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Original Article

Screening for Cognitive Impairment in Bilinguals: What Is the Influence of the Language of Assessment?

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ABSTRACT: ***Background:*** Bilingualism's impact on cognitive assessment remains underexplored. This study analyzes the efficacy of the Mini-Mental State Examination (MMSE) as a screening tool for bilinguals, specifically examining the influence of language choice on balanced and unbalanced Lebanese bilinguals (Arabic-French) and its implications for diagnosing cognitive impairment. ***Methods:*** Ninety-three bilingual healthy controls (mean age = 67.99 ± 9.3) and 29 Alzheimer's disease patients (mean age = 77.2 ± 5.9), including 26 with mild and 3 with moderate dementia, underwent MMSE assessments in both Arabic and French. The study aimed to assess language impact on cognitive screening outcomes in different bilingual subtypes. ***Results:*** Sensitivity in screening for cognitive impairment using the MMSE varied based on language and bilingualism subtype. For unbalanced bilinguals, using the prominent language increased sensitivity. Conversely, in balanced bilinguals, employing the societal majority language enhanced sensitivity. This suggests that the conventional use of the non-prominent language in cognitive screening for foreigners/immigrants may result in a subtle loss of MMSE sensitivity. ***Conclusion:*** This study emphasizes the critical role of language choice in cognitive assessment for bilinguals. The MMSE's sensitivity is influenced by language selection, with clinical implications for screening procedures. Recommendations include using the prominent language for cognitive screening in dominant bilinguals and the societal majority language for balanced bilinguals. This nuanced approach aims to improve the accuracy and cultural sensitivity of cognitive screening in bilingual populations, addressing the gap in current assessment practices.

RÉSUMÉ : Dépistage des troubles cognitifs chez les individus bilingues : quelle est l'influence de la langue d'évaluation ? ***Contexte :*** L'impact du bilinguisme de patients sur leur évaluation cognitive demeure sous-exploré. Cette étude entend donc analyser l'efficacité du test de Folstein (TF ou *Mini-Mental State Examination*) en tant qu'outil de dépistage chez des individus bilingues en examinant plus particulièrement l'influence du choix de la langue chez des individus d'origine libanaise dont le bilinguisme (arabe et français) est équilibré et non équilibré de même que les implications sous-jacentes en vue d'un diagnostic de troubles cognitifs. ***Méthodes :*** Au total, 93 témoins en santé et bilingues (âge moyen = 67,99 ± 9,3), ainsi que 29 patients atteints de la maladie d'Alzheimer (âge moyen = 77,2 ± 5,9), dont 26 souffraient de démence légère et 3 de démence modérée, ont subi un TF en arabe et en français. Notre étude visait donc à évaluer l'impact de la langue sur les résultats du dépistage cognitif dans différents sous-types d'individus bilingues. ***Résultats :*** La sensibilité du dépistage de troubles cognitifs à l'aide du TF a varié en fonction de la langue et du sous-type d'individus bilingues. Chez les individus bilingues « déséquilibrés », l'utilisation de la langue dominante a augmenté le niveau de sensibilité du test. Inversement, chez les bilingues « équilibrés », l'utilisation de la langue majoritaire de la société a augmenté la sensibilité. Cela suggère en somme que l'utilisation conventionnelle de la langue non dominante dans le dépistage cognitif des étrangers ou des immigrants peut entraîner une perte subtile de sensibilité du TF. ***Conclusion :*** Cette étude souligne en définitive le rôle essentiel du choix de la langue dans l'évaluation cognitive des individus bilingues. La sensibilité du TF est en effet influencée par le choix de la langue, ce qui a des implications cliniques pour les procédures de dépistage. Voilà pourquoi il est recommandé d'utiliser la langue dominante pour le dépistage cognitif effectué chez des individus bilingues « déséquilibrés » et la langue majoritaire de la société chez des individus bilingues « équilibrés ». En comblant les lacunes des pratiques actuelles d'évaluation, cette approche nuancée entend améliorer la précision et la sensibilité culturelle du dépistage cognitif au sein de populations bilingues.

Keywords: Alzheimer's disease; bilingualism; language; MMSE; testing

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Introduction

In clinical practice, practitioners are increasingly confronted with bilingual patients referred for cognitive complaints. This frequently raises the issue of the effect of the language used to assess cognitive abilities on the determination of cognitive status and ultimately the diagnosis.

