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Assessment of executive functions in older adults: Translation and initial validation of the Swedish version of the Frontal Assessment Battery, FAB-Swe

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ABSTRACT

Objectives: The Frontal Assessment Battery (FAB) is a screening test for executive functions. The purpose of this study was to describe the translation process and to make an initial evaluation of the reliability and convergent validity of the Swedish version of the FAB, the FAB-Swe.

Methods: The FAB-Swe was translated and adapted to Swedish using a translation and back-translation procedure. Seventy community-dwelling participants aged 65 years or older participated. Participants completed the FAB-Swe, the Mini-Mental State Examination – Swedish Revision (MMSE-SR), three established tests of executive functions (FAS, Trail Making Test—part B [TMT-B] and Stroop), and self-ratings of executive abilities. Reliability of the FAB-Swe was measured using Cronbach's alpha. Convergent validity was measured using Spearman's rank correlation.

Results: Internal consistency was moderately high (.675). Statistically significant correlations were found between the FAB-Swe and MMSE-SR, FAS, TMT-B, Stroop, and education. No significant correlations were found between the FAB-Swe and age or self-rated executive functioning.

Conclusions: This study indicates that the FAB-Swe has acceptable reliability and convergent validity. Further normative studies are needed to further investigate the effect of age and educational level. Studies are also needed to evaluate the diagnostic accuracy in clinical populations.

KEYWORDS

Aging; cognitive screening; dementia; geriatric; neuropsychological test; psychometric

Introduction

Executive functions (EFs) is an umbrella term for a set of mental processes that regulate complex human behaviors, such as reasoning, planning, problem-solving and self-control (Diamond, 2013). An influential model has proposed a common EF factor comprised of three core intercorrelated but separable EFs: mental set shifting, working memory updating and inhibition (Miyake et al., 2000; Miyake & Friedman, 2012). EFs have been linked to the prefrontal cortex of the brain (Miyake & Friedman, 2012), and the words "executive functions" are often used interchangeably with "frontal functions" or "prefrontal functions" (Henri-Bhargava et al., 2018). Impairments in EFs have been documented in a range of psychiatric and neurodevelopmental conditions (e.g., schizophrenia, major depression, bipolar disorder, obsessive-compulsive-disorder, ADHD) (Snyder et al., 2015) as well as in neurodegenerative and neurological disorders (e.g., Alzheimer's disease, frontotemporal dementia, Parkinson's disease, Huntington's disease) (Moreira et al., 2017). Impairments in EFs may predict functional disability: i.e., the bigger the impairments, the more need for support in everyday activities (Amanzio et al., 2018; Johnson et al., 2007). The assessment of EFs plays an important role in differential diagnoses, particularly in neurocognitive disorders.

EFs are traditionally investigated through comprehensive batteries of neuropsychological tests (Lezak, 2012), which can be time consuming and requires access to neuropsychological expertise. As an initial step of assessment, screening tests are a viable option when time and resources are limited (Moreira et al., 2017). Several screening tests have been developed to assess EFs, often consisting of modified tests from larger EFs test batteries (Moreira et al., 2017).

The Frontal Assessment Battery (FAB) is a brief neuropsychological screening test of EFs/frontal functions suitable for use at bedside (Dubois et al., 2000). It consists of six items, each tapping into different aspects of executive functioning: conceptualization, mental flexibility, motor programming, sensitivity to interference, inhibitory control, and environmental autonomy. The total score ranges from 0 to 18 points (0–3 points per item), with higher scores indicating better performance. The test takes about 10 minutes to administer.

The FAB has been validated for clinical use in different neurological and cognitive disorders, including Alzheimer's disease, fronto-temporal dementia, amyotrophic lateral sclerosis, Parkinson's disease, Lewy body dementia, vascular dementia (Moreira et al., 2017), and mild cognitive

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impairment (Fernández-Fleites et al., 2021). Several studies in clinical populations have shown that the FAB items correlate with frontal regions of the brain (Hurtado-Pomares et al., 2018). Diagnostic accuracy studies have been conducted in several populations. With a cutoff of 12, the FAB has been found to have 92% sensitivity and 78% specificity in distinguishing healthy older adults from adults with mild cognitive impairment (Chong et al., 2010), and 77% sensitivity and 87% specificity in distinguishing between Alzheimer's dementia and fronto-temporal dementia (Slachevsky et al., 2004). In addition, with a cutoff of 11, it has been found to have 76% sensitivity and 79% specificity in distinguishing between healthy older adults from adults with Huntington's disease (Rodrigues et al., 2009). The Cronbach's alpha has varied between different studies, from .68 (Asaadi et al., 2016) to .78 (Dubois et al., 2000), demonstrating acceptable internal consistency. The convergent validity between FAB and established measures of EFs has been demonstrated in previous studies using correlations, lexical word fluency ranging from .41 (Lima et al., 2008) to .79 (Rodrigues et al., 2009), Stroop Test from −.39 (Asaadi et al., 2016) to −.72 (Rodrigues et al., 2009), Trail Making Test—Part B (TMT-B) .62 (Iavarone et al., 2004), and Wisconsin Card Sorting Test from .37 (Mok et al., 2004) to .77 (Dubois et al., 2000). The validity of the FAB in relation to functional abilities in everyday life has been shown by a significant correlation of .79 with the Functional Capacity Scale (Rodrigues et al., 2009).

