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RESEARCH ARTICLE

Frontal Assessment Battery: Reliability, validity and discriminative ability in a Spanish sample of amnestic mild cognitive impairment and Alzheimer's disease

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Abstract

Dementia constitutes one of the most widespread neurological disorders, representing an important health concern due to its increasing prevalence. Among the various types of dementia, Alzheimer's disease (AD) is the most common in the elderly, characterized by episodic memory impairment and also a decline in executive functions. Mild cognitive impairment (MCI) is considered a transitional stage between normal ageing and dementia, often described as a pre-dementia state. Distinguishing between these states is of paramount importance for the detection and appropriate care of patients. Functional Assessment Battery (FAB) is a screening tool for assessing executive function. In this study, 36 healthy individuals (HC), 31 single-domain amnestic mild cognitive impairment (aMCI) patients, and 29 Alzheimer's disease (AD) patients were assessed using FAB to determine its reliability, validity, and discriminative validity in a Spanish sample. Results indicated a good internal consistency of FAB in the AD sample ($\alpha = .71$), but not in the aMCI group ($\alpha = .49$). Significant differences between HC and both aMCI and AD groups were observed in the total scores of FAB. The FAB also showed good accuracy in distinguishing between HC and patients (AUC = 0.85), with an estimated optimal cut-off point of 16.5. However, its ability to distinguish between aMCI and AD individuals was lower (AUC = 0.68). More studies are necessary to corroborate our results using larger samples.

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KEYWORDS
Alzheimer's disease, cognitive decline, executive functions, FAB, neuropsychology tests, single-domain amnestic mild cognitive impairment

INTRODUCTION

Dementia constitutes one of the most widespread neurological disorders, representing an important health concern due to its increasing prevalence (Manero et al., 2014). Among the various types of dementia, Alzheimer's disease (AD) is the most common in the elderly (Cummings & Cole, 2002). It is a severe and irreversible condition characterised by a gradual and continuous decline in cognitive function and the eventual loss of functional independence in daily activities (Marshall et al., 2011; Torrente et al., 2025). AD comprises a broad range of symptoms that evolve as the disease progresses. This includes an initial pre-dementia stage, which represents the early stage of the disease, followed by the dementia stage. During the pre-dementia stage, the predominant symptoms are typically linked to episodic memory loss, although these do not generally impair the individual's ability to perform daily living activities (Dubois et al., 2010).

Mild cognitive impairment (MCI) is considered a transitional stage between normal ageing and dementia (Jung et al., 2020), often described as a pre-dementia state. While not all individuals with MCI will progress to dementia (Petersen et al., 2014), those with amnestic MCI (aMCI) have a higher likelihood of progressing to AD (Edmonds et al., 2024). Indeed, aMCI is viewed as a prodromal stage of AD in the absence of physiological biomarkers (Rabi et al., 2020). A recent study investigated the role of executive functions (EF) in relation to the episodic memory network (EMN) in individuals with aMCI (Wang et al., 2024). The authors found that alterations in the functional connectivity of the EMN are mediated by EF, suggesting that executive dysfunction may serve as a potential biomarker for predicting the progression to AD, given its strong association with an increased rate of conversion from aMCI to AD (Jung et al., 2020; Xue et al., 2019). These findings are consistent with the "executive function decline hypothesis," which posits that EF plays a critical role in the process of memory deterioration (Lee et al., 2012). The co-occurrence of executive and episodic memory impairments compromises an individual's ability to respond appropriately to environmental demands, thereby contributing to deficits in instrumental activities of daily living (Guarino et al., 2019; Marshall et al., 2011). Thus, accurate assessment of these functions could be crucial for early diagnosis, monitoring disease progression and designing effective interventions.