The current literature in neuroscience and linguistics offers various definitions of bilingualism; however, the one that seems most fitting for our study describes it as the ability to switch between two languages, suggesting that a bilingual individual "utilizes at least two languages in their daily life."[1] Numerous factors, both intrinsic (age of acquisition, proficiency level, learning context, etc.) and extrinsic (linguistic practice, usage contexts, social hierarchy, etc.), influence bilingual competencies and allow for the determination of the type of bilingualism.[2,3] For instance, the age of first exposure distinguishes between early and late bilingualism: early bilingualism can be simultaneous or sequential – simultaneous if both languages are acquired from birth and sequential if both languages are acquired from an early age but successively.[4,5] Moreover, bilingualism is considered late when the second language is learned after the age of 12 years.[4,6] Distinctions are also made between prominent bilingualism, where the individual has a better mastery of one language over the other, and balanced bilingualism, where the individual has similar competencies in both languages.[7–9]

Accordingly, bilingualism influences neuropsychological test performance in older adults, and this has consequences on the assessment of language and executive functions.[10,11]

As a matter of fact, bilingualism may result in slower lexical access and lower scores in naming and verbal fluency tasks[11–16] due to language interference.[17–19] However, associated with favorable living conditions, bilingualism is believed to have positive cognitive effects,[20–22] particularly on measures assessing inhibitory control,[11] whether through conflict resolution tasks evaluated by the Stroop test[10,23,24] or flexibility and switching in adults.[25] Nevertheless, other studies have failed to demonstrate the tangible benefits of bilingualism in the area of executive functions.[12,26,27] Consequently, norms for monolinguals on executives and language tests should be adjusted when assessing bilingual individuals in their non-prominent language to avoid misestimating their abilities and to ensure a reliable diagnosis.

In patients with dementia, especially in Alzheimer's disease (AD), it is frequently claimed that language impairment is more marked in the non-prominent language[28–31] although this remains controversial.[32–34] In assessing naming abilities, a recent study highlighted the heightened sensitivity of using the prominent language in bilingual AD patients.[35] This was evidenced through the application of the Multilingual Naming Test.[35]

Regarding screening tests, only two studies were identified that investigate the influence of language on cognitive assessment outcomes in bilingual individuals, highlighting the complexities of language choice in the Montreal Cognitive Assessment (MoCA) and the Mini-Mental State Examination (MMSE). One study[36] explored the MoCA[37] and revealed that the choice of language used in the MoCA significantly influenced the cognitive test outcomes among balanced bilinguals. As a matter, in this study, balanced bilinguals that completed the MoCA in English performed better than balanced bilinguals that completed the MoCA in Spanish. However, its design does not compare scores in the two languages in unbalanced bilinguals and exploration was only done in healthy controls (HC). As for the MMSE,[38] only one study was found and compared both language scores – Irish and English – in an Irish prominent population (based on informal measure) and showed better sensitivity in the prominent and societal majority language for the diagnosis of cognitive impairment.[39] However, authors used one single cognitive test, and bilingualism subtype, based on an informal report, was not clearly specified. Moreover, some may question the similarity between the languages' tested in this study, being Irish (i.e., Goidelic language) and English (i.e., Germanic language). The phenomenon of cross-linguistic influence highlights how similarities between languages can aid in testing in another language, potentially facilitating cognitive assessments.

Overall, controversies between studies in bilingual populations globally and in AD more precisely are likely to be due to the use of variable determination of bilingualism subtype and the lack of control for the bilingualism subtype on performance across languages.

Moreover, it is often challenging to conduct assessments of bilingual individuals in their first and most proficient language. As a result, testing is commonly carried out in the societally majority language, which may not be the individual's primary language. Therefore, there are concerns about tests validity and the influence of the used language on cognitive screening accuracy. It's pertinent to note, especially in European contexts influenced by non-European immigration, that patients are frequently tested in a European language, usually their second language (i.e., non-prominent).

