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Accounting for ethnic-cultural and linguistic diversity in neuropsychological assessment of patients with drug-resistant epilepsy: A retrospective study

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ABSTRACT

Neuropsychological assessment is critical in both diagnosis and prognosis of patients with epilepsy. Beyond electrophysiological and anatomical alterations, other factors including different ethnic-cultural and linguistic backgrounds might affect neuropsychological performance.

Only a few studies considered migration and acculturation effects and they typically concerned nonclinical samples.

The current study aimed at investigating the influence of ethnic background and time spent in Italy on a full neuropsychological battery administered to both Italian and foreign-born patients and at providing a brief interview for obtaining relevant information on each patient's transcultural and language-related history.

Clinical reports from 43 foreign-born patients with drug-resistant epilepsy were collected from the archives of Milan Niguarda Hospital. Epileptogenic zone, age, education, profession, illness duration, seizure frequency, handedness, and gender were considered in selecting 43 Italian controls.

Ethnicity (Italian/foreign-born) and years spent in Italy were analyzed as main predictors on 21 neuropsychological scales by means of General(ized) Linear Models. An additional analysis studied two composite scores of overall verbal and nonverbal abilities.

Ethnicity significantly affected the following: the verbal overall score, Verbal Fluency, Naming, Token-test, Digit Span, Attentional Matrices, Trail-Making-Test, Line-Orientation-Test, and Raven matrices; no effects were found on the nonverbal overall score, Word Pairs Learning, Episodic Memory, reading accuracy, visual span, Bells test, Rey Figure, and face memory and recognition. No significant effects of years spent in Italy emerged.

While years spent in Italy does not predict neuropsychological performance, linguistic background had a strong impact on it. With respect to Italian-speaking patients, those who were foreign-born showed large task-related variability, with an especially low performance on language-related tests. Hence, language tests should not be considered as valid measures of neuropsychological impairment in this population, not even in foreign-born patients with good Italian fluency. Clinicians should consider such asymmetries in order to improve the accuracy of neuropsychological assessment of foreign-born patients.

1. Introduction

Over the past few decades, migratory flows of people have been increasing all over the world; 8.1% of the Italian population are foreign-born [1]. As a consequence, clinicians are routinely dealing with ethnic and linguistic diversity. Neuropsychological assessment is crucial in defining diagnostic and prognostic outcomes of patients with drug-resistant epilepsy (DRE) [2] and to investigate how electrophysiological and anatomical cerebral alterations modulate cognitive functions. Although these two components seem to be the most relevant in inducing neuropsychological impairments, there are several other variables to consider e.g., the diverse ethnic, cultural, and linguistic

Abbreviations: DRE, drug-resistant epilepsy; ROCF, Rey-Osterrieth Complex Figure; TMT-A, Trail Making Test-A; ILAE, International League Against Epilepsy; FGB, foreign-born group; ICG, Italian control group; EZ, epileptogenic zone; YI, years in Italy; VIF, variance inflation factor; JLO, Judgment of Line Orientation; TMT-B, Trail Making Test-B; CSRMT, Camden Short Recognition Memory Test; CPM, Colored Progressive Matrices; GLM, General Linear Model; GzLM, Generalized Linear Model; FW, forward; BW, backward; WPL, Word Pairs Learning; IF, Italian fluency; Corsi SS, Corsi Sovraspan; BFR, Benton Facial Recognition; L1, mother tongue; L2, L3, second languages.

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background [3,4], which might affect the patients' performance on neuropsychological testing. The effects of bilingualism on neuropsychological performance have primarily been studied; for instance, lower scores on verbal tests (Verbal Fluency and Naming) were frequently observed in early bilinguals compared with monolinguals [5–7], although the assessed individuals typically showed very high fluency levels. However, most of these studies did not take into account the possible modulation by ethnicity and cultural factors, which might have induced some of the differences observed between international samples [8–10] and among the American main ethnic subgroups [11–13]. Furthermore, only a few studies were conducted considering the migratory contexts rather than the effect of bilingualism.

When comparing the performance of Caucasian-American groups with that of ethnic minority groups on verbal tests such as Verbal Fluency, Naming, Digit Span, Stroop test, and Similarities test, the latter showed lower scores despite their good fluency in English [14–16]. Interestingly enough, ethnic minorities also performed worse in some nonverbal tasks: ROCF (Rey-Osterrieth Complex Figure), TMT-A (Trail Making Test-A), and visual integration [16,17].

Brickman [3] suggested that although ethnicity does not directly impact on cognitive performance, it might influence the level of acculturation, which is very relevant in the assimilation process of individuals into a majority or dominant culture [5].

