Pathways to Global Neuropsychology

Pacific Northwest Neuropsychological Society

David J Schretlen

March 3, 2018

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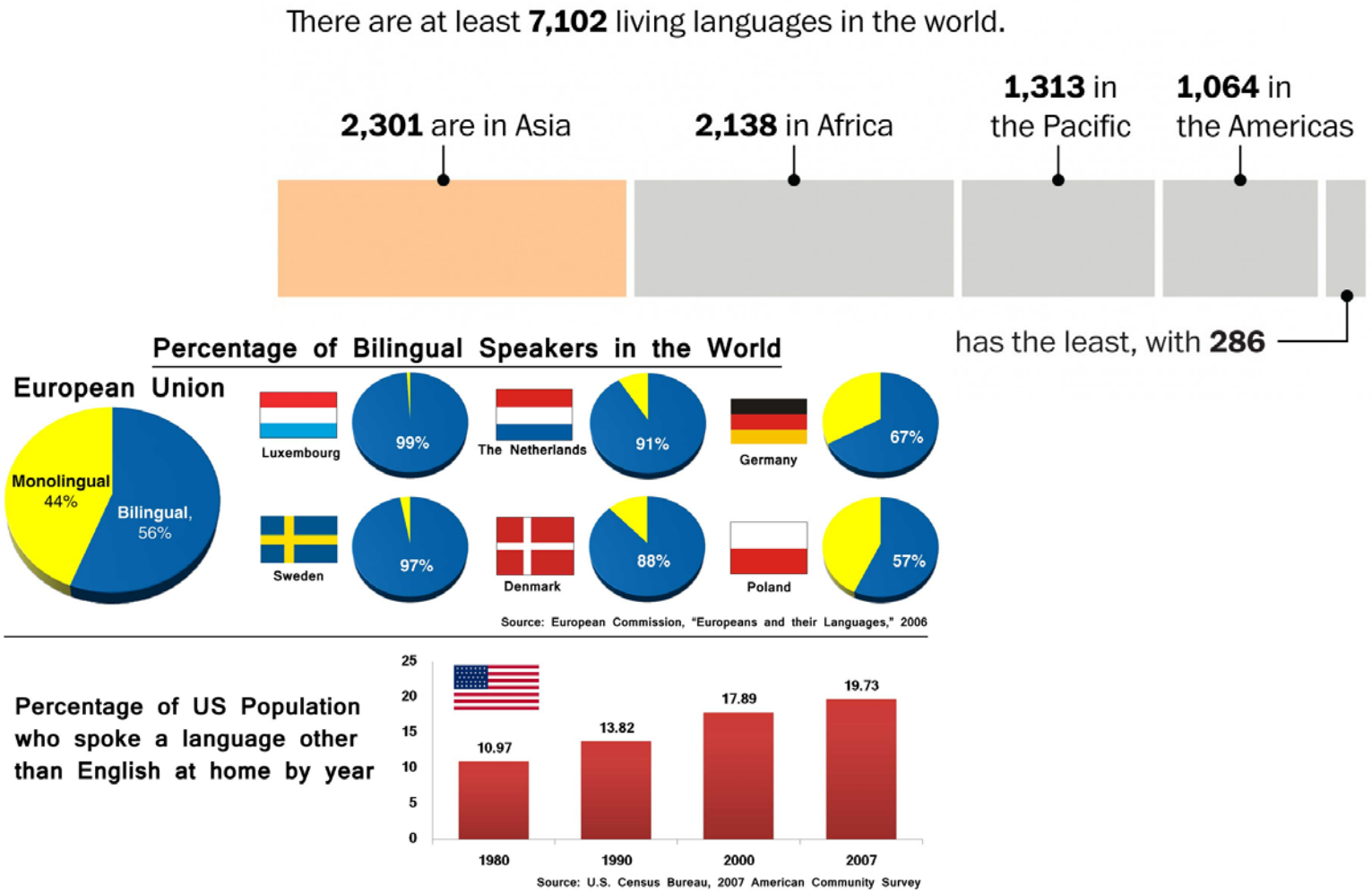
AACN
Relevance 2050

Worldwide language composition



Worldwide education disparities

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- Children from the wealthiest 20% of the world population are 4 times more likely attend school than the poorest 20%
- There were 61 million unenrolled primary school-age children in 2010
  - 47% were never expected to enter school
  - 26% attended school but left
  - 27% expected to attend school in the future

Population trends in the world

By 2050, ~7.8 billion people will be living in less developed regions vs. ~1.2 billion in more developed regions

- Most neuropsychological research comes from developed countries
- Our resulting knowledge base likely is incomplete, and may not adequately represent most people in the world
- The goals of Dr. Postal's Relevance 2050 initiative already have global implications
- Why?

The ubiquity of cognitive dysfunction in medicine

- Neurocognitive dysfunction accompanies hundreds of conditions that require treatment by almost every medical specialty
- It afflicts persons of either sex at any age and without regard for racial, ethnic, cultural, or linguistic background.
- “While the work of developing and standardizing new, reliable, and valid measures for different languages and cultures is demanding, it is essential if neuropsychology is to play an important role in other cultures and languages” (Yamada & Lamberty, 2015).