In this context, the Frontal Assessment Battery (FAB; Dubois et al., 2000) is a tool developed to assess executive functions. The FAB is a brief, easy-to-administer battery that is well received by patients and can be completed in <10 min. Thus, it is an excellent alternative to longer assessments. The battery consists of six subtests, each exploring different cognitive processes associated with the frontal lobes. The overall score not only reflects the severity of the dysexecutive syndrome but also offers valuable insights that may help to differentiate between various neuropsychiatric disorders (Hurtado-Pomares, Terol-Cantero, Sánchez-Pérez, Peral-Gómez, et al., 2018). Additionally, the FAB can be useful as a screening tool for sub-syndromes related to the dysexecutive profile (Appollonio et al., 2005). Several studies have investigated the psychometric properties of the FAB across diverse populations and for a variety of pathologies. In the original study by Dubois et al. (2000), the FAB showed strong psychometric properties, including optimal inter-rater reliability, high internal consistency and good criterion and concurrent validity. Further research has shown that the FAB could effectively distinguish AD from other forms of dementia, including frontotemporal dementia (Slachevsky et al., 2004), dementia with Lewy bodies (Hanyu et al., 2009), vascular dementia (D'Onofrio et al., 2018) and MCI in Aβ-positive patients (Aiello, Esposito, et al., 2022; Aiello, Verde, et al., 2022; Yamao et al., 2011). However, no studies about FAB's capacity to distinguish between HC and aMCI are available.

The FAB has also been applied in other clinical contexts, including studies involving Parkinson's disease (Hurtado-Pomares, Terol-Cantero, Sánchez-Pérez, Leiva-Santana, et al., 2018), Huntington's

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disease (Solca et al., 2022), amyotrophic lateral sclerosis (Aiello et al., 2023), schizophrenia (Gulec et al., 2008) and obstructive sleep apnea (Ladera et al., 2018), among others. Moreover, the FAB has been translated and validated in several languages, with normative values available for Spanish (Hurtado-Pomares, Terol-Cantero, Sánchez-Pérez, Leiva-Santana, et al., 2018), Italian (Aiello, Esposito, et al., 2022; Aiello, Verde, et al., 2022; Appollonio et al., 2005), German (Benke et al., 2013), Korean (Kim et al., 2010), Slovak (Abrahámová et al., 2022), Brazilian (Beato et al., 2012), Iranian (Asaadi et al., 2016) and Taiwanese (Wang et al., 2016) populations. Despite these advancements, the psychometric properties of the FAB in the Spanish population with AD have not yet been thoroughly explored. Furthermore, while the ability of the FAB to differentiate MCI from AD has been assessed in only two studies, neither of these involved the Spanish population.

All things considered, the primary objectives of the present study are twofold: (1) to evaluate the psychometric properties, including reliability and validity, of the FAB in the Spanish population with AD and single-domain aMCI and (2) to assess the capacity of the FAB to distinguish between healthy individuals, aMCI patients and AD patients within the Spanish context. It is important to note that instruments such as the FAB may be more appropriate for other clinical populations, such as those with multi-domain aMCI. However, the aim of this study was to assess whether the FAB, despite being a screening tool, could detect subtle executive alterations in this population and be useful for patient classification. Based on previous articles relating EF and conversion to AD, we assumed that individuals identified by the test might be at higher risk of developing severe cognitive decline, even within the single-domain aMCI.

The following hypotheses are proposed: (1) the FAB will demonstrate good reliability and validity in these samples, (2) the FAB will effectively differentiate healthy individuals from aMCI patients and (3) the FAB will differentiate between single-domain aMCI and AD patients. Results in favour of these hypotheses could support the use of the FAB as an additional diagnostic tool for identifying individuals with single-domain aMCI who are at a higher risk of severe cognitive impairment, by enabling accurate classification across clinical groups.