To our knowledge, there is no official translation of the FAB to Swedish prior to our translation, and no studies on the reliability and validity of the FAB in Swedish. The aim of the present study was to describe the translation process of the FAB-Swe and to evaluate the reliability and validity of the FAB-Swe in older adults.

Materials and methods

Design

The present study was a cross-sectional psychometric study. The sample was a convenience sample from the Psychiatric Syndromes in Late Life—Assessment and Treatment Study, a trial aimed at validating Swedish versions of psychiatric measures and neuropsychological tests, using data collected in 2019 and 2020. The study received ethical approval from the Swedish Ethical Review Authority (registration number 2019-00944). All participants were recruited from the County of Västmanland in Sweden and were residing in the community. All participants provided written informed consent, and for participants with dementia diagnoses, a family member or legal representative also approved their participation.

Participants

Participants were approached through organizations for senior citizens and via two primary health-care centers in the County of Västmanland. The inclusion criteria for participants were that they were 65 years old or older, fluent in spoken and written Swedish, and willing to participate in the trial. Exclusion criteria were a current alcohol/substance use disorder, severe visual impairment (not able to read the questionnaires) or color blindness (not able to perform the neuropsychological tests). For persons with dementia diagnoses, less than 20 points on the Mini-Mental State Examination – Swedish Revision (MMSE-SR) cognitive screening test was also an exclusion criterion, and the limit for participants without a dementia diagnosis was 24 points on the MMSE-SR. In all, 70 participants were included in the study. Note that the original plan was to recruit additional participants with dementia, but due to the COVID-19 pandemic the recruitment had to be terminated early.

Power calculation

In previous studies, the correlation coefficient between the FAB and established measures of EFs ranged between .37 and .79. Our sample of 70 participants had 80% power to detect a correlation of .33 with a two-tailed alpha of .05.

Procedure

Translation and adaptation of the FAB into Swedish

The FAB was translated using a translation and back-translation procedure. It was translated from English to Swedish by a licensed psychologist proficient in English. The translated version was then back-translated into the original language (French) by an independent translator. After comments from the originator, a final version of the FAB-Swe was constructed. One adaptation was made: i.e., "daisy," was changed to "bluebell" because the former is not well known in Sweden and the latter occurs in almost all of Sweden. The FAB-Swe is available upon request to the corresponding author.

Materials

In addition to the FAB-Swe, demographic and clinical information was collected (age, years of education, dementia diagnoses). Depressive symptoms were assessed with the Geriatric Depression Scale 15-item short form (Sheikh & Yesavage, 1986), and anxiety symptoms were assessed with the 7-item Generalized Anxiety Disorder Scale (GAD-7) (Spitzer et al., 2006). Global cognitive functioning was tested with the MMSE-SR (Palmqvist et al., 2011). The participants also self-rated their executive abilities in everyday life using the Adult Executive Functioning Inventory (ADEXI) (Holst & Thorell, 2018). Three established tests of EFs were used: The FAS verbal fluency test (Tallberg et al., 2008), TMT-B (Fernandez & Marcopulos, 2008), and the Stroop Color-Word Test from the Cognitive Assessment Battery (Nordlund et al., 2011).

Table 1. Demographic and clinical characteristics.

	Total sample ($N = 70$)
Age, mean (SD) years	76.6 (5.81)
Education, mean (SD) years	11.84 (3.13)
Women, *n* (%)	43 (61.43)
Dementia, *n* (%)	7 (10)
GDS-15, mean (SD)	1.28 (1.70)
PHQ-9, mean (SD)	1.44 (2.85)
MMSE-SR	28.66 (1.72)
FAB-Swe total, mean (SD)	15.84 (2.42)
FAB-Swe 1, mean (SD)	2.51 (0.74)
FAB-Swe 2, mean (SD)	2.54 (0.77)
FAB-Swe 3, mean (SD)	2.89 (0.40)
FAB-Swe 4, mean (SD)	2.83 (0.54)
FAB-Swe 5, mean (SD)	2.07 (1.05)
FAB-Swe 6, mean (SD)	3.00 (0.00)
FAS, mean (SD)	33.11 (12.63)
TMT-B, mean (SD)	136.47 (101.92)
Stroop, mean (SD)	38.91 (32.82)
ADEXI, mean (SD)	25.50 (7.11)

Note. SD = standard deviation, GDS-15 = Geriatric Depression Rating Scale 15-item Short Form, GAD-7 = Generalized Anxiety Disorder 7-item, MMSE-SR = Mini-Mental State Examination – Swedish Revision, FAB = Frontal Assessment Battery (total score and subtests 1–6), FAS = verbal fluency test (total score), TMT-B = Trail Making Test – Part B (seconds), PHQ-9 = 9-question Patient Health Questionnaire, Stroop = Stroop Color-Word Test (seconds), ADEXI = Adult Executive Functioning Inventory (total score).