A meta-review of cognitive dysfunction across diseases and conditions

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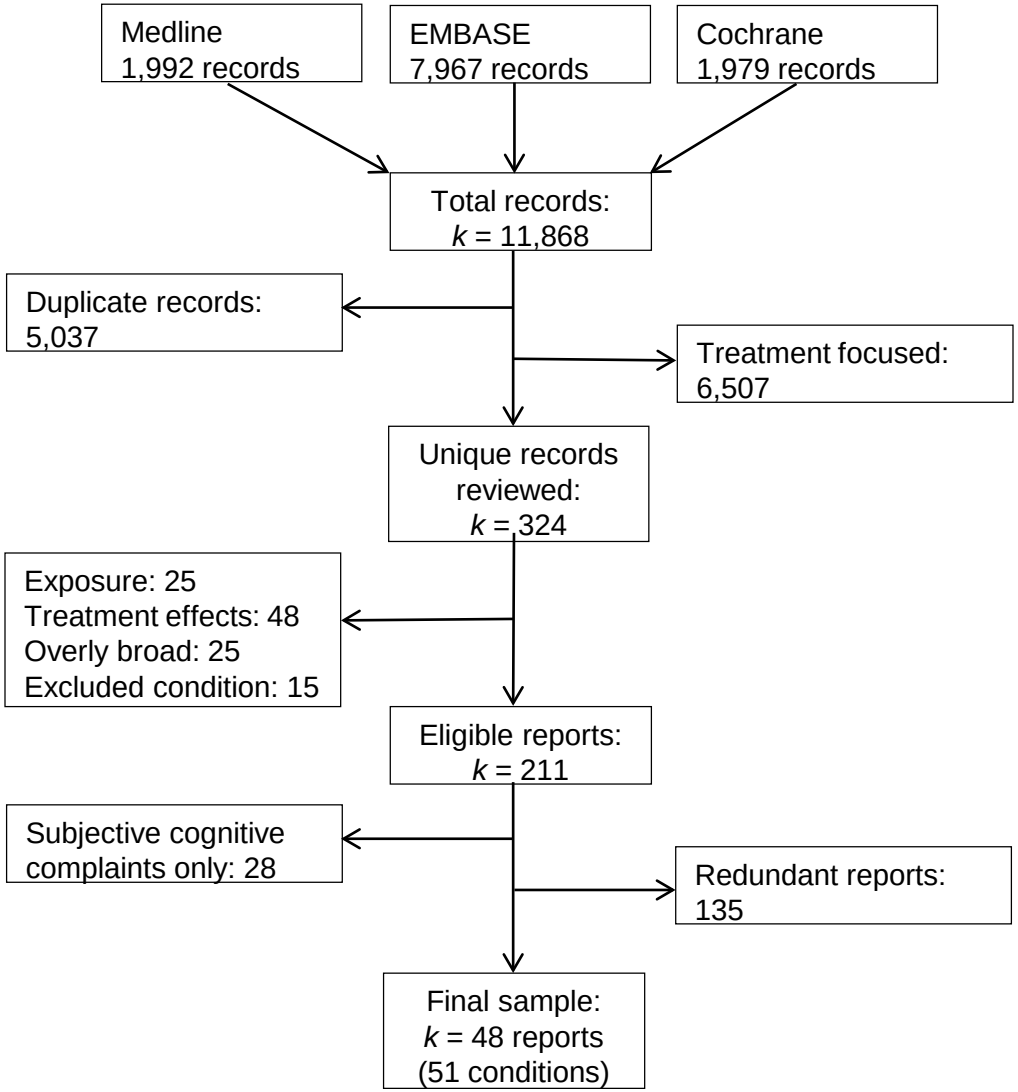
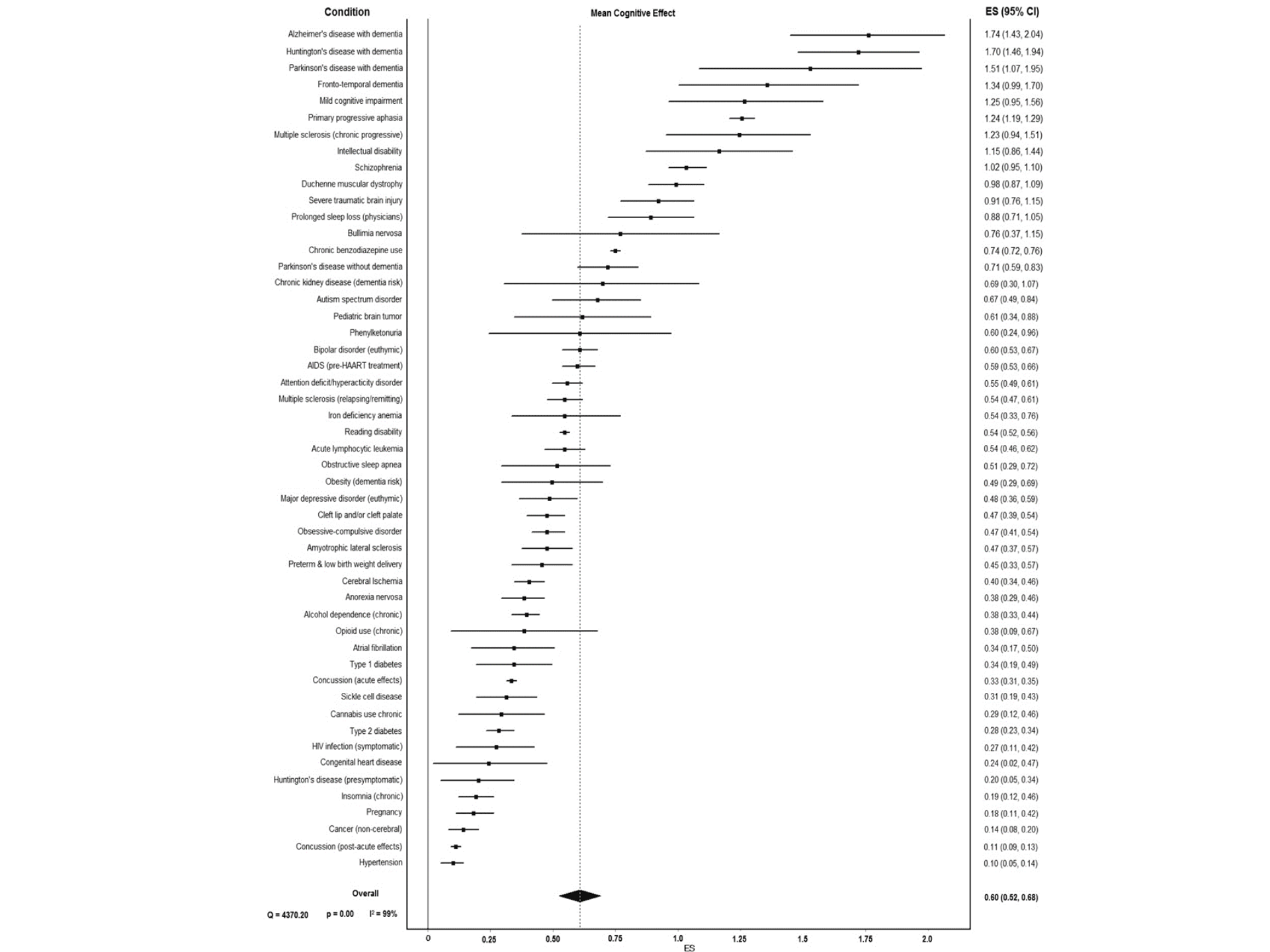
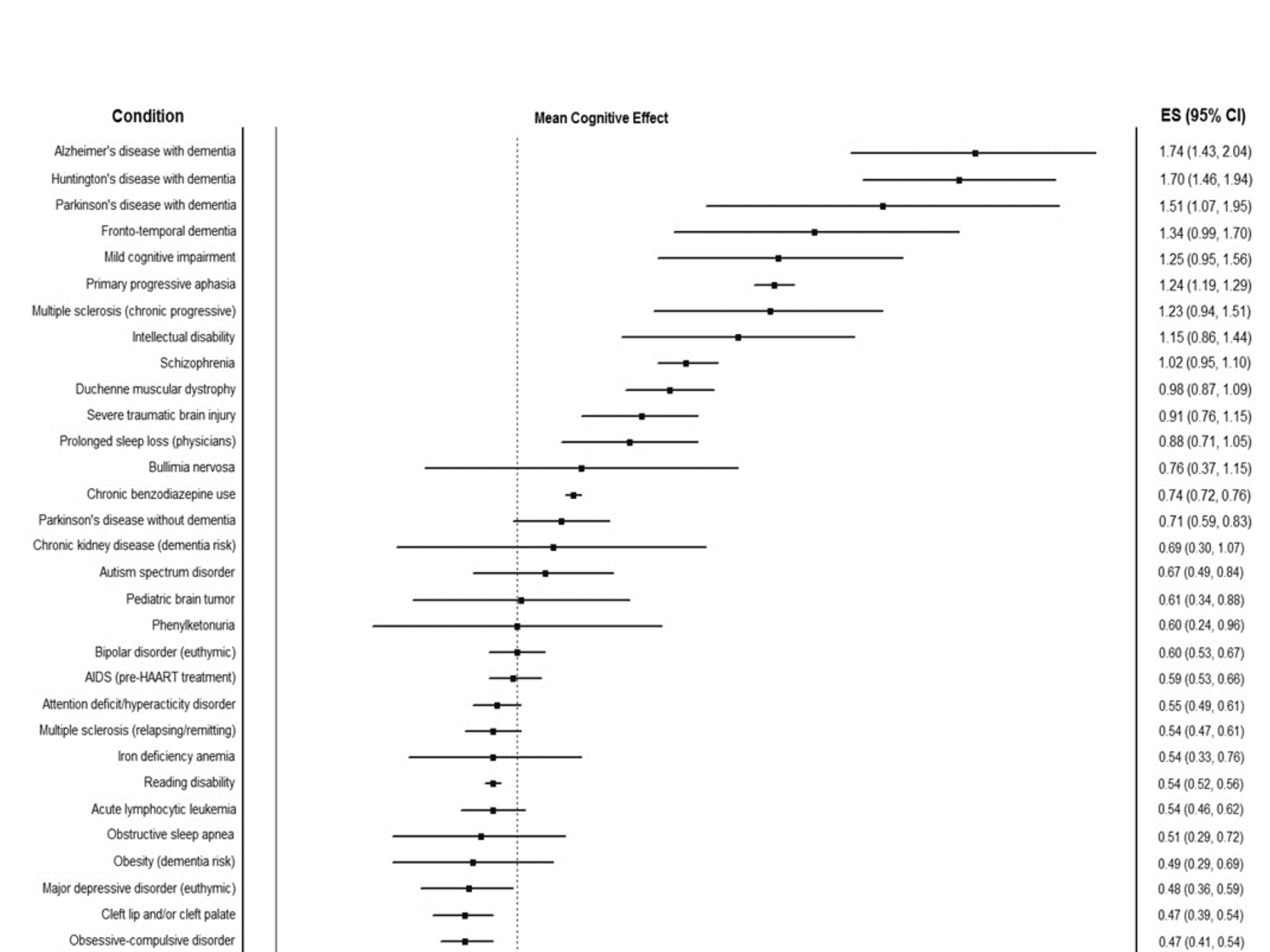