MATERIALS AND METHODS

Participants

The study sample consisted of 96 participants, comprising 36 healthy subjects, 31 subjects with a previous diagnosis of aMCI and 29 subjects with a previous diagnosis of AD. All were native Spanish speakers from the province of Tarragona, in Catalonia, and they aged between 60 and 84 years. Regarding gender distribution, 52.1% were men and 47.9% were women. The inclusion criteria for the AD group were (1) AD diagnosis by a neurology service following NIA-AA 2011 criteria (McKhann et al., 2011); (2) aged 60 to 85 years; (3) Global Deterioration Scale (GDS-FAST) score of 4 to 5 points (Reisberg, 1988). For the aMCI group, the criteria were (1) single-domain aMCI diagnosis by a neurology service following NIA-AA 2011 (Albert et al., 2011); (2) aged 60 to 85 years; (3) GDS-FAST score of 3 points (Reisberg, 1988). Control group participants were healthy individuals aged 60 to 85 years. The exclusion criteria for all groups were: (1) diagnosis or comorbidity with other major neurological disorders; (2) illiteracy. This study followed the ethical principles of the World Medical Association's Declaration of Helsinki (as revised in Tokyo in 2004) and was approved by the Ethical Committee of Clinical Research with Medicines (CEICm) of the IISPV (Ref. CEIM: 183/2020). Informed consent was obtained from all participants or their legal representatives before enrolling in the study.

Instruments

Frontal Battery Assessment (FAB): The FAB is a screening tool that assesses various aspects of executive function developed by Dubois et al., 2000. It consists of six subtests addressed to different functions

of the frontal lobes: (1) similarities – abstract reasoning conceptualization, (2) lexical fluency – mental flexibility, (3) motor series – programming and motor planning, (4) conflicting instructions – resistance to interference, (5) go-no go test – inhibitory control and (6) prehension behaviour – ability to inhibit a response to sensory stimulation. Each subtest is rated from 0 to 3 and the total score ranges from 0 to 18. Higher scores indicate better performance.

Mini-Mental State Examination (MMSE; Folstein et al., 1975): The MMSE is an 11-item test measuring general cognitive function. It consists of six sections: orientation, fixation, attention and calculation, memory, language and visuoconstructive abilities. The total score ranges from 0 to 30.

Mini-Examen Cognoscitivo (MEC; Lobo et al., 1979): The MEC is the Spanish-adapted and validated version of the MMSE. It includes items assessing orientation, fixation, attention and calculation, memory, language and visuoconstructive abilities. Like the MMSE, it maintains the same assessment structure of six cognitive domains but incorporates five more questions. Three of these refer to attention and calculation, and the remaining two refer to language. Total score ranges from 0 to 35.

Trail Making Test (TMT; Reitan, 1958): The Trail Making Test is one of the most widely utilized in neuropsychological assessments and consists of two subtests: TMT-A and TMT-B. In TMT-A, participants are instructed to draw a line connecting the numbers 1 to 25, which are randomly arranged on a sheet, in the correct ascending order as quickly as possible. In TMT-B, participants must alternate between numbers and letters while following the alphabetical sequence. The score is measured in seconds taken to complete the task, with longer times indicating poorer attentional capacity. TMT-B is also related to cognitive flexibility and working memory performance. In this study, the version validated by Peña-Casanova et al., 2009 was used.

All tests were administered in the following order to all study participants: MMSE, MEC, TMT and FAB. The evaluators were not blinded for the diagnostic group.

Statistical analysis

Descriptive analyses were made to compare socio-demographic characteristics and neuropsychological examination according to the different groups of participants. Normality of data were checked by the Shapiro-Wilks test. Due to the continuous variables in the sample not being normally distributed, non-parametric tests were used (Rank ANCOVA controlling for age and education and Dunn-Bonferroni correction method across all post-hoc and correlation analyses). Reliability was evaluated using Cronbach's alpha and item-total correlations were examined using Spearman's rank correlation coefficient. Concurrent validity using Spearman correlations between the FAB and MMSE, TMT A-B and MEC questionnaires was assessed considering ≥0.4 moderate, ≥0.7 strong and ≥0.9 very strong (Schober et al., 2018). We also assessed the criterion validity by performing a linear discriminant analysis including all items to differentiate between groups (HC, aMCI and AD). The area under the curve (AUC) was used to calculate the optimal total cut-off point for distinguishing between groups (HC-aMCI and aMCI-AD). AUC scores were interpreted as follows: ≥0.7 fair, ≥0.8 good and ≥0.9 excellent (Nahm, 2022). Significance for all tests was established at $p < .05$ and all the analyses were conducted by RStudio (R version 4.4.1, R Foundation for Statistical Computing, Vienna, Austria) and IBM SPSS Statistics v29 (IBM Corp., Armonk, NY, USA).