Procedure

The participants attended the study research clinic to complete the rating scales and neuropsychological tests. All neuropsychological tests were performed by the same psychologist (the corresponding author) in one session in the following order: MMSE-SR, FAB-Swe, TMT-B, FAS, and Stroop Color-Word Test.

Statistical analyses

Reliability was assessed with Cronbach's alpha. The reliability coefficient was interpreted in line with recommendations by (Ponterotto & Ruckdeschel, 2007), taking into account test length ($\leq$6 items) and number of participants ($N \leq 100$), as follows: .60, fair; .65, moderate; .70, good; and .75, excellent. Convergent validity was assessed using Spearman's rank correlation between the FAB-Swe, MMSE-SR, FAS, TMT-B, Stroop, and ADEXI. The correlation between FAB-Swe and age and years of education was also assessed using Spearman's rank correlation.

Results

Demographic and clinical characteristics are shown in Table 1.

All participants were able to complete the FAB-Swe. No difficulties in understanding the instructions were observed. Cronbach's alpha was .675, indicating moderately high internal consistency. However, item 6 was removed from the analysis because of zero variance. The Spearman's rank correlation coefficients between the FAB-Swe and the MMSE-SR, FAS, TMT-B, Stroop, ADEXI, age and years of education are shown in Table 2. Statistically significant correlations were found between the FAB-Swe and the MMSE-SR, FAS, TMT-B, Stroop and years of education. No significant correlations were observed with age or ADEXI.

Table 2. Correlations between the FAB-Swe and age, years of education and other tests of cognitive and EFs.

	Spearman's rho	*p*
Age	−.206	.087
Education	.337	.004
MMSE-SR	.342	.004
FAS	.533	<.001
TMT-B	.402	.001
Stroop	.361	.002
ADEXI	.016	.903

Note. EFs = executive functions; MMSE-SR = Mini-Mental State Examination – Swedish Revision; FAS = verbal fluency test; TMT-B = Trail Making Test – Part B; Stroop = Stroop Color-Word Test, ADEXI = Adult Executive Functioning Inventory.

Discussion

To our knowledge, this was the first study to evaluate the reliability and validity of the FAB in Swedish. The results indicate that the FAB-Swe has moderately high internal consistency in line with previous studies (Moreira et al., 2017), although item 6 was removed from the reliability analysis because of zero variance (no participant scored below 3 points). This has been pointed out in previous studies (Appollonio et al., 2005; Iavarone et al., 2004; Lima et al., 2008), raising questions about the utility of this item. The results show good convergent validity compared with the established tests of executive functioning, FAS, TMT-B and Stroop, in line with previous studies (Asaadi et al., 2016; Iavarone et al., 2004; Lima et al., 2008; Rodrigues et al., 2009). The FAB-Swe also correlated significantly with the MMSE-SR, suggesting that the FAB taps into cognitive domains other than EFs, as shown previously (Appollonio et al., 2005; Kugo et al., 2007; Mok et al., 2004). This difficulty in separating different neuropsychological functions in tests is known as "task impurity" and has been documented in other studies of EF-tests (Miyake et al., 2000). The FAB-Swe showed a correlation with years of education, which has also been demonstrated in other studies of the FAB (Appollonio et al., 2005; Fernández-Fleites et al., 2021; Iavarone et al., 2004; Lima et al., 2008; Rodrigues et al., 2009). Contrary to some previous studies (Appollonio et al., 2005; Iavarone et al., 2004; Lima et al., 2008), but in line with others (Dubois et al., 2000; Fernández-Fleites et al., 2021), no significant correlation was found with age, suggesting the FAB-Swe is useful as a screening test in a broad population of older adults. The FAB-Swe did not display a significant correlation with self-rated executive abilities using the ADEXI. This lack of convergence between performance-based tests of EFs and self-rated executive abilities in everyday life has been seen in other studies, suggesting that they may be assessing different underlying mental constructs (Holst & Thorell, 2018; Toplak et al., 2013).

There are limitations to this study. First, all neuropsychological tests were administered by the same psychologist. This is considered a strength in one way as it limits variability in the administration, but is also a potential source of bias. However, instructions and scoring were highly standardized. Second, as we used a small convenience sample with both normal controls and participants with neurocognitive disorders, it is not possible to generalize the scores to older

individuals in general. A strength of the study is that the rating scales were administered by a research nurse, so that the psychologist was blinded to the ADEXI results when the neuropsychological tests were administered.

In summary, our study indicates that the FAB-Swe is a feasible, reliable and valid instrument for screening EFs in older adults. The FAB-Swe may fill an important gap in clinical practice, by adding an instrument in Swedish that can assess EFs in a brief manner. Further normative studies in larger samples are needed to investigate the effect of age and educational level in more detail. Studies are also needed to evaluate the diagnostic accuracy in clinical populations.

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Data access

Data available from the authors upon reasonable request.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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