Condition
Mean Cognitive Effect
ES (95% CI)
Alzheimer's disease with dementia
1.74 (1.43, 2.04)
Huntington's disease with dementia
1.70 (1.46, 1.94)
Parkinson's disease with dementia
1.51 (1.07, 1.95)
Fronto-temporal dementia
1.34 (0.99, 1.70)
Mild cognitive impairment
1.25 (0.95, 1.56)
Primary progressive aphasia
1.24 (1.19, 1.29)
Multiple sclerosis (chronic progressive)
1.23 (0.94, 1.51)
Intellectual disability
1.15 (0.86, 1.44)
Schizophrenia
1.02 (0.95, 1.10)
Duchenne muscular dystrophy
0.98 (0.87, 1.09)
Severe traumatic brain injury
0.91 (0.76, 1.15)
Prolonged sleep loss (physicians)
0.88 (0.71, 1.05)
Bullimia nervosa
0.76 (0.37, 1.15)
Chronic benzodiazepine use
0.74 (0.72, 0.76)
Parkinson's disease without dementia
0.71 (0.59, 0.83)
Chronic kidney disease (dementia risk)
0.69 (0.30, 1.07)
Autism spectrum disorder
0.67 (0.49, 0.84)
Pediatric brain tumor
0.61 (0.34, 0.88)
Phenylketonuria
0.60 (0.24, 0.96)
Bipolar disorder (euthymic)
0.60 (0.53, 0.67)
AIDS (pre-HAART treatment)
0.59 (0.53, 0.66)
Attention deficit/hyperacticity disorder
0.55 (0.49, 0.61)
Multiple sclerosis (relapsing/remitting)
0.54 (0.47, 0.61)
Iron deficiency anemia
0.54 (0.33, 0.76)
Reading disability
0.54 (0.52, 0.56)
Acute lymphocytic leukemia
0.54 (0.46, 0.62)
Obstructive sleep apnea
0.51 (0.29, 0.72)
Obesity (dementia risk)
0.49 (0.29, 0.69)
Major depressive disorder (euthymic)
0.48 (0.36, 0.59)
Cleft lip and/or cleft palate
0.47 (0.39, 0.54)
Obsessive-compulsive disorder
0.47 (0.41, 0.54)
Amyotrophic lateral sclerosis
0.47 (0.37, 0.57)
Preterm & low birth weight delivery
0.45 (0.33, 0.57)
Cerebral Ischemia
0.40 (0.34, 0.46)
Anorexia nervosa
0.38 (0.29, 0.46)
Alcohol dependence (chronic)
0.38 (0.33, 0.44)
Opioid use (chronic)
0.38 (0.09, 0.67)
Atrial fibrillation
0.34 (0.17, 0.50)
Type 1 diabetes
0.34 (0.19, 0.49)
Concussion (acute effects)
0.33 (0.31, 0.35)
Sickle cell disease
0.31 (0.19, 0.43)
Cannabis use chronic
0.29 (0.12, 0.46)
Type 2 diabetes
0.28 (0.23, 0.34)
HIV infection (symptomatic)
0.27 (0.11, 0.42)
Congenital heart disease
0.24 (0.02, 0.47)
Huntington's disease (presymptomatic)
0.20 (0.05, 0.34)
Insomnia (chronic)
0.19 (0.12, 0.46)
Pregnancy
0.18 (0.11, 0.42)
Cancer (non-cerebral)
0.14 (0.08, 0.20)
Concussion (post-acute effects)
0.11 (0.09, 0.13)
Hypertension
0.10 (0.05, 0.14)
Overall
0.60 (0.52, 0.68)
Q = 4370.20
p = 0.00
I² = 99%
0
0.25
0.50
0.75
1.0
1.25
1.5
1.75
2.0
ES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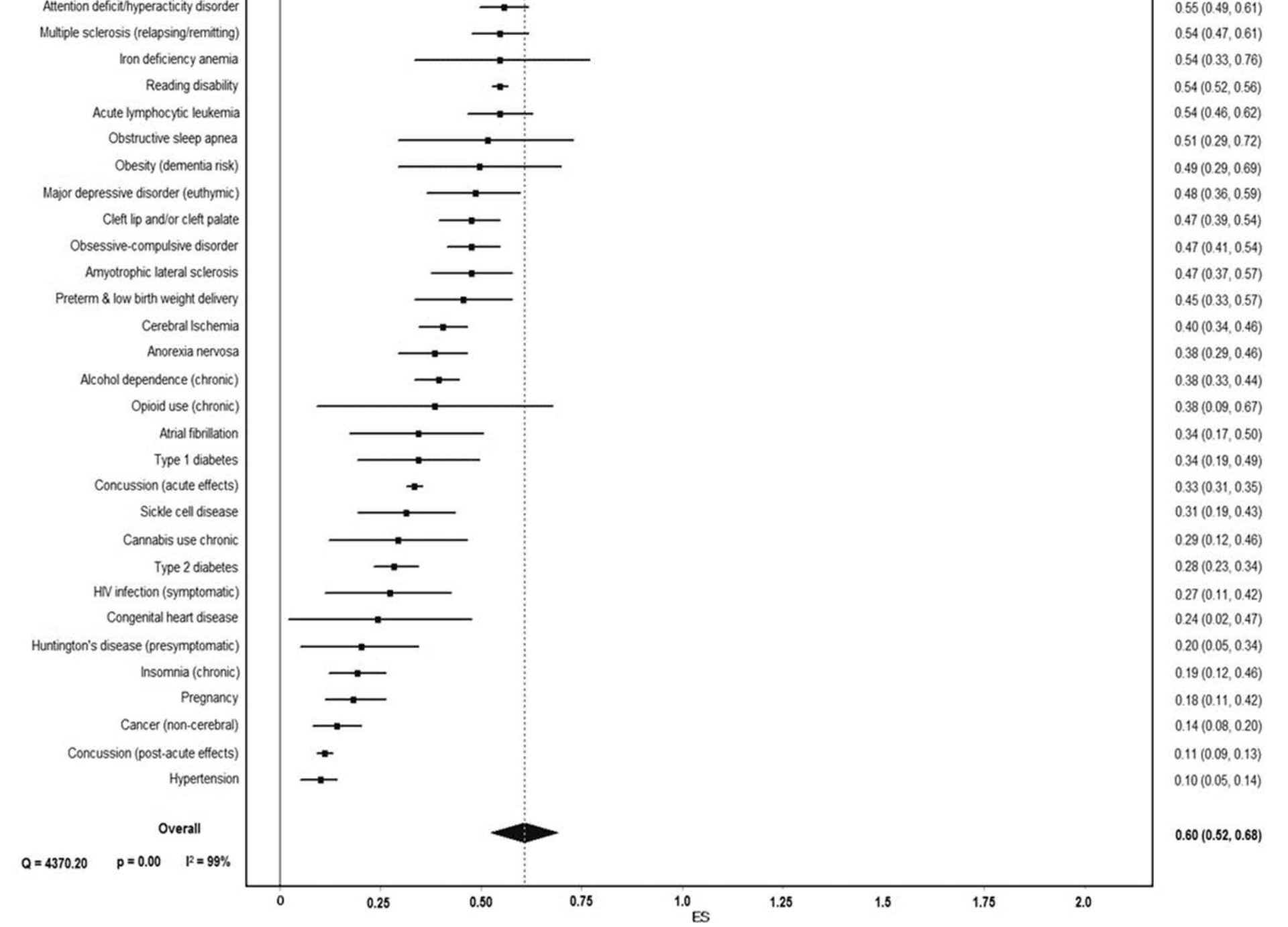
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0
0.25
0.50
0.75
1.0
1.25
1.5
1.75
2.0
ES

How shall we develop instruments for global use?

- At minimum, we must consider
  - A age, sex, and education, likely including literacy
  - Language, including the number of languages in which a person is proficient
  - Nationality & cultural background
  - Two-way interactions such as sex by educ or age by educ and three-way interactions such as age cohort by sex by educ

Another basis of cultural differences?

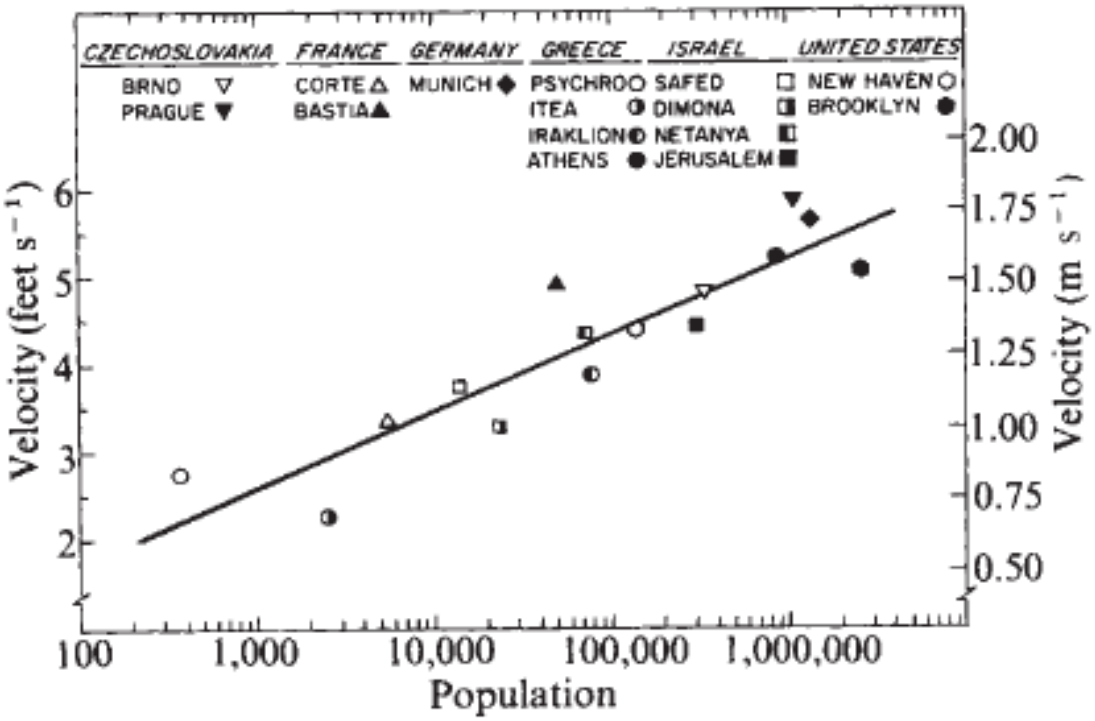
- The “pace of life” and differences in psychomotor tempo

Bornstein & Bornstein (1976)

Measured rates at which solo pedestrians walked 50 feet on a main street in 15 cities

Population strongly predicted pace (multiple R = 0.91)

Do such large differences in the pace of life affect performance On speeded cognitive tasks?