RESULTS

General characteristics of the sample

Table 1 shows the general characteristics of the participants. Participants in the healthy controls group were significantly younger than participants in the other two groups: aMCI and AD. As

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expected, they also scored higher on the MMSE, the MEC and lower on the two parts of the TMT. In the years of schooling (Education), significant differences were observed between the HC and aMCI groups. However, no significant differences were observed between the AD group and the other groups. There were also no significant differences between groups for the gender variable.

Internal consistency and reliability measures

Tables 2 and 3 present the internal consistency and reliability results for the AD and aMCI groups. In Table 2, in the AD group a Cronbach's alpha value of 0.71 was obtained, suggesting good internal

TABLE 1 General characteristics of study participants (n = 99).

	HC (n = 36)	aMCI (n = 31)	AD (n = 29)	p-value
Age (years)	67.3, 66 (62.5–71.5)[a]	71, 71 (67–75.7)[b]	73, 74 (71–77.2)[b]	<.000
Gender, n (%)				
Men	18 (50%)	14 (48.3%)	18 (58.1%)	.71
Women	18 (50%)	15 (51.7%)	13 (41.9%)	
Education (years)	12.4, 11 (9-15)[a]	9.9, 9 (7.2–13.7)[b]	13, 11 (8.5-20)[ab]	.015
GDS	1	3	4 (80%), 5 (20%)	
MMSE	30, 30 (30–30)[a]	26.4, 26 (25-28)[b]	25.8, 26 (25-28)[b]	<.001
MEC	34.3, 35 (33.5-35)[a]	30.3, 31 (28.2–32)[b]	30.6, 31 (28.5–33.2)[b]	<.001
TMT-A	49.8, 42 (31.5-56)[a]	68.9, 62.5 (49–92.2)[b]	57.8, 58.5 (44.5–69.5)[b]	<.001
TMT-B	122.1, 97 (68–160.5)[a]	238, 226.5 (130.7–272.7)[b]	205.8, 159.5 (112.5–285.7)[ab]	.001

Note: Data are expressed as mean, median and (interquartile range). Sharing a letter indicates no significant differences between these groups in post-hoc tests.

Abbreviations: aMCI, amnesic mild cognitive impairment; AD, Alzheimer's disease; HC, healthy controls.

TABLE 2 Internal consistency and reliability measures for AD and aMCI groups.

	Mean (SD)	α^a	Corrected item-total correlation
AD (n = 29)			
Item 1 – Similarities	2.10 (0.96)	0.647	0.540
Item 2 – Lexical fluency	1.90 (1.01)	0.619	0.624
Item 3 – Motor series	1.69 (1.19)	0.699	0.374
Item 4 – Conflicting instructions	2.10 (1.31)	0.673	0.461
Item 5 – Go – No go	1.45 (1.29)	0.625	0.580
Item 6 – Prehension behaviour	3.00 (0.00)	0.742	0.000
aMCI (n = 31)			
Item 1 – Similarities	2.26 (0.85)	0.416	0.318
Item 2 – Lexical fluency	2.42 (0.62)	0.536	0.043
Item 3 – Motor series	2.13 (0.99)	0.418	0.313
Item 4 – Conflicting instructions	2,65 (0,83)	0.361	0.412
Item 5 – Go – No go	2.35 (1.01)	0.400	0.339
Item 6 – Prehension behaviour	3.00 (0.00)	0.519	0.000

Abbreviations: SD, standard deviation; α^a, Cronbach's alpha if item is deleted.

TABLE 3 Correlations between FAB's items for AD and aMCI groups (except for Item 6).