The debate is still open as to which factor weights the most on acculturation. The number of school-years carried out in the host country seems to be a significant predictor of cognitive test scores in ethnically diverse individuals [5,16,18,19], while the role of the time spent in the host country and language preference remains unclear [14–16,18].

To our knowledge, only one research studied and confirmed the impact of the extent of acculturation on nonverbal cognitive tasks in adult Latin-American patients with epilepsy who migrated to the U.S. [20].

In the current study, cognitive test scores of 86 patients, 43 Italians, and 43 immigrants, diagnosed with DRE and assessed during the presurgical stage were collected from the archives of Niguarda Hospital in Milan. The immigrant group was characterized by different ethnic backgrounds, allowing a broader generalization to the heterogeneous set which is typical in clinical practice.

A multiple regression analysis allowed us to study the influence of different ethnic backgrounds and of time spent in Italy on a full neuropsychological battery, compliant with ILAE (International League Against Epilepsy) guidelines [21] as it includes internationally adopted cognitive tasks. We aimed at identifying which tests are less affected by ethnic, cultural, and linguistic diversity, hence, suggesting ways of improving the current approach to the neuropsychological evaluation of foreign-born patients.

As a final step, we developed a brief interview for collecting information about the patient's transcultural and linguistic history.

2. Material and methods

2.1. Participants

We accessed an initial set of 64 clinical reports from foreign-born patients with DRE from the archives of the Cognitive Neuropsychology Centre of Niguarda Hospital in Milan. All the data were retrospective and referred to the presurgical neuropsychological assessment.

The data collection was approved by the Ethics Committee of Milan Area C.

From the initial N = 64 sample, 21 patients were excluded because of young age (<15 years; N = 16), antipsychotic treatment (N = 1), low education (less than 3 years; N = 2), Intellectual Disability (N = 1), and uncertain epileptic diagnosis (N = 1). After this selection, we had presurgical clinical reports and neuropsychological test scores from 43 foreign-born patients with epilepsy. This will be referred to as the foreign-born group (FBG).

We aimed at collecting a control sample of 43 Italian monolingual patients (Italian control group, ICG), taken from the same database and years, that was as close to the FBG as possible in terms of the distributions of the following: hemisphere and lobe of epileptogenic zone (EZ), seizure frequency, illness duration, gender, age, education, profession, and handedness. To achieve such a matching, we took each foreign-born patient and searched in the database for the Italian patient who was closest to him/her in terms of the maximum number of the above variables; the group-level matching result was very close and satisfactory (see Table 2). This allowed us to obtain highly reliable covariation for those variables in the statistical design.

2.2. Neuropsychological test battery

The neuropsychological battery assessed a broad set of cognitive skills, consistent with the ILAE guidelines [21]: lexical access, reading, verbal comprehension, verbal and visuospatial memory, perceptual and visuoconstructive skills, visual exploration, attention, executive functions, and abstract reasoning.

Test descriptions and number of completed tasks are reported in Table 1. Test standardizations are available in the online version of this article (Supplementary material).

2.3. Statistical analyses

Our aim was to study the influence of ethnic-cultural variables on neuropsychological outcome (dependent variables). As a consequence, ethnicity (Italian/foreign-born) was used as a main predictor, with Years in Italy (YI), age, education, gender, illness duration (time since epilepsy onset), and EZ hemisphere as covariates. In this way we could tell pure effects of ethnicity from possible differences in those nuance variables.

We preliminarily ascertained that correlations between predictors did not produce important multicollinearity problems: indeed the VIF parameter (Variance Inflation Factor) never exceeded 1.24, thus providing evidence for a low level of collinearity.

As a second step, we analyzed the shape of the distributions of the 21 outcome variables. Many of these (13) showed gross violations of the

Table 1
Neuropsychological battery.

	Tests		N FBG	N ICG	Main cognitive skills involved
Verbal	Verbal Fluency	Phonemic	40	43	Lexical organization and access, executive functions
		Semantic	40	43	
	Naming		34	35	Lexical access through visual presentation
	Token test		36	35	Verbal comprehension
	Reading accuracy		24	17	Grapheme–phoneme conversion accuracy
	Forward Digit Span		42	43	Short–term verbal memory
	Backward Digit Span		39	32	Verbal working memory
	Word Pairs Learning		37	42	Associative learning and anterograde verbal memory
	Episodic Memory		37	43	Episodic verbal memory
	TMT	TMT–B	35	42	Sustained and divided attention, processing speed, planning and flexibility
Non–verbal		TMT–A	40	42	Sustained attention and processing speed
	Bells test		31	14	Visual exploration, selective attention
	Attentional Matrices		40	43	Sustained and selective attention, exploration speed
	Corsi Span		41	43	Short–term visuospatial memory
	Corsi Supra–span		30	37	Long–term visuospatial memory and learning
	ROCF	Copy	41	43	Visuo–constructive skills, visuo–motor planning
		Recall	39	43	Long–term visuospatial memory
	CSRMT		32	22	Memory for faces
	BFR		26	29	Face recognition
	Judgement of Line Orientation		30	37	Perceptualand visuospatial skills, orientation matching
	Raven CPM		41	43	Deductive and inductive abstract reasoning