Investigating the effects of culture on cognitive test performance

- Beyond the well-known effects of language on cognitive (eg, the number of syllables required to say numbers affects Digit Span performance), we must examine the effects of many other “cultural” differences
- One problem is that many of these factors remain unknown, require very large samples to study, and defy simple experimental design
- How might one parse the effects of cultural differences in pace of life from the effect of a person’s unique tempo?

Three fundamental approaches to developing multi-cultural tests

Researchers have tried to create “culture-fair” tests, but with little success. This leaves three alternate approaches:

1. Adapt and translate tests developed in one language and culture for use in others
2. Re-norm tests that have been translated in various countries and compare or pool results
3. Develop and standardize tests prospectively in multiple languages and countries

Methodology for the development of normative data for ten Spanish-language neuropsychological tests in eleven Latin American countries

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Joan Guàrdia-Olmos[a,*], Maribel Peró-Cebollero[a], Diego Rivera[b] and Juan Carlos Arango-Lasprilla[b,c]

Table 2
Sample distribution by age, education and gender

	n Total	Age	Education		Gender	
		Mean (SD)	1 to 12 *n* (%)	>12 *n* (%)	Male *n* (%)	Female *n* (%)
Argentina	320	45.7 (19.5)	148 (46.3%)	172 (53.8%)	96 (30.0%)	224 (70.0%)
Bolivia	274	55.8 (22.0)	226 (82.5%)	48 (17.5%)	99 (36.1%)	175 (63.9%)
Chile	320	55.1 (19.6)	241 (75.3%)	79 (24.7%)	134 (41.9%)	186 (58.1%)
Cuba	306	53.0 (19.7)	234 (76.5%)	72 (23.5%)	142 (46.4%)	164 (53.6%)
El Salvador	257	56.0 (20.7)	203 (79.0%)	54 (21.0%)	100 (38.9%)	157 (61.1%)
Guatemala	214	53.2 (17.4)	133 (62.1%)	81 (37.9%)	95 (44.4%)	119 (55.6%)
Honduras	184	48.6 (18.8)	140 (76.1%)	44 (23.9%)	67 (36.4%)	117 (63.6%)
Mexico	1300	52.5 (20.5)	1005 (77.3%)	295 (22.7%)	431 (33.2%)	869 (66.8%)
Paraguay	263	53.0 (14.8)	216 (82.1%)	47 (17.9%)	101 (38.4%)	162 (61.6%)
Peru	245	43.4 (20.6)	87 (35.5%)	158 (64.5%)	87 (35.5%)	158 (64.5%)
Puerto Rico	294	50.9 (18.5)	160 (54.4%)	134 (45.6%)	126 (42.9%)	168 (57.1%)

Modified Wisconsin Card Sorting Test (M-WCST): Normative data for the Latin American Spanish speaking adult population

J.C. Arango-Lasprilla[a,b,*], D. Rivera[b], M. Longoni[c], C.P. Saracho[d], M.T. Garza[e], A. Aliaga[f], W. Rodríguez[g], Y. Rodríguez-Agudelo[h], B. Rábago[i], M. Sutter[j], S. Schebela[k], M. Luna[l], N. Ocampo-Barba[m], J. Galarza-del-Angel[n], M.L. Bringas[o], L. Esenarro[p], C. Martínez[q], P. García-Egan[r] and P.B. Perrin[j]

Table A3
Normative data for the M-WCST Numbers of categories stratified by age for CHILE

	Age (Years)												
Percentile	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
95	–	–	–	–	–	–	–	–	–	–	–	–	–
90	–	–	–	–	–	–	–	–	–	–	–	–	–
85	–	–	–	–	–	–	–	–	–	–	–	–	6.0
80	–	–	–	–	–	–	–	6.0	6.0	6.0	6.0	6.0	5.9
70	–	–	–	6.0	6.0	6.0	6.0	5.9	5.8	5.7	5.6	5.6	5.5
60	6.0	6.0	6.0	5.9	5.8	5.7	5.7	5.6	5.5	5.4	5.3	5.2	5.1
50	5.9	5.8	5.7	5.6	5.5	5.4	5.3	5.3	5.2	5.1	5.0	4.9	4.8
40	5.6	5.5	5.4	5.3	5.2	5.1	5.0	5.0	4.9	4.8	4.7	4.6	4.5
30	5.2	5.1	5.1	5.0	4.9	4.8	4.7	4.6	4.5	4.4	4.4	4.3	4.2
20	4.8	4.7	4.7	4.6	4.5	4.4	4.3	4.2	4.1	4.0	4.0	3.9	3.8
15	4.6	4.5	4.4	4.3	4.2	4.1	4.1	4.0	3.9	3.8	3.7	3.6	3.5
10	4.3	4.2	4.1	4.0	3.9	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2
5	3.8	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.1	3.0	2.9	2.8

Table A14
Normative data for the M-WCST Perseveration errors stratified by age for CHILE

	Age (Years)												
Percentile	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
95	–	–	–	–	–	–	–	–	–	–	–	–	–
90	–	–	–	–	–	–	–	–	–	–	–	–	–
85	–	–	–	–	–	–	–	–	–	–	–	–	–
80	–	–	–	–	–	–	–	–	–	–	–	–	–
70	–	–	–	–	–	–	0.0	0.1	0.3	0.5	0.7	0.9	1.1
60	0.1	0.3	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	1.9	2.1	2.3
50	1.2	1.4	1.6	1.8	2.0	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5
40	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.7	3.8	4.0	4.2	4.4	4.6
30	3.6	3.8	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.4	5.6	5.8
20	5.0	5.2	5.4	5.6	5.8	6.0	6.1	6.3	6.5	6.7	6.9	7.1	7.3
15	5.9	6.1	6.3	6.5	6.7	6.9	7.1	7.2	7.4	7.6	7.8	8.0	8.2
10	7.0	7.2	7.4	7.6	7.8	8.0	8.1	8.3	8.5	8.7	8.9	9.1	9.3
5	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.2	10.3	10.5	10.7	10.9

Table A25
Normative data for the M-WCST total errors stratified by age for CHILE

	Age (Years)												
Percentile	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
95	–	–	–	–	–	–	–	–	–	–	–	–	–
90	–	–	–	–	–	–	–	–	–	–	–	–	–
85	–	–	–	–	–	–	–	–	–	–	–	–	–
80	–	–	–	–	–	–	–	–	–	–	–	–	–
70	–	–	–	–	–	–	–	0.1	0.3	0.5	0.7	0.9	1.1
60	0.1	0.3	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	1.9	2.1	2.3
50	1.2	1.4	1.6	1.8	2.0	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5
40	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.7	3.8	4.0	4.2	4.4	4.6
30	3.6	3.8	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.4	5.6	5.8
20	5.0	5.2	5.4	5.6	5.8	6.0	6.1	6.3	6.5	6.7	6.9	7.1	7.3
15	5.9	6.1	6.3	6.5	6.7	6.9	7.1	7.2	7.4	7.6	7.8	8.0	8.2
10	7.0	7.2	7.4	7.6	7.8	8.0	8.1	8.3	8.5	8.7	8.9	9.1	9.3
5	8.7	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.2	10.3	10.5	10.7	10.9

Historical developments in the norming of cognitive tests

- Raw scores
  - Centuries old, still used today, and remain the most useful for concrete, performance-based criteria (e.g., flying a fighter jet)
- Age-calibrated scores
  - Introduced by Alfred Binet (MA–CA)
  - Refined by Stern (MA/CA $\rightarrow$ IQ), Wechsler (deviation IQ), and Zachary & Gorsuch (RBNs)
- Demographically-calibrated scores
  - Heaton (HRB), Ivnik (MOANS), Schretlen (CNNS), etc.

Benedict et al. BMC Neurology 2012, 12:55
http://www.biomedcentral.com/1471-2377/12/55

BMC Neurology

ORIGINAL PAPER Open Access

Brief International Cognitive Assessment for MS (BICAMS): international standards for validation

Ralph HB Benedict*, Maria Pia Amato, Jan Boringa, Bruno Brochet, Fred Foley, Stan Fredrikson, Paivi Hamalainen, Hans Hartung, Lauren Krupp, Iris Penner, Anthony T Reder and Dawn Langdon

Abstract

An international expert consensus committee recently recommended a brief battery of tests for cognitive evaluation in multiple sclerosis. The Brief International Cognitive Assessment for MS (BICAMS) battery includes tests of mental processing speed and memory. Recognizing that resources for validation will vary internationally, the committee identified validation priorities, to facilitate international acceptance of BICAMS. Practical matters pertaining to implementation across different languages and countries were discussed. Five steps to achieve optimal psychometric validation were proposed. In Step 1, test stimuli should be standardized for the target culture or language under consideration. In Step 2, examiner instructions must be standardized and translated, including all information from manuals necessary for administration and interpretation. In Step 3, samples of at least 65 healthy persons should be studied for normalization, matched to patients on demographics such as age, gender and education. The objective of Step 4 is test-retest reliability, which can be investigated in a small sample of MS and/or healthy volunteers over 1–3 weeks. Finally, in Step 5, criterion validity should be established by comparing MS and healthy controls. At this time, preliminary studies are underway in a number of countries as we move forward with this international assessment tool for cognition in MS.