Lebanon offers a unique perspective for studying bilingualism due to its multilingual environment. The country utilizes several languages, including Modern Standard Arabic (the official language used mainly in writing and media), Lebanese Arabic (spoken by 93.7% of the population for daily communication)[40] French, English and Armenian.[41–44] A survey in 2007 revealed that 45% of the Lebanese population spoke French and 40% English,[45] leading to the frequent use of Lebanese, French and English within the same sentence.[46]

This prevalent bilingualism is also reflected in the education system. In the Lebanese national curriculum, subjects such as Arabic, geography, history and civic education are taught in Arabic, while other subjects like physics, chemistry, biology, science and foreign languages are taught in either English or French.[47] This system underscores the simultaneous or sequential bilingualism present in the Lebanese society, offering insights into balanced versus dominant bilingualism in a context where mastering at least two languages is commonplace despite the multilingual setting. In the context of Lebanon's multilingual environment, the MMSE is particularly utilized for cognitive assessment due to its calibration for the Lebanese population.

This brief paper investigated the effect of the language used for administering MMSE on its ability to accurately diagnose cognitive impairment among Lebanese bilinguals (Arabic-French). This study leveraged a previously validated approach for categorizing bilingual subtypes, utilizing the Language Experience and Proficiency Questionnaire (LEAP-Q)[48] and additional language tests.[49]

Population and methods

The main inclusion criteria of patients were the following: bilingual (Arabic and French) patients aged between 55 and 92 years referred between January 10, 2020 and November 11, 2021 to neurology department of Hôtel-Dieu de France in Beirut, Lebanon, with mild to moderate dementia (defined by $\geq$ 16 in both languages (Arabic and French) fitting the criteria for probable

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Table 1. Demographic characteristics of healthy controls group (HC) (n = 93) and Alzheimer's disease (AD) patients' group (n = 29) expressed as number (n) of participants and mean ± standard errors

	Alzheimer's disease patients			Healthy controls			
	All	**Arabic prominent**	**Balanced**	**All**	**Arabic prominent**	**Balanced**	***p***
N	29	8	21	93	35	58	
Sex (women/men)	20/9	5/3	15/6	54/39	18/17	36/22	
Age	77.10 ± 5.90	77.00 ± 5.90	77.10 ± 6.60	67.99 ± 9.30	67.60 ± 9.10	68.22 ± 9.50	
Education level (*n*)							
1/2/3	9/8/12	6/1/1	3/7/11	25/20/48	7/10/18	18/10/30	
Handedness (*n*)							
Right/left/ambidextrous	27/1/1	8/0/0	19/1/1	87/6/0	32/3/0	55/3/0	
Order of completion (*n*)							
Arabic/French tests first	16/13	5/3	11/10	50/43	19/16	31/27	
Mini-Mental State Examination score (/30)							*<0.001*
Arabic	22.72 ± 3.4	22.50 ± 3.20	22.80 ± 3.60	27.30 ± 2.00	27.90 ± 2.00	28.00 ± 2.10	
French	22.24 ± 3.80	21.40 ± 4.00	22.60 ± 3.60	27.90 ± 2.60	26.40 ± 2.30	27.60 ± 2.70	
Ar-Fr dMMSE	0.03 ± 1.61	0.47 ± 0.87	0.49 ± 1.35	1.2 ± 0.79	1.57 ± 0.63	0.37 ± 0.49	*0.6*

Ar-Fr dMMSE: MMSE score in Arabic – the score in French.
Level (1): less or equal to 8 years of education after the end of elementary school; (2): between 8 and 11 years of education after the end of elementary school; (3): baccalaureate level or equivalent and above.

AD[50] consenting to participate to the study and free of exclusion criteria (illiteracy, any previous psychiatric or neurological disease affecting cognition and any perceptual [auditory and/or visual] or motor deficit precluding cognitive testing) with no severe comprehension difficulties (Token test[51] in each language ≥ 26). MMSE was administered in Lebanese Arabic[52] and French[53] in counterbalanced order. Both MMSE assessments were conducted within the same assessment session following the administration guidelines specified by the respective authors.

These criteria encompassed 29 AD patients (20 females, mean age = 77.2 ± 5.9), 26 with mild (as determined by the worst MMSE score ≥ 20) and 3 moderate dementia (worst MMSE ≥ 16) (Table 1). The HC group consisted of healthy Lebanese resident participants who fulfilled the following inclusion criteria: (1) must have been exposed before the age of 12 years to at least 2 languages, Arabic and French, (2) aged between 55 and 92 years, (3) living in Lebanon and (4) free of exclusion criteria (illiteracy, any declared psychiatric or neurological disease affecting cognition and any auditory or visual or motor deficit precluding cognitive testing).