Number of completed tasks and verbal / non-verbal cognitive skills involved are reported for each test of the full neuropsychological battery. Test standardizations are available in the online version of this article (Supplementary material). FBG: foreign-born group; ICG: Italian control group; TMT: Trail Making Test; ROCF: Rey-Osterrieth Complex Figure test; CSMRT: Camden Short Recognition Memory Test for Faces. BFR: Benton Facial Recognition test; Raven CPM: Raven Coloured Progressive Matrices.

Table 2
Demographic and diagnostic data.

		FBG	ICG
Age (years)	Mean	27.07	26.84
	SD	8.56	7.93
Gender	Male	22	20
	Female	21	23
Education	Mean	11.70	11.60
	SD	2.85	2.73
Years in Italy (YI)	Mean	9.20	/
	SD	5.09	
Epileptogenic zone	Right	23	23
	Left	20	20
Illness duration (months)	Mean	153.56	131.02
	SD	119.86	87.62
Seizure frequency	Annual	6	4
	Monthly	16	15
	Weekly	14	15
	Daily	6	9

Demographic and diagnostic data are summarized. Years in Italy (YI) were available for 37 out of 43 FBG patients. One seizure frequency datum was unavailable in the FBG. FBG: foreign-born group; ICG: Italian control group; YI: years spent in Italy.

normality assumption; in some cases (5: Phonemic Fluency, Semantic Fluency, Judgment of Line Orientation (JLO), TMT-A, TMT-B), the shape was asymmetric and/or leptokurtic, but the shape was, in general, rather regular; in some other cases (8: Naming, Token test, reading accuracy, ROCF-copy, Camden Short Recognition Memory Test for faces (CSRMT), Bells test, Raven Colored Progressive Matrices (CPM) Attentional Matrices), there were also significant density at ceiling or floor values. Regular shapes (i.e., no floor/ceiling effects) were normalized by means of logarithmic transformations (leading to close-to-zero skewness and kurtosis indices) and where then treated as close-to-Gaussian distributions (General Linear Model, GLM); irregular shapes were left untransformed and entered a Generalized Linear Model (GzLM) with Tweedie distribution and log-link. This latter analysis allows one to study the effect of many simultaneous predictors, even though significant accumulation points characterize the distribution [22].

A first round of GLM/GzLM analyses was run with the whole set of 86 patients, using ethnicity, age, education, gender, illness duration, and EZ hemisphere as predictors and each of the 21 outcome variables as measures. A second round of GLM/GzLM had the purpose of studying possible effects of YI on FBG patients ($N = 43$) — hence, we gave up ethnicity in these additional analyses.

As a third step, we asked whether the nature of the task, verbal vs nonverbal, has a significant impact on performance. Indeed, one might expect FBG to show a lower performance profile on the former. To do so, we needed to obtain an overall score of verbal ability to be compared with an overall score of nonverbal ability. Such overall scores were obtained by combining scores from different scales, trying to maximize the number of component scales and the number of patients who performed all of them. A good compromise was reached with five verbal tests (Verbal Fluency, Forward (FW) and Backward (BW) Digit Span, Word Pairs Learning (WPL), Episodic Memory) plus six nonverbal tests (visuospatial span, ROCF copy and recall, Attentional Matrices, Raven CPM and TMT-A), which were performed by 74 patients: 41 ICB, and 33 FBG. In order to standardize the scales before averaging them into the overall scales, each score was transformed in the rank out of the overall $N = 74$ set.

As a last step, we investigated whether a possible "deficit" on TMT-B by FBG was due to insufficient knowledge of the Latin alphabet by some of the foreign patients. We divided the set of FBG patients who performed the task ($N = 35$) according to the alphabet roots of their language, i.e., patients whose L1 alphabet derived from the Latin one (e.g., French, Romanian, Albanian, Spanish; $N = 26$) and patients whose L1 was not Latin-rooted (e.g., Russian, Bosnian, Arabic, Greek; $N = 9$); a GLM was used to test for significant effect of alphabet roots (Latin/non-Latin) covarying for, age, education, duration, gender, EZ hemisphere, and YI.