Home Objectives Data Committee Committee Section

BICAMS

BICAMS (Brief International Cognitive Assessment for MS) is an international initiative to recommend and support a cognitive assessment that is brief, practical and universal.

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The BICAMS committee meetings and BICAMS.net are sponsored by Bayer Healthcare.

Page last modified: 13 May 2012

www.BICAMS.net

Influence of nationality on the Brief International Cognitive Assessment for Multiple Sclerosis (BICAMS)

A. Smerbeck[a], Ralph H. B. Benedict[b], Arman Eshaghi[c], Sandra Vanotti[d], Carina Spedo[e], Jana Blahova Dusankova[f], Mohammad Ali Sahraian[c], Vanessa D. Marques[e] and Dawn Langdon[g]

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Table 1. Participant characteristics by nation.

	Entire sample	Argentina	Brazil	Czech Republic	Iran	USA
N	1097	150	559	133	89	166
Gender	343 M	38 M	193 M	38 M	32 M	42 M
	754 F	112 F	366 F	95 F	57 F	124 F
Age	39.3 ± 11.6	42.8 ± 10.0	39.3 ±12.4	33.5 ±8.4	33.8 ± 9.4	43.3 ± 10.9
Years of education	13.9 ± 3.5	14.9 ± 2.6	13.0 ± 4.0	14.3 ± 2.5	14.3 ± 3.6	15.3 ± 2.2

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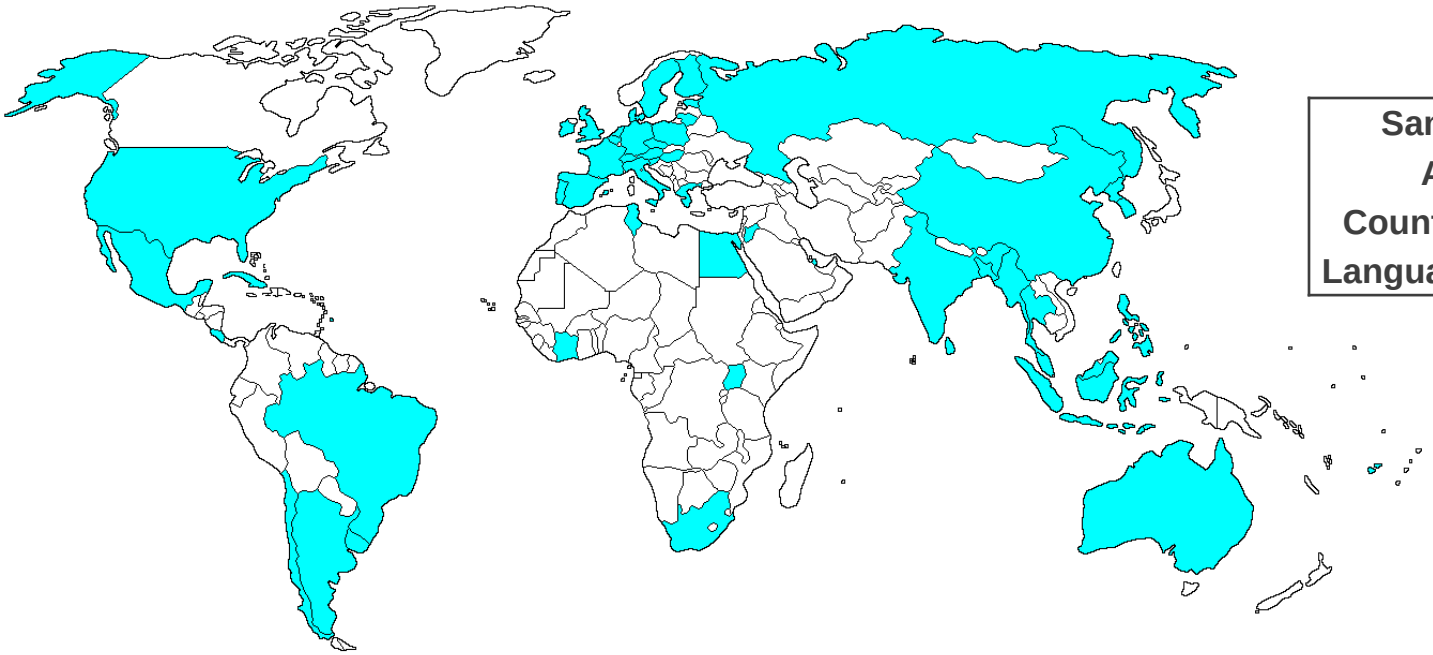
Table 2. Regression analysis results, variance explained by predictor variables.

		SDMT		CVLT2		BVMTR	
Predictor variable	Controlling for	R^2	*p* value	R^2	*p* value	R^2	*p* value
Age		.141	<.001	.049	<.001	.143	<.001
Sex		.004	.029	.007	.004	.002	.179
Education		.190	<.001	.191	<.001	.138	<.001
Nationality		.123	<.001	.041	<.001	.083	<.001
		R^2 Δ	*p* value	R^2 Δ	*p* value	R^2 Δ	*p* value
Age^2	Age	.014	<.001	.002	.121	.006	.007
Nationality	Age, Edu.	.073	<.001	.015	<.001	.048	<.001
Age-Edu. Interaction	Age, Edu.	.001	.233	<.001	.561	.005	.009
Age-Nat. Interaction	Age, Nat.	.007	.043	.006	.102	.005	.142
Edu.-Nat. Interaction	Edu., Nat.	.007	.045	.008	.031	.009	.017
		R^2 Δ	*p* value	R^2 Δ	*p* value	R^2 Δ	*p* value
Age-Sex Interaction	Age, Sex	<.001	.997	<.001	.523	<.001	.811
Edu.-Sex Interaction	Edu., Sex	<.001	.568	.002	.121	.001	.254
Nat.-Sex Interaction	Nat., Sex	.009	.029	.011	.015	.009	.017

International Neuropsychological Normative Database Initiative

A GLOBAL RESOURCE



Sample:	307,458
Ages:	5 – 111 years
Countries:	52
Languages:	85

Creating regression-based norms to calibrate cognitive test performance for a test taker's age, sex, education, nationality, and language

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Big World – Big Challenges

- Age: What is the best way to think about it?
  - Lived time
  - Proximity to life expectancy
- Education
  - Aptitude & attainment
    - Is their “relationship” culturally invariant?
    - Interactions: sex by culture, age by birth cohort, etc.
    - Is illiteracy the same in every language?
- Confounds – like culture, nationality, and language
- Test translations
  - How many versions of the MMSE are there in China?

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Percentile equivalents of a single MMSE score in 3 persons

- An MMSE score of 25/30 represents the...
  - 80th percentile for an 83-year-old South Korean man with less than 5 years of education
  - 50th percentile for a 78-year-old Brazilian woman with 8 years of education
  - 2nd percentile for a 61-year-old British man with more than 16 years of education

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Education from the top down

ISCED 1997	ISCED 2011
	0 Early childhood education (designed for children under 3 years)
0 Pre-primary (designed for children above 3 years)	Pre-primary (designed for children above 3 years)
1 Primary (or 1st stage of basic education)	1 Primary
2 Lower secondary (or 1st stage of basic education)	2 Lower secondary
3 Upper secondary	3 Upper secondary
4 Post secondary non-tertiary	4 Post secondary non-tertiary
5 First stage of tertiary	5 Short cycle tertiary 6 Bachelor's or equivalent 7 Master's or equivalent
6 Second stage of tertiary	8 Doctoral level