	Item 1: Similarities	Item 2: Lexical fluency	Item 3: Motor series	Item 4: Conflicting instructions	Item 5: Go-No go
AD (n = 29)					
Item 1 – Similarities	1	0.46	0.17	0.31	0.64
Item 2 – Lexical fluency		1	0.37	0.49	0.44
Item 3 – Motor series			1	0.27	0.33
Item 4 – Conflicting instructions				1	0.34
Item 5 – Go – No go					1
aMCI (n = 31)					
Item 1 – Similarities	1	−0.64	0.14	0.21	0.14
Item 2 – Lexical fluency		1	0.07	0.09	−0.04
Item 3 – Motor series			1	0.21	0.03
Item 4 – Conflicting instructions				1	0.09
Item 5 – Go – No go					1

consistency. This value remained similar when one item was removed, ranging from 0.61 to 0.74. The corrected item-total correlations showed good values except for item 6, which did not show variability and did not help to discriminate between subjects.

In the aMCI group, a Cronbach's alpha value of 0.49 was obtained, suggesting poor internal consistency. This value also did not vary substantially when any of the items were removed, ranging from 0.40 to 0.53. Finally, the corrected item-total correlations showed inadequate values for items 2 and 6 in this group.

Table 3 shows the correlation coefficients for the items of the FAB in both samples. While clear heterogeneity can be observed in the AD group, the aMCI sample showed less variability and lower coefficients.

Concurrent validity

In the AD group, strong correlations were obtained between the FAB total score and the MMSE and MEC tests. The correlation was moderate and inverse with part A of the TMT, while no significant correlation with TMT-B was observed. Among FAB items, the most strongly related with MMSE, MEC and TMT-A tests was item 5 (Go-No go) (see Table 4). Item 6 of the FAB was not included in the analysis due to the absence of variability in the two groups. In contrast, the aMCI group obtained moderate correlations with the scores of the other tests, except for item 5 of the FAB (conflicting instructions) which obtained a strong inverse correlation with part B of the TMT.

Comparison of FAB scores between groups

Table 5 shows the results of the between-group comparison analyses for the FAB. None of the items showed significant differences between all groups in the pairwise comparisons (HC, aMCI and AD). However, the aMCI and AD groups showed significant differences in the total test score. Items 1 and 3 scored significantly differently between the HC group and the other groups, while item 5 shows lower scores in the AD group compared to aMCI and HC groups.

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TABLE 4 Concurrent validity between scores in FAB and other neuropsychological tests for AD and aMCI groups (except for Item 6).

	Total score	Item 1: Similarities	Item 2: Lexical fluency	Item 3: Motor series	Item 4: Conficting instructions	Item 5: Go – no go
AD						
MMSE	0.821**	0.626**	0.632**	0.507**	0.457*	0.699**
MEC	0.828**	0.640**	0.650**	0.436*	0.507**	0.710**
TMT-A	−0.554**	−0.312	−0.245	−0.373*	−0.560**	−0.412*
TMT-B	−0.610	−0.475	−0.623	0.158	¶	−0.772**
aMCI						
MMSE	0.645**	0.406*	0.148	0.572**	0.240	0.436*
MEC	0.617**	0.488**	0.177	0.444*	0.280	0.372*
TMT-A	−0.352	−0.091	−0.247	−0.108	−0.380*	−0.250
TMT-B	−0.542*	0.037	−2.92	−0.141	−0.865**	0.184

¶Standard Deviation = 0.
*$p < .05$.
**$p < .001$.

TABLE 5 Comparison of FAB scores between groups.

	HC ($n=36$)	aMCI ($n=31$)	AD ($n=29$)	p-value[§]
FAB items				
Total score	17 (17-18)[a]	15 (9–15.5)[b]	12 (14-17)[c]	**$p<.001$**
Item 1 – Similarities	3 (3-3)[a]	2 (2-3)[b]	2 (1-3)[b]	**$p=.044$**
Item 2 – Lexical fluency	3 (2–3)	2 (2–3)	2 (1–3)	$p=.114$
Item 3 – Motor series	3 (3-3)[a]	2 (1-3)[b]	2 (1-3)[b]	**$p=.027$**
Item 4 – Conflicting instructions	3 (3–3)	3 (3–3)	3 (0.5–3)	$p=.363$
Item 5 – Go – No go	3 (2-3)[a]	3 (2-3)[a]	2 (0-3)[b]	**$p=.009$**
Item 6 – Prehension behaviour	3	3	3	¶

Note: Data are expressed as median and interquartile range. Sharing a letter indicates no significant differences between these groups in post-hoc tests. Bold values indicates significant differences between groups in the Quade's test.
§Rank ANCOVA (Quade's test).
¶Standard deviation = 0.