SPSS package [23] was used for all analyses.

3. Results

3.1. Descriptive statistics

Demographics and diagnostics from the full sample are reported in Table 2, along with neuropsychological test average scores (Table 3).

As for the exact origin of our FBG patients, 11 were born in Balkan countries (Albania, Bosnia-Herzegovina, Bulgaria, Croatia, and Greece), 11 in Eastern Europe (Romania, Russia, Moldavia, and Ukraine), six in Northern Africa (Morocco, Egypt, and Tunisia), six in Latin America (Ecuador, Argentina, Colombia, Guatemala, Peru), five in Western Europe (Germany, France, and Portugal), two in Central America (Guatemala and El Salvador), one in South Africa, and one in an Indian area (Bengal). The most frequent first languages learned (L1) were Spanish (eight patients), Albanian (seven patients), Arabic (six patients), and Romanian (seven patients). The remaining 15 patients spoke French, English, German, Russian, Bengali, Bosnian, Bulgarian, Greek, Moldavian, Portuguese, or Ukrainian as their L1.

Italian fluency (IF) was assessed by means of four qualitative categories: Good/Excellent IF ($N = 19$), sporadic difficulties in verbal comprehension and/or production ($N = 14$), limited IF ($N = 6$), and very limited IF ($N = 4$). Patients with very limited IF typically could not fulfill the test battery or were helped by a cultural mediator.

Epileptogenic zone was defined on grounds of surgery data. In the FBG, 20 patients had EZ in the left hemisphere (15 temporal, 1 frontotemporal, 3 frontal, 1 parietal). Twenty-three patients had EZ in the right hemisphere (13 temporal, 3 frontal, 2 parietal, 2 in the insular–opercular area, 2 parietotemporal, 1 frontotemporal).

Similarly to the FBG, the ICG 20 patients had left partial epilepsy (15 temporal, 1 frontotemporal, 3 frontal, 1 parietal). Twenty-three Italian patients had right partial epilepsy (13 temporal, 4 frontal, 2 parietal, 1 in the insular–parietal area, 1 parietotemporal area, 1 temporooccipital, 1 frontotemporal).

3.2. GzLM and GLM

From the first set of analyses, significant main effects of ethnicity were found for Phonemic and Semantic Fluency, Naming, Token test, FW and BW Digit Span, Attentional Matrices, TMT-A, TMT-B, JLO, and Raven CPM (Table 3). Among the significant interaction effects involving ethnicity, some were quite interesting in their own right. On Corsi SS (ethnicity $*$ gender, $t(45) = -3.206$, $p = 0.002$) and ROCF-recall (ethnicity $*$ gender, $t(60) = -2.068$, $p = 0.04$), a disadvantage for FBG only appeared among women; on Raven CPM, while FBG made globally more errors than ICG, EZ-hemisphere had opposite effects in the two groups: while foreign-born left-hemisphere-EZ patients performed worse than right-hemisphere-EZ ones, the opposite held true for Italian patients (ethnicity $*$ EZ hemisphere, $\text{Wald}(1) = 8.328$, $p = 0.004$).

No significant effects of YI were found on any of the outcome variables (Table 3). However, on some tests, an interesting increase of variance with YI was found in spite of a stable average performance; such increase was obvious on the Token test (correlation between YI and absolute deviation from the regression line was the following: Phonemic Fluency, $r(34) = 0.349$, $p = 0.043$; Token, $r(31) = 0.597$, $p < 0.001$; TMT-B, $r(32) = 0.391$, $p = 0.027$). These were not an artifact of the correlation of YI with Age, as correlations of absolute deviation from regression with Age were nonsignificant (if anything, score variance *decreased* with Age, on BW Digit Span and WPL).

The main effect of ethnicity on the ranked verbal overall score turned out to be significant ($t(67) = -3.682$; $p < 0.001$). Conversely,

Table 3
Results on the neuropsychological tests.