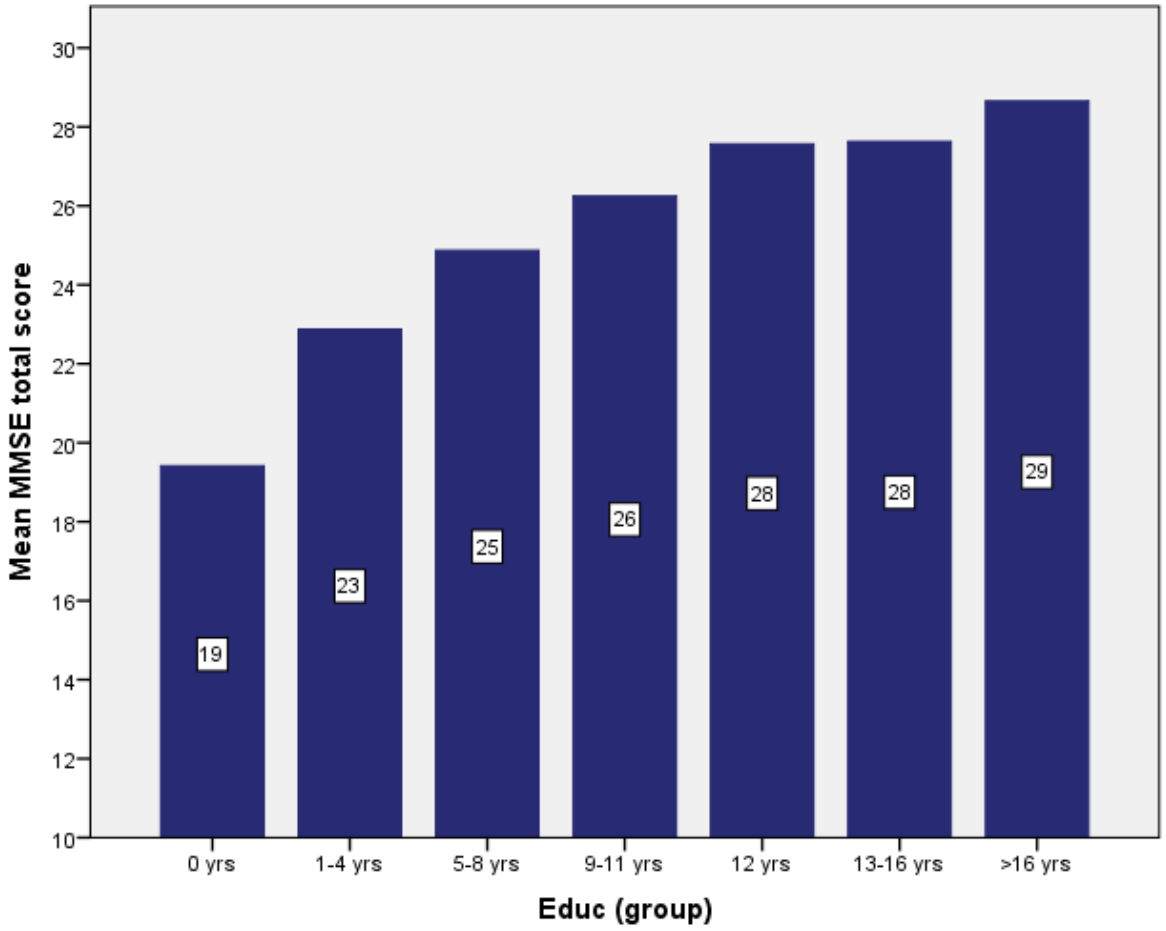
UNESCO International Standard Classification of Education

INNDI

Education from the bottom up: MMSE scores by education and country

	Years of education					
	0	**1 - 4**	**5-8**	**9-12**	**13-15**	**≥16**
N	3,265	5,761	15,583	29,477	10,691	19,676
Overall	19.4 (5.7)	22.8 (5.0)	25.0 (4.6)	27.0 (3.9)	27.2 (3.9)	28.5 (2.4)
Age						
Mean (SD)	71.9 (9.5)	70.7 (9.9)	65.3 (12.5)	65.1 (17.4)	63.3 (19.0)	64.0 (14.9)
Range	20—105	19—103	18—107	18—108	18—105	20—105
Country						
Brazil	20.1 (4.9)	23.7 (3.9)	25.1 (3.4)	26.4 (2.8)	27.2 (2.5)	27.2 (2.9)
China	18.0 (5.7)	18.7 (5.1)	20.9 (5.1)	25.7 (3.8)	27.4 (2.6)	--
Denmark	19.6 (3.8)	24.5 (1.4)	26.0 (2.5)	27.7 (0.6)	--	29.5 (0.7)
England	19.1 (5.0)	22.8 (5.0)	24.0 (4.1)	25.9 (3.5)	27.4 (2.5)	28.6 (1.4)
Greece	26.0 (1.4)	26.2 (2.5)	27.3 (2.3)	28.9 (1.3)	28.6 (1.9)	29.0 (2.0)
Ireland	--	26.6 (2.8)	27.0 (2.7)	28.3 (1.3)	28.9 (1.3)	29.2 (1.2)
Italy	19.7 (1.9)	25.1 (3.3)	27.6 (2.1)	28.9 (1.2)	29.0 (1.0)	29.1 (1.0)
S. Korea	18.1 (6.2)	21.7 (5.6)	25.9 (3.8)	27.8 (2.5)	28.0 (2.0)	28.3 (2.1)
Spain	--	28.5 (1.5)	28.9 (1.1)	28.9 (1.1)	--	29.4 (0.9)
USA	21.4 (5.7)	22.0 (5.6)	24.7 (5.0)	27.4 (3.3)	28.3 (2.3)	28.8 (1.9)

MMSE-30 scores by education



MMSE total score

Educ	Mean	N	*SD*
0 yrs	19.4	3,390	5.6
1-4 yrs	22.9	6,158	5.0
5-8 yrs	24.9	16,811	4.6
9-11 yrs	26.2	13,993	3.5
12 yrs	27.6	15,021	3.2
13-16 yrs	27.6	18,917	3.5
>16 yrs	28.7	11,871	2.1
Total	26.3	86,161	4.3

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But other versions of the MMSE have been used around the world

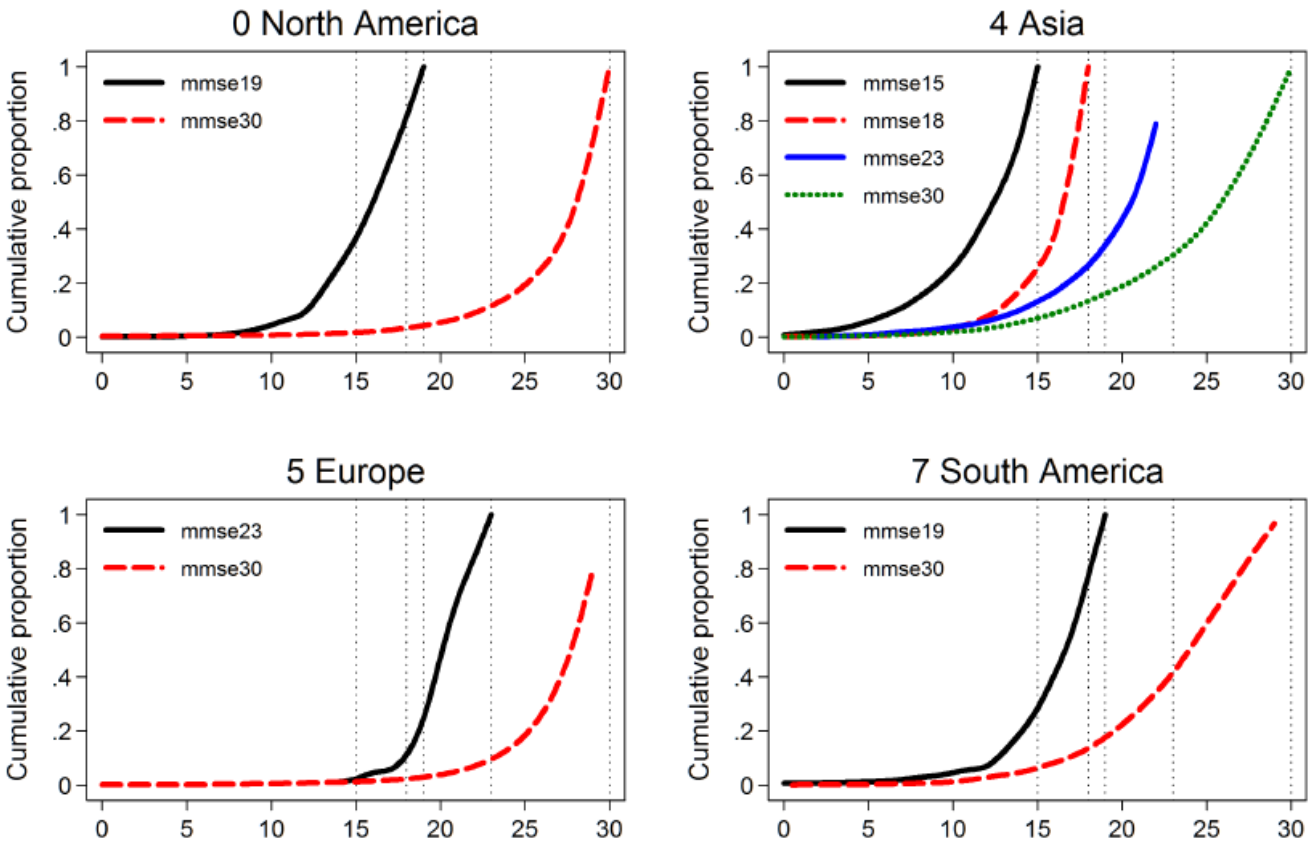
	MMSE 23	MMSE 19	MMSE 18	MMSE 15	MMSE 14
N	5,169	10,089	9,825	3,404	2,255
Age, Mean (SD)	89.4 (7.5)	70.2 (8.7)	69.0 (7.3)	70.1 (7.4)	74.5 (9.1)
Countries	China	Argentina	Bahrain Jordan	Fiji	Costa Rica
	Greece*	Barbados	Burma N. Korea	S. Korea	
		Brazil	Egypt Sri Lanka	Philippines	
		Chile	Indonesia Thailand	Malaysia	
		Mexico	Tunisia		
Excluded Questions					
Orientation	Year	State	State	Season	Season
	State	County	County	State	State
	City	City	City	County	County
	Location	Location	Floor	City	City
	Floor	Floor	[describe where lives]	Floor	Location
				[describe where lives]	Floor
Attention/Concentration			[money subtraction]	Serial 7s	Serial 7s
Language	Read and obey	Naming	Read and obey	3-step command	Naming
	Sentence	Repeat phrase	Sentence	Sentence	Repeat phrase
		Read and obey		[repeat & recall name]	Read and obey
		Sentence		[touch R ear with L hand]	Sentence
Drawing			Design		[circles]