Criterion validity

To evaluate the discriminative ability of FAB between groups, linear discriminant analysis (including all FAB's items) was used; ROC curves and optimal cut-off points were calculated also. In LDA, the model obtained an accuracy of 0.67, with items 3 and 1 being those with the highest contribution to the classification (coefficients 0.73 and 0.41 respectively). The values of sensitivity and specificity for each group were the following: HC group (0.97 and 0.73), aMCI group (0.51 and 0.87) and AD group (0.48 and 0.89). The confusion matrix of the model is displayed in Figure 1.

Finally, Figure 2 shows the AUC values for FAB total score to discriminate between HC and aMCI subjects, and between those diagnosed with aMCI and AD. In the first case, the AUC obtained a value of 0.85 (good). The estimated optimal cut-off point was 16.5 ($J=0.45$, sensitivity = 0.77, specificity = 0.32). In the second case, the AUC obtained a value of 0.68 (very fair). The estimated optimal cut-off point was 10.5 ($J=0.38$, sensitivity = 0.96, specificity = 0.58).

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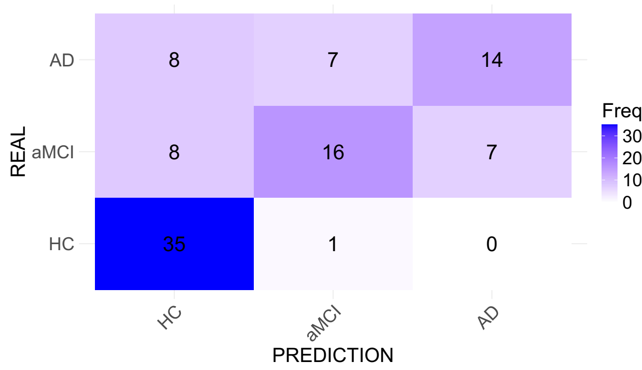

FIGURE 1 Confusion matrix of the linear discriminant analysis.

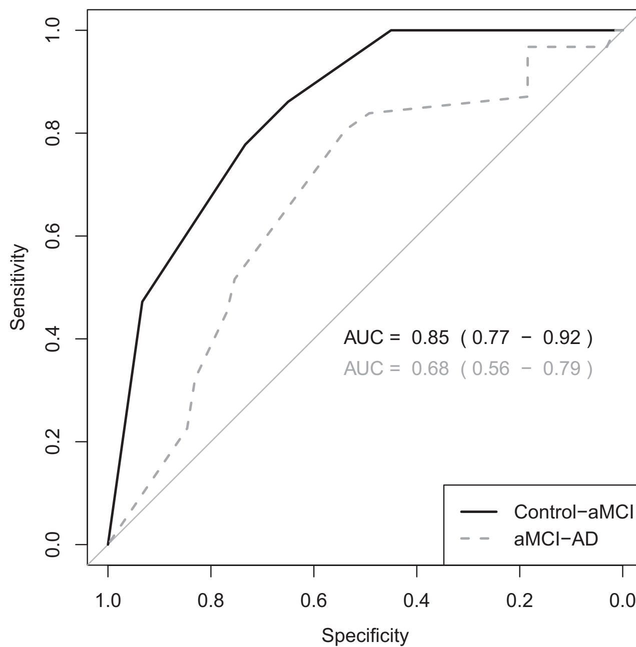

FIGURE 2 ROC curves and AUCs for Control-aMCI and aMCI-AD groups.