Neuropsychological test scores			Ethnicity main effect		YI main effect	
	FBG Mean SD	ICG Mean SD	t/Wald (df) p value	CI 95% Lower Upper	t/Wald (df) p value	CI 95% Lower Upper
Phonemic fluency	20.77	27.58	t(61) = −3.775	−0.110	t(27) = 0.569	−0.008
	7.80	*9.89*	p < 0.001**	−0.034	p = 0.57	0.014
Semantic fluency	28.97	35.21	t(61) = −3.550	−0.133	t(27) = −0.800	−0.022
	8.53	*8.35*	p = 001*	−0.037	p = 0.43	0.010
Naming	19.06	21.97	Wald(1) = 15.913	0.303	Wald(1) = 1.126	−0.106
	3.85	*2.66*	p < 0.001**	0.889	p = 0.29	0.031
Token test	32.03	33.34	Wald(1) = 4.727	0.021	Wald(1) = 1.187	−0.097
	3.03	*2.23*	p = 0.03*	0.407	p = 0.28	0.028
Reading accuracy	5.35	4.29	Wald(1) = 0.944	−0.145	Wald(1) = 1.148	−0.107
	4.11	*4.47*	p = 0.33	0.430	p = 0.28	0.031
Forward Digit Span	4.88	5.67	t(63) = −4.046	−0.739	t(29) = −0.224	−0.083
	1.02	*1.11*	p < 0.001**	−0.250	p = 0.82	0.067
Backward Digit Span	3.74	4.19	t(49) = −2.957	−0.596	t(26) = 0.762	−0.041
	1.02	*0.93*	p = 0.005*	−0.114	p = 0.45	0.088
WPL	11.89	11.68	t(57) = 0.854	−0.517	t(26) = 0.350	−0.247
	3.64	*4.16*	p = 40	1.285	p = 0.73	0.348
Episodic Memory	11.51	11.93	t(58) = −0.001	−0.921	t(25) = 0.572	−0.255
	4.43	*4.07*	p = 0.99	0.920	p = 0.57	0.452
Corsi Span	4.83	4.74	t(62) = −0.696	−0.282	t(29) = 0.460	−0.047
	0.86	*1.16*	p = 0.49	0.136	p = 0.649	0.074
Corsi Supra-span	17.24	19.31	t(45) = −0.286	−2.005	t(20) = 0.961	−0.301
	7.90	*5.63*	p = 0.78	1.507	p = 0.35	0.815
ROCF-copy	32.91	33.06	Wald(1) = 0.444	−0.161	Wald(1) = 3.144	−0.008
	3.16	*3.32*	p = 0.505	0.326	p = 0.08	0.160
ROCF-recall	18.33	19.02	t(60) = −1.094	−2.150	t(27) = −0.337	−0.503
	5.68	*7.74*	p = 0.28	0.630	p = 0.74	0.361
CSRMT	22.56	23.27	Wald(1) = 1.440	−0.149	Wald(1) = 1.010	−0.193
	2.71	*1.93*	p = 0.23	0.621	p = 0.31	0.062
Bells test	33.68	33.50	Wald(1) = 0.550	−0.428	Wald(1) = 0.592	−0.193
	1.66	*2.38*	p = 0.46	0.949	p = 0.44	0.084
Attentional Matrices	51.97	54.58	Wald(1) = 5.235	0.030	Wald(1) = 0.024	−0.053
	6.32	*5.28*	p = 0.022*	0.386	p = 0.88	0.045
TMT-A	49.52	42.12	t(60) = 2.567	0.044	t(28) = 0.118	−0.048
	25.73	*23.34*	p = 0.01*	0.355	p = 0.907	0.054
TMT-B	130.11	99.60	t(55) = 3.227	0.093	t(25) = −0.680	−0.055
	65.31	*57.18*	p = 0.002*	0.398	p = 0.50	0.028
Judgment of Line Orientation	23.80	24.86	t(45) = 2.211	0.013	t(19) = 0.481	−0.023
	3.52	*4.51*	p = 0.03*	0.273	p = 0.64	0.037
BFR	47.08	44.27	t(33) = 1.322	-0.593	t(16) = −0.704	−0.531
	4.45	*4.85*	p = 0.19	2.791	p = 0.492	0.267
Raven CPM	29.36	30.70	Wald(1) = 10.047	0.103	Wald(1) = 1.600	−0.144
	6.08	*5.51*	p = 0.002*	0.438	p = 0.21	0.025

Raw score means and standard deviations are reported for all neuropsychological tests, separately for FBG and ICG, along with ethnicity and YI main effects (General Linear Model or Generalized Linear Model). FBG: foreign-born group; ICG: Italian control group; WPL: Word Pairs Learning; TMT: Trail Making Test; ROCF: Rey-Osterrieth Complex Figure test; CSMRT: Camden Short Recognition Memory Test for faces. BFR: Benton Facial Recognition test; Raven CPM: Raven Colored Progressive Matrices.

* p < .05.

** p < .01.

no significant effects of ethnicity on the ranked nonverbal overall score were observed ($t(67) = -1.751$; $p = 0.08$).

Latin-alphabet subgroup average score on TMT-B was 127.56 (SD = 50.99), whereas non-Latin alphabet subgroup average score was 131 (SD = 70.46). There were no significant main effects of alphabetic roots resulted on TMT-B outcome ($F(3) = 0.737$; $p = 0.45$).