Information contained in [ ] describes what has been substituted for the original MMSE 30 item

* Item break-down for Greece MMSE 23 not available: this version was given to illiterate individuals

MMSE: Before equipercentile Equating (from Dr. Alden Gross)

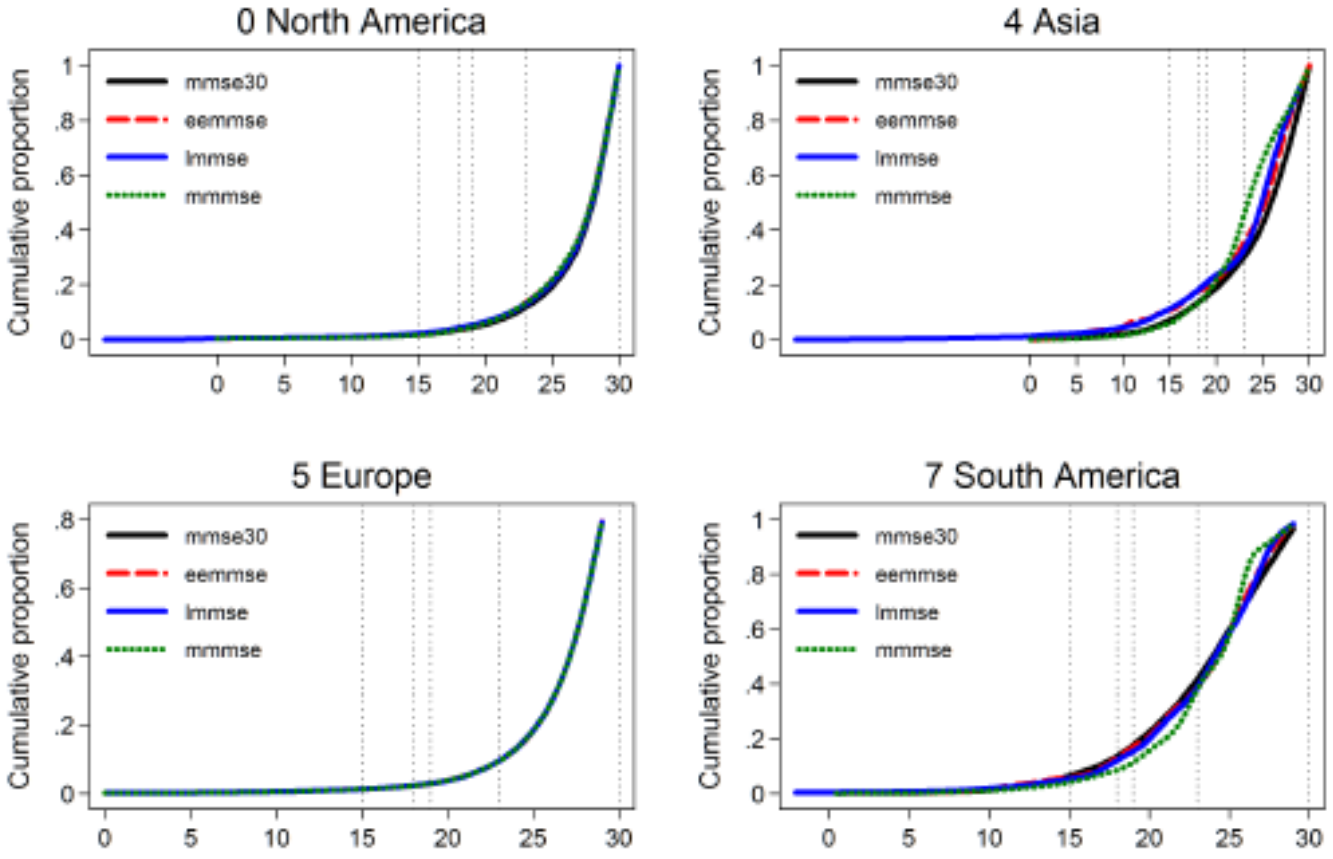
Cumulative probability plots of MMSE score by MMSE version and continent: Results from INNDI (N=112467)



INNDI

MMSE: After equipercentile Equating (from Dr. Alden Gross)

Cumulative probability plots of MMSE score by continent: Results from INNDI (N=112138)



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Cognitive Aging on Four Continents

Campbell Sullivan, Alex Kueider, and David Schretlen

Cognitive aging

- Many factors contribute to individual differences in normal cognitive aging
- Many factors also contribute to individual differences in longevity and life expectancy
- Some of these likely overlap
- We sought to test whether measures of life expectancy account for significant incremental variability in MMSE performance beyond that explained by age, nationality, sex, and education in adults aged 50–90 years.

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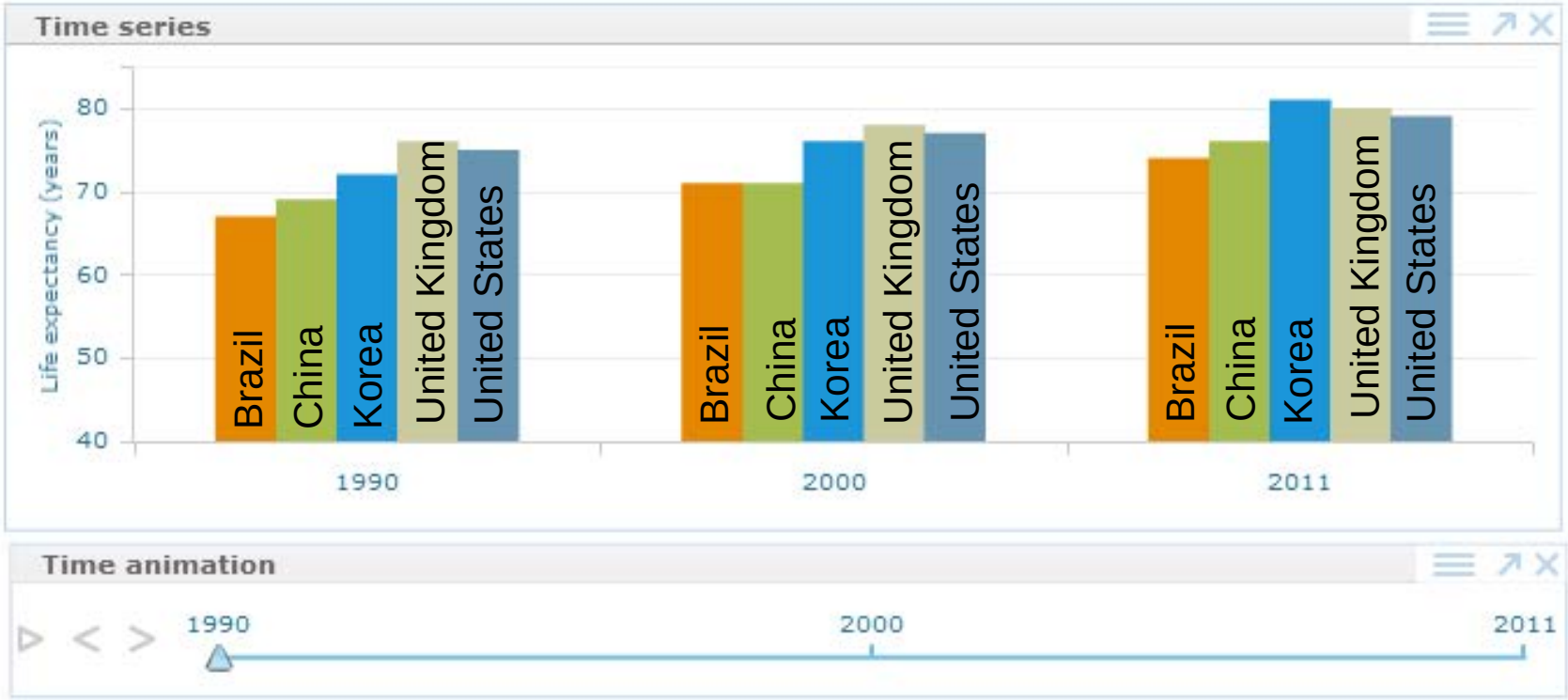
Life expectancy *at birth* for three cohorts in five countries



Crude life expectancy estimates for 60-year-old men and women by year

	1990		2000		2011	
Country	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Brazil	17	19	18	21	19	23
China	16	19	17	20	19	21
S Korea	15	20	18	22	21	26
UK	18	22	20	23	22	25
US	19	23	20	23	21	24

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Crude life expectancy & extrapolated proximity to life expectancy