Bilingualism subtype was determined using the previously validated bilingualism index[49] based on proficiency level in speaking and understanding of the LEAP-Q[49] informed by the patient and caregiver. This subdivided the AD group into 8 Arabic-prominent and 21 balanced patients. Their performance was compared to those of a control group of 93 bilingual HC[54] (54 females; mean age = 67.99 ± 9.3) with 35 Arabic-prominent and 58 balanced HC. The agreement of the ethics committee of the Hôtel-Dieu de France Hospital has been granted for the study (file CEHDF 1449).

Statistics

Statistical analyses were based on a validated framework for the analysis and interpretation of cognitive data.[55] First, MMSE scores were adjusted for age and education separately in each language. Scores were adjusted for age and education level using a regression analysis and coefficients computed in HC. Residuals were used in all analyses.

MMSE scores across groups and languages

Adjusted MMSE scores (adjMMSE) were compared across groups and languages using a repeated analysis of variance (ANOVA) with the between-subject factors group (HC, AD) and bilingualism subtypes (Arabic prominent, balanced) and the within-subject factor language (Arabic, French). Then, we examined whether the differential decrement across languages was related to severity of cognitive impairment by exploring the correlation between the best MMSE score (i.e., disease severity) and the difference of MMSE scores across languages (Ar-Fr dMMSE) (i.e., the score in Arabic – the score in French).

Discriminative ability of adjusted MMSE scores

Ability of adjMMSE to discriminate AD from HC was examined in each language (Arabic, French) by a stepwise logistic regression analysis with the group (HC, AD) as dependent variable. The independent variables submitted to analysis were bilingualism subtype (Arabic prominent, balanced) and adjMMSE scores in each language (Arabic, French). This analysis was repeated in each subgroup (Arabic prominent, balanced).

All statistical analyses were performed using SPSS®. A p value ≤ 0.05 was considered significant, unless otherwise indicated.

Results

MMSE scores across groups and languages

MMSE scores (Table 1) differed across groups (F (1,118) = 63.8; p <.001) due to overall lower scores in AD group (HC group: 27.3 ± .26; AD group: 22.9 ± .5). MMSE did not differ according to bilingualism subtypes (F (1,118) = 1.1; p = .29) (Arabic prominent: 24.8 ± .5; balanced: 25.3 ± .3) and to language (F (1,118) = .002; p = .96) (Arabic: 25.45 ± .3; French: 24.7 ± .3). Interactions did not reach significance (language × bilingualism subtype: p = .14;

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language × group: $p = .3$; bilingualism subtype × group: $p = .8$; language × bilingualism subtype × group: $p = .35$).

This analysis indicates that MMSE scores were lower in AD patients regardless of the language used and the bilingualism subtype.

The best MMSE score across languages did not correlate ($R^2 = -0.07$, $p = .4$) with the Ar-Fr dMMSE even after controlling for groups ($R^2 = -0.04$, $p = .6$). Thus, the differential decrement across languages was not related to the severity of cognitive impairment.

Discriminative ability of adjusted MMSE scores

The stepwise logistic regression selected the Arabic adjMMSE score (odds ratio [OR]:0.54, 95%confidence interval [CI]: 0.43–0.68, $p = .0001$) to discriminate AD from HC and the bilingualism subtype was not significant ($p = .3$). Accordingly, similar results were obtained in repeated analyses performed in both the Arabic prominent (Arabic adjMMSE score) (OR:0.44, 95%CI: 0.26–0.75, $p = .003$) and the balanced subgroups (OR:0.58, 95%CI: 0.45–0.74, $p = .0001$).

Discussion

This study shows that MMSE is impaired in bilingual AD patients to a similar extent whatever the language used. More importantly, it shows that cognitive screening using MMSE in Arabic provides the most discriminative measure of cognitive impairment in both Arabic-prominent and balanced Lebanese bilinguals. Regarding Arabic-prominent patients, this indicates that the prominent language (i.e., Arabic) provides the most sensitive measure of impairment. Regarding balanced Lebanese bilinguals, our results indicate that the use of the societal majority language (i.e., Arabic) provides the most sensitive measure of impairment.

This raises questions about cognitive screening methodologies for immigrants/foreigners, potentially affecting their assessments and diagnosis.