4. Discussion

To our knowledge, this is the first study comparing foreign-born and native patients with DRE aimed at finding out which neuropsychological tests the clinician could rely on when assessing ethnically and linguistically diverse individuals.

Our study estimated the effect of ethnicity in 86 patients with DRE partialling out many confounding effects, like age, education, gender, illness duration, and affected hemisphere. It might be argued that education, which is trivially measured in number of school years, does not reflect equal degree and intensity of exposure to educational input in different countries; hence, foreign-born patients might have additional difficulties with respect to Italian controls not because of cultural/linguistic factors but because they might have received less intense education even with an identical number of school years. However if this had been the case, we would have found a disadvantage on all tests; as we could observe, this was definitely not the case, thus excluding the inappropriateness of the education scale as the only explanation.

The analysis of overall scores of verbal and nonverbal ability showed that FBG was disproportionately impaired on the verbal scale with respect to ICG, while no difference could be detected on the nonverbal scale; such a result demonstrated an overall (and expected) disadvantage for foreign patients on grounds of their diverse linguistic backgrounds. However, language in itself was not the only relevant variable: other cultural background factors must have been responsible for the differences between ICG and FBG which we found on nonverbal tasks. Hence, a good fluency in Italian, and, in general, in the hosting-country language, does not guarantee complete validity of a neuropsychological test battery.

Years in Italy (YI) failed to produce a significant impact on the average score in any task. This failure is unlikely to be just an effect of

Table 4
Further recommendations.

Task	Recommendations
Verbal fluency	Double administration (in both spoken languages) could be useful on a qualitative level. It is advisable to start with L1 administration if it is clearly dominant, to minimize facilitation effects.
Naming	Double administration (in both spoken languages) could be useful on a qualitative level to disentangle lexical access deficits from limited vocabulary effects or other cultural influences.
TMT-B	Sequencing automatism in Latin-derived alphabets should be taken into account.
Reading accuracy	Orthographical depth of the administration language has to be considered. This index may be less reliable for deeper orthographies such as the English one.
Corsi Supra-span and ROCF-recall	Long-term visuospatial memory tasks turned out to be less valid in assessing foreign-born women.
Face memory and recognition	Examiner should consider possible *own-race bias,* which was described in previous studies [24]. Such an effect could not be investigated in the current study because items were all pictures of Caucasian individuals (as were most of our participants).

TMT: Trail Making Test; ROCF: Rey-Osterrieth Complex Figure test.

statistical power, since N = 43 cannot be regarded as a small sample size, and especially, given that the effect was null on each and every test. One possible explanation is that the highest possible level of cognitive performance is already achieved after a few months of living in Italy and that no further sizeable improvement occurs over time. From another perspective, positive and negative effects linked to YI might cancel each other out, e.g., learning of the hosting language/culture on the positive side, and marginalization, ghettoization, and many sources of social discrimination linked to the phenomena of mass immigration on the negative side. While we still lack a direct demonstration, we do have indirect evidence that this might indeed be the case. On three tests, and obviously so on the Token test, while average performance of the FBG did not vary with YI, score variance did increase with YI. Hence, patients who had been in Italy for a short time had homogeneous scores, while patients with a long stay in Italy had very variable scores. This is fully compatible with the idea that there are different trajectories in different subjects, with a positive evolution in some (possibly reflecting good social integration) and a negative one in others (possible reflecting the downside of immigration, i.e., ghettoization, marginalization etc.). This is a very interesting issue, deserving further work, especially in search for objective means of measuring degree of social integration. Anyhow, our provisional conclusion, consistent with some previous studies [15,18,19], is that YI alone is not likely to give an accurate representation of the extent of acculturation; more refined statistics are required.

When looking at specific test scores, foreign-born patients achieved poorer Verbal Fluency, FW and BW Digit Span, Token test, Naming, JLO, TMT, Attentional Matrices, and Raven CPM scores compared with Italians. By contrast, no differences emerged on WPL, reading accuracy, Episodic Memory, Bells test, Corsi Span and SS, ROCF, BFR, and CSRMT. Thus, this latter set of tests can safely be regarded as valid cognitive assessment tools for ethnic-minority patients with epilepsy. An interpretation of such a profile can be proposed by assuming that lexical access through phonemic, semantic, and visual cueing was influenced by ethnicity, probably due to cross-language interference as well as vocabulary-size effects [6,7,25]. In bilingual subjects, lexical activation occurs in both spoken languages, entailing nonrequested words to be actively inhibited and response times to increase. Syntactic comprehension performance on Token test was likewise influenced by ethnicity.

