioral Systems Scale, or FrSBe-SA, permits characterization of two types of clinical patients sharing frontal dysfunction: ABI and substance abusers, as well as between the clinical populations and a sample of healthy volunteers. It is important to understand that this adaptation was completed with Spanish speakers in Spain and that the total number of patients and clinical subgroups were limited. Thus, it would be appropriate to address the development of more comprehensive norms for Latin-American populations in future research. Professionals must be aware of this limitation when applying this study to the primary cultural groups represented in the US. In the interim, the present scale serves to better understand the potential behavioral disruption of Spanish individuals with damage to frontal systems and provides the foundation for the development of functionally and ecologically more appropriate intervention programs.

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## Abstract

OBJECTIVE: To evaluate the performance of a Chinese version of the Frontal Systems Behavior Scale (FrSBe) among a sample of individuals with and without ADHD. RESULTS: The FrSBe showed good reliability and validity. CONCLUSIONS: The FrSBe is a valid and reliable measure of executive dysfunction in individuals with ADHD. © 2008 J

## Keywords

## 1. Introduction

Attention deficit hyperactivity disorder (ADHD) is a common neurodevelopmental disorder that affects children and adolescents. It is characterized by inattention, hyperactivity, and impulsivity. The disorder can have a significant impact on the individual's academic, social, and occupational functioning. The Frontal Systems Behavior Scale (FrSBe) is a self-report measure of executive dysfunction that has been widely used in the assessment of ADHD. The purpose of this study was to evaluate the performance of a Chinese version of the FrSBe among a sample of individuals with and without ADHD.

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