Cognitive impairment across languages

Overall, our results contrast with previous studies suggesting that cognitive impairment on MMSE of non-balanced bilinguals is more severe in the non-prominent language.[29–31] The discrepancy with previous results might be due to the assessment of various bilingual subtypes defined according to a strict and validated methods.[49] It might also be due to the analysis of MMSE scores after adjustment for age and education in each language.[55] This adjustment for demographic factor is critical as balanced and unbalanced bilinguals are likely to differ regarding age and education, a characteristic that was not observed in our population.

Sensitivity of language use in cognitive screening

Overall, our results are congruent with Ní Chaoimh[39] et al. (2015) and indicate that screening for cognitive impairment using the MMSE is more sensitive when the prominent language is used in unbalanced bilinguals or when the societal majority language is used in balanced bilinguals. This might be attributed to greater daily life exposure and its practical use, although this warrants further studies.

In light of these considerations, we have elaborated in our article that the observed sensitivity of the MMSE in Arabic-prominent individuals, which was more pronounced when tested in their prominent language, suggests a complex interplay between language proficiency and cognitive assessment outcomes.

This finding holds clinical significance, suggesting that employing the standard method for detecting cognitive impairment in foreigners/immigrants (i.e., use of the non-prominent language), such as utilizing the non-prominent language, unveils a subtle reduction in the sensitive measure on the MMSE. In practical terms, we recommend employing the prominent language for cognitive screening in dominant bilinguals and the societal majority language for balanced bilinguals. These recommendations aim to bridge the gap between research findings and clinical practice, facilitating more nuanced and culturally sensitive approaches to cognitive screening in bilingual individuals. The rich linguistic and cultural contexts of bilingual individuals must be taken into consideration to enhance the reliability and validity of cognitive assessments.

Study limitations and future directions

Several limitations of this study should be acknowledged. First, the sample size of the patient group is relatively modest, and this may lead to underestimate the crossed effects of language and bilingualism subtype in the ANOVA. Although this limitation holds, the sample size did not prevent demonstrating a language advantage (i.e., Arabic) to discriminate AD patients from HC. Second, our cross-sectional design does not rule out a different temporal course of impairment in the two languages with the progression of AD. As a matter of fact, in a longitudinal exploration,[29] authors highlighted a larger deficit for the prominent language at the initial stage of the disease together with a steeper deterioration in the non-prominent language on the longitudinal assessment on the Boston Naming Test[56] in 12 unbalanced Spanish-English bilinguals with probable AD. An exploration using the MMSE remains unexplored across languages. Although a longitudinal study is mandatory to document such difference across languages in the time course of cognitive performance, the lack of correlation between the severity of cognitive impairment and the differential MMSE impairment across languages provides no evidence for such interpretation in mild to moderate AD population. Third, due to the pandemic and Lebanese situation, the present study was not able to include a subgroup of French-prominent AD bilinguals of a size necessary to be informative. Thus, we were unable to determine whether French MMSE would be more sensitive (than Arabic MMSE) to detect cognitive impairment in French-prominent AD. Although this limitation does not prevent from showing a clear effect in Arabic-prominent and balanced bilinguals, the next step will be to include these patients.

More broadly our goal of future studies is to assess bilingual patients with the three bilingualism subtypes from different countries and languages in order to assess the cross-cultural generalizability of the present findings. Notably, we envision the inclusion of a group of bilingual Alzheimer's subjects, particularly those proficient in French: collaborative efforts with French centers will be sought to facilitate the collection of pertinent data, contributing to the comprehensive nature of our study and further enhancing its relevance. This will be necessary to optimize the diagnosis of cognitive impairment in bilinguals which constitutes a growing concern. Additionally, it would be beneficial to explore in future studies whether the advantage observed with the MMSE in our current research extends to other pathologies. Such an investigation could further contribute

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to our understanding of cognitive assessments in diverse linguistic and clinical contexts, potentially leading to more nuanced and effective diagnostic tools.

Data availability. The data that support the findings are stored at Laboratoire de Neurosciences Fonctionnelles et Pathologiques (LNFP) UR UPJV 4559 in Amiens (France) and may be shared by the corresponding author upon reasonable request.

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H.A. contributed to the study design and revised the manuscript.

O.G. conceived and designed the study, analyzed the data, provided critical feedback and revised the manuscript.

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