DISCUSSION

The aim of this study was to analyse the psychometric properties of reliability and validity of the FAB in a Spanish sample with aMCI and AD patients. The results showed good internal consistency for the Alzheimer's group, but did not achieve a good result in the aMCI group. However, the characteristics of the instrument need to be considered. On the one hand, alpha is influenced by the short length of the questionnaire, as it is a battery comprising only six items. In addition, item 6 showed no ability to discriminate between groups. This can be explained by the fact that this item assesses environmental autonomy, a function that deteriorates in advanced stages of AD. And, in our sample, there is no subject with a Global Deterioration Scale (GDS; Reisberg et al., 1982) and Functional Assessment Staging Tool (FAST; Reisberg, 1988) (GDS-FAST) score of 6 or 7 points. Furthermore, the low variance of the Prehension behaviour subtest has also been observed in other studies with patients with AD and dementia with Lewy bodies (Hanyu et al., 2009) and with Parkinson's disease (Hurtado-Pomares,

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Terol-Cantero, Sánchez-Pérez, Leiva-Santana, et al., 2018; Hurtado-Pomares, Terol-Cantero, Sánchez-Pérez, Peral-Gómez, et al., 2018). This item also obtained the lowest correlation coefficients in a recent validation of the instrument in a healthy Spanish population (Hurtado-Pomares et al., 2024). Similarly, in a study by Heikkinen et al. (2024) involving a sample of younger patients, no correlation was found between this item and other measures of executive function, such as the Trail Making Test or the Stroop Test. Thus, the Prehension behaviour subtest may need to be revised to improve the overall reliability of the scale. On the other hand, the internal consistency can also be affected by the fact that the FAB assesses executive functions, which is a very heterogeneous construct, and each function can be altered independently. In this sense, the heterogeneous correlations observed between FAB's items in the AD sample support this interpretation.

Concurrent validity analysis showed that FAB, MEC and MMSE scores were strongly correlated, in line with previous studies with patients with AD (Castiglioni et al., 2006; Lipton et al., 2005). Moreover, studies with patients with frontotemporal dementia (Castiglioni et al., 2006) and Parkinson's (Asaadi et al., 2016; Hurtado-Pomares, Terol-Cantero, Sánchez-Pérez, Leiva-Santana, et al., 2018; Hurtado-Pomares, Terol-Cantero, Sánchez-Pérez, Peral-Gómez, et al., 2018) have also reported a strong correlation. In contrast, only moderate correlations were obtained in the aMCI group. This result again indicates a lower ability of the scale to predict cognitive impairment in this population. The results show only a moderate correlation between the FAB score and the TMT-A and TMT-B, and only for some items in both groups. This result agrees with previous studies conducted in patients with AD and frontotemporal dementia (Castiglioni et al., 2006) and younger MCI patients (Heikkinen et al., 2024), in which no correlation was reported. Nevertheless, the results are inconsistent with previous studies with patients with Parkinson's disease (Hurtado-Pomares, Terol-Cantero, Sánchez-Pérez, Leiva-Santana, et al., 2018; Hurtado-Pomares, Terol-Cantero, Sánchez-Pérez, Peral-Gómez, et al., 2018). Specifically, the authors observed strong correlations between the TMT and the Motor series and Go-No go items of the FAB.

With regard to the FAB comparison between groups, the results indicate that the FAB total score and subscores, except for the Prehension behaviour, the Lexical fluency and the Go-no Go subtests, show some differences among the three groups. Only the total score showed significant differences between the 3 groups (HC vs. aMCI, aMCI vs. AD and HC vs. AD). Moreover, aMCI and AD groups differed in the scores of Similarities and Motor series. aMCI and AD groups only differed in the Go/No-Go subtest. The Go/No-go item assesses inhibitory control and impulsivity. The results demonstrated that this item yielded the lowest performance for the AD group, a finding consistent with previous studies (Yamao et al., 2011). Furthermore, these results are coherent with the fact that dysexecutive function in AD patients is mainly characterised by impaired inhibitory control, as well as impaired cognitive flexibility, as discussed in the introduction. Similar to the results of our study, Yamao et al. (2011) did not observe significant differences between the aMCI and AD groups for the lexical fluency item. Some authors have proposed the discrepancy scores of lexical and semantic fluencies as a marker of the early identification of AD (Lonie et al., 2009) and a recent study by Cintoli et al. (2024) has showed that verbal fluency measures could serve as neuropsychological markers for predicting cognitive decline in individuals with single domain aMCI. However, the first study did not report any information about the composition of the aMCI sample, which is assumed to be heterogeneous. The second study analysed a single-domain aMCI sample and included a more extensive assessment of lexical fluency. These differences could therefore account for the discrepancy in results.