Foreign-born group verbal short-term and working memory spans were smaller compared with ICG, consistent with previous studies [15,16]. It is likely that in less-fluent foreign-born individuals, cognitive resources are addressed to digit processing in addition to the retrieval process itself.

Time-dependent selective and sustained attention tasks (Attentional Matrices and TMT) were negatively impacted by ethnic diversity. The examiner's request to perform the task in a fast way might be perceived as unfamiliar and judged as inappropriate in many cultures; speed might indeed be perceived as an irrelevant component of a task [17,26].

Over and above these remarks, TMT-B also requires accurate knowledge of the Italian alphabetic sequence [27]. This might explain the larger disadvantage that foreign-born patients showed on TMT-B (+31% of processing time with respect to Italians) than on TMT-A (+18%): indeed, the latter task does not require alphabetic knowledge. However, within FBG, we failed to find differences of TMT-B performance between patients whose mother tongue's alphabet was Latin or non-Latin. Hence linguistic knowledge is unlikely to be the critical factor here: a culturally-related stress on accuracy rather than on speed is likely to have a role.

Some previous studies revealed discrepancies among ethnic groups in visual tasks [16,28,29]. In the current research, ethnic-minority disadvantage involved JLO but not ROCF tasks. One might hypothesize that, although both task types are based on visual abilities, the Rey Figure may be perceived as simpler and more familiar compared with the JLO patterns that represent more abstract visual-perceptual stimuli.

Score differences among ethnic groups on Raven Progressive Matrices were ascribed in other studies to actual differences in abstracting skills, perhaps due to the adverse effects of discrimination, socioeconomic and educational disadvantage [30]. Other authors [31,32] suggested that Raven Matrices may contain elements that benefit one ethnic group more than another one. Inductive reasoning is part of formal education in Western Countries where children are more exposed

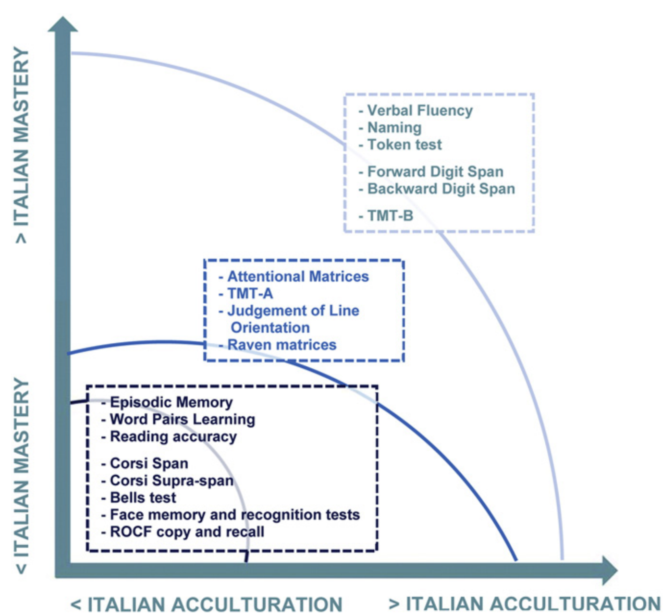

Fig. 1. Visual summary of test validity in the neuropsychological assessment of patients with epilepsy. Increasing Italian-acculturation degree and Italian mastery are represented on X and Y respectively. The most valid tasks, which require lower acculturation and mastery levels, are reported in dark blue. Nonverbal tasks, whose (in)validity depends on cultural factors, require a higher level of acculturation and are reported halfway through the plot. Verbal invalid tasks are likely influenced by both Italian mastery and acculturation: these are reported in light blue. Further recommendations for some tests are proposed in Table 4. TMT: Trail Making Test; ROCF: Rey-Osterrieth Complex Figure test. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

NAME	EXAMINER	DATE

Ethnic-linguistic background and Italian acculturation structured interview

Cross-cultural demographic data and ethnic identity

Country and birthdate		
Residence		
Citizenship		
Age on arrival in Italy		
Cultural bonds	0 - Full identification with original culture 1 - Prevalent identification with original culture 2 - Half way between original and Italian culture 3 - Prevalent identification with Italian culture 4 - Full identification with Italian culture	
Education level	Total years:	In the country of origin:
		In Italy:
		In other Countries:

Linguistic anamnesis

First language learned			
Second languages learned	L2		L3
Systematic, continuous and intensive L2/L3 exposure	L2	Age:	Background:
	L3	Age:	Background:
Self-assessment of Italian comprehension and production skills (0-10).	Spoken Italian		Written Italian
	comprehension		comprehension
	production		production
Preferred language			
Frequency (0-4)* and background of spoken language use	L1	Frequency:	Background:
	L2	Frequency:	Background:
	L3	Frequency:	Background:

*0=never; 1=almost never (less than once a week); 2= sometimes (less than once a day); 3=often (more than once a day); 4=always

Clinical observation

Italian mastery (0-4)*		
Instruction comprehension (0-4)*		
Bilingualism profile	Early (< 7 y.o.)	Late
	Simultaneous	Consecutive
	Balanced	Dominant

*0=totally lacking; 1=partially lacking; 2=sufficient; 3=good; 4=complete; U=unrevealed

Non-administered tests due to linguistic and cultural diversity

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Fig. 2. Ethnic-linguistic background and Italian acculturation structured interview.

to problem analysis and are taught to abstract a general conclusion from data. Furthermore, in a large-scale international meta-analysis, Raven Matrices performance related to an “educational permeation index” including educational input and output factors, which in turn was associated with socioeconomic development of a particular country [31]. From this perspective, FBG disadvantage in Raven CPM may be the consequence of lesser exposure to specific reasoning styles and approaches to problem solving rather than due to pathology. Interestingly in our sample, FBG with left-hemisphere involvement showed impairment with respect to those with right-hemisphere involvement; the opposite held true among Italians; this suggests different strategies (verbalization by FBG and visuospatial reasoning in ICG), another instance of radical cultural differences.

However, not all tests were sensitive to ethnicity. Some verbal and nonverbal cognitive tests proved immune to such a factor, hence providing valuable tools for diagnosing epilepsy-related cognitive dysfunction in spite of possible social and cultural differences. Firstly, clinicians can evaluate long-term verbal memory by means of WPL and Episodic Memory tests. Both tests are characterized by semantic and episodic links that, together with repeated exposure to items, facilitate content processing, compared with the Digit Span test which uses a single presentation of stimuli that are devoid of semantic links. These features make WPL and Episodic Memory tests similar to the primary school tasks shared even by distant educational systems.

Reading accuracy performance was also free from an effect of ethnicity; this likely reflects the Italian language's shallow orthography [33], so this test can be used to assess grapheme–phoneme conversion skills.

Corsi Span, Corsi SS, and ROCF-recall tasks turned out to be valid measures of visuospatial short- and long-term memory, consistent with previous studies [5,8,14,16]. Nevertheless, gender and ethnicity interacted in determining both ROCF-recall and Corsi SS performance: foreign-born women achieved poorer scores compared with other groups, possibly because of the *stereotype threat*. According to this notion, culturally-shared negative stereotypes about a social group tend to induce its members to confirm those stereotypes [34]. Previous studies showed that visuospatial performance of ethnically-diverse women, which belong to a “double-minority group”, was likely to be reduced when the stereotype threat was activated [35].

Finally, visual-constructive and visual-exploration tasks, as well as face recognition and memory tests, proved suitable for foreign-born patient assessment.

A number of limitations of our study derive from its retrospective design; important variables such as language preference, abroad schooling, and Italian acquisition context, which all may contribute to explain outcome variability, are missing in some clinical reports. Considering these limitations, we have developed a brief and structured interview on linguistic and cultural history (10 min), which is reported in Fig. 2. Acculturation degree and linguistic background are investigated in the first two parts of the interview. The interviewer's observations are collected in the third part including report of nonperformed cognitive tests due to linguistic and/or cultural diversities. This interview should be administered both in the presurgical phase and on follow-up, in order to disentangle the effects of surgery from those related to improved linguistic and acculturation components, especially in younger patients.

The FBG was characterized by a relevant heterogeneity of ethnicity, cultural bonds, and L1 affinity with Italian. As a consequence, it is difficult to ascribe the performance variability we observed to any of these factors in particular.

5. Conclusions

In the current study, 43 foreign-born and 43 native patients with DRE were compared in order to investigate the influence of ethnic background and time spent in Italy on a full neuropsychological battery. Tests assessing verbal long-term and visual memory, reading accuracy, visual exploration, and face recognition proved suitable for foreign-born patients. Tests of verbal short-term memory, comprehension, lexical access, exploration speed, orientation matching, and abstract reasoning were less reliable (Fig. 1). Years spent in the host country after migration did not predict the neuropsychological outcome. We provided a brief interview aimed at obtaining relevant information on each patient's transcultural and language-related history (Fig. 2).

Test standardizations are available in the online version of this article. Supplementary data associated with this article can be found in the online version, at http://dx.doi.org/10.1016/j.yebeh.2016.09.011.

Conflict of interest

None of the authors has any conflict of interest to discolse.

Ethics statement

The work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). The study was approved by the Ethics Committee of Milan Area C.

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