Regarding the FAB's general ability to discriminate between the three groups included in the study, the results showed values that can be interpreted as low discriminant ability. However, the model obtained a high sensitivity in the HC group, indicating some ability of the test to separate healthy subjects from aMCI and AD. This is also reflected in the confusion matrix in which only one subject with a diagnosis of aMCI was classified as healthy. This result is interesting as it allows patients with suspected cognitive impairment to be quickly referred for more extensive assessments. This conclusion is also supported by the ROC analyses for HC–aMCI groups. However, the expectations of the third hypothesis were not met. The FAB showed a good capacity to distinguish subjects between the control and aMCI groups, demonstrating good diagnostic ability. The optimal cut-off point for detecting

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dysexecutive function in aMCI, compared to healthy subjects, was 16.5. However, the results differ when discriminating between aMCI and AD groups, falling below the acceptable threshold. While previous studies have indicated that the FAB effectively differentiates both MCI (Aiello, Esposito, et al., 2022; Aiello, Verde, et al., 2022) and aMCI (Yamao et al., 2011) from AD, the results of this study did not provide evidence supporting this discriminative ability. The discrepancy in the results could be due to several reasons, including the fact that the study design and statistical analyses used in the studies were different. On the one hand, Yamao et al. (2011) recruited a heterogeneous sample of patients with single-domain and multi-domain aMCI, and only a comparative analysis between groups was performed. The study by Aiello, Esposito, et al. (2022); Aiello, Verde, et al. (2022) does not provide information about the composition of the aMCI sample. It could therefore be hypothesised that the positive results obtained in those studies were due to the inclusion of individuals with multi-domain aMCI. Moreover, different versions of the FAB were used in the other articles, namely the Japanese (Yamao et al., 2011) and the Italian with adjusted scores (Aiello, Esposito, et al., 2022; Aiello, Verde, et al., 2022). It is important to bear in mind that tests such as the FAB, particularly its verbal tasks, may be influenced by cultural and linguistic factors. Caution should therefore be exercised when extrapolating results across populations, and cross-cultural validation studies are essential to ensure the equivalence of different language versions.

It is important to consider various limitations of this study. The most important limitation was the homogeneity in the aMCI group, which comprised only a single-domain subtype. Future research should examine the diagnostic utility of the FAB in a multi-domain aMCI sample. Another limitation is the relatively small sample size, which reduces the statistical power of the analyses, and the fact that the FAB is considered a bedside test, limiting its usefulness in diagnosing MCI. Furthermore, this study did not include AD patients with a GDS-FAST score of 6 or 7. Although in this instance, it was better to leave them out to be more accurate in comparisons with aMCI patients, it may be interesting to consider and include them in future studies. Future research could compare the discriminatory power of the FAB and a test that assesses memory. Better discriminative ability of the FAB would be expected as the main difference between aMCI and AD patients is independence in activities of daily living, which is more related to executive functions.

CONCLUSION

The FAB may be used as a valid and reliable screening tool to evaluate executive function deficits in patients with AD. Although these findings highlight the importance of further research, they may help therapists to guide their clinical diagnoses, specifically in identifying those single-domain aMCI individuals at higher risk of developing severe cognitive impairment. However, it is important to emphasize that the usefulness of this instrument should be considered as complementary to other screening tests in this population. In addition, FAB has been shown to be useful in distinguishing the healthy population from those with a diagnosis of cognitive impairment, which can help in making appropriate referral decisions for further assessment.

AUTHOR CONTRIBUTIONS

Luis Heredia: Formal analysis; methodology; writing – original draft; writing – review and editing. **María Marco:** Data curation; formal analysis; investigation; writing – original draft. **Nerea Carrión:** Data curation; investigation; writing – review and editing. **Margarita Torrente:** Conceptualization; funding acquisition; supervision; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

Authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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