- Crude life expectancy (LE)
  - W.H.O. estimate of life expectancy for 60-year-olds by sex in 1990, 2000, or 2011
- Extrapolated proximity to life expectancy (E-PLE)
  - W.H.O. crude estimate of life expectancy minus age at testing

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Modeling life expectancy effects on MMSE performance in 5 countries

Results for five-country sample (*n* = 64,917)	R^2	Δ in R^2
Crude life expectancy (LE)		
Country, education, education^2 & sex	0.313	0.313
Country, education, education^2 & sex + age, age^2	0.339	0.026
Country, education, education^2, sex, age & age^2 + crude LE	0.352	0.013
Extrapolated proximity to life expectancy (E-PLE)		
Country, education, education^2 & sex	0.313	0.313
Country, education, education^2 & sex + age, age^2	0.339	0.026
Country, education, education^2, sex, age & age^2 + extrapolated PLE	0.352	0.013

The final models yielded similar R^2 values, but the beta weight for E-PLE (0.92) was considerably larger than the beta weight for LE (0.20), and adding LE and E-PLE as predictors lowered the beta weights for country, age, and age^2 in both analyses

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A third estimate of proximity to life expectancy

- Birth cohort-based proximity to life expectancy (C-PLE)
  - Life expectancy for each person by age, sex, and birth cohort
  - Only available for the UK and US

Finer-grained, birth cohort-based, life expectancy estimates

	Life expectancy for Caucasian men in the U.S. by age and year				
Year	0	20	40	60	80
1890	42.5	40.7	27.4	14.7	5.4
1900	48.2	42.2	27.7	14.4	5.1
1910	50.2	42.7	27.4	14.0	5.1
1920	56.3	45.6	29.9	15.3	5.5
1930	59.1	46.0	29.2	14.7	5.3
1940	62.8	47.8	30.0	15.1	5.4
1950	66.3	49.5	31.2	15.8	5.9
1960	67.6	50.3	31.7	16.0	5.9
1970	67.9	50.2	31.9	16.1	6.2
1980	70.8	52.5	34.0	17.6	6.8
1990	72.7	54.0	35.6	18.7	7.1
1995	73.4	54.5	36.1	19.3	7.2
2000	74.8	55.7	37.1	20.0	7.6
2004	75.7	56.7	38.0	20.9	8.1

Modeling life expectancy effects on MMSE performance in the UK and US

Results for the UK & US sample (*n* = 44,642)	R^2	Δ in R^2
Crude life expectancy (LE)		
Country, education, education^2 & sex	0.235	0.235
Country, education, education^2 & sex + age, age^2	0.285	0.05
Country, education, education^2, sex, age & age^2 + crude LE	0.286	0.002
Extrapolated proximity to life expectancy (E-PLE)		
Country, education, education^2 & sex	0.235	0.235
Country, education, education^2 & sex + age, age^2	0.285	0.05
Country, education, education^2, sex, age & age^2 + E-PLE	0.286	0.002
Cohort-based proximity to life expectancy (C-PLE)		
Country, education, education^2 & sex	0.235	0.235
Country, education, education^2 & sex + age, age^2	0.285	0.05
Country, education, education^2, sex, age & age^2 + C-PLE	0.30	0.02

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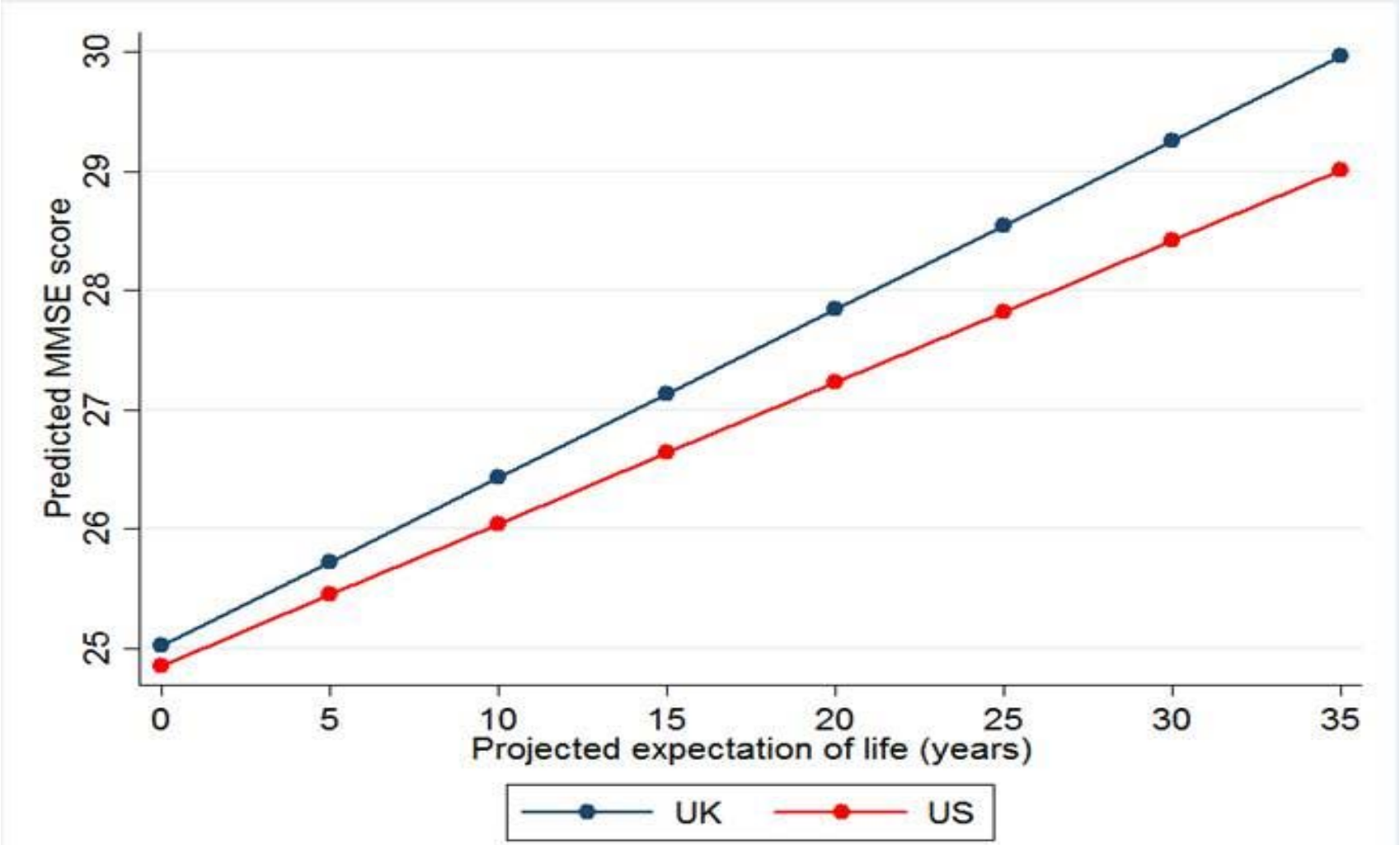
Predicted MMSE score by proximity to life expectancy in the UK & USA



Conclusions

- Even crude life expectancy estimates improved predictions of MMSE performance in the five-country (*n* = 64,917) and combined UK & US (*n* = 44,642) samples
- Extrapolating proximity to life expectancy further improved the models in both samples
- Using cohort-based estimates of proximity to life expectancy that were available only for the UK and US samples yielded the greatest improvement
- Future research on cognitive aging might yield even more precise and powerful methods of accounting for proximity to life expectancy in cognitive aging

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Cultural Differences in the Effects of Education and Illiteracy on Animal Naming

David Schretlen, Alexandra Kueider, and Campbell Sullivan

Animal naming by age and sex

	Age in 20-year bands			
	40 - 59	**60 - 79**	**80 - 99**	**≥ 100**
N	51,349	82,378	17,020	45
% male	45.1	44.5	36.2	35.6
Overall, Mean (SD)	18.1 (7.5)	17.0 (6.7)	14.6 (6.0)	9.7 (5.8)
Animal naming by sex				
Male	18.3 (7.2)	17.3 (6.6)	15.2 (6.0)	13.5 (5.1)
Female	18.1 (7.6)	16.8 (6.7)	14.3 (5.9)	9.1 (4.6)

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Animal naming by education and country

	Years of education					
	0	**1 - 4**	**5 - 8**	**9 - 12**	**13 - 15**	**≥16**
N	14,404	9,978	30,498	44,961	17,493	26,896
Overall mean	11.0 (4.4)	12.7 (5.0)	14.6 (5.8)	17.8 (6.5)	20.6 (6.8)	20.6 (6.8)
Country						
Brazil	10.9 (3.6)	13.1 (3.7)	14.5 (3.8)	16.3 (3.7)	18.3 (4.6)	18.6 (4.3)
China	10.7 (4.1)	12.2 (4.4)	13.5 (4.8)	15.3 (5.3)	18.3 (4.3)	16.9 (5.6)
Czech Republic	14.3 (3.9)	21.1 (6.5)	17.6 (6.5)	21.3 (6.9)	24.6 (6.9)	26.4 (7.6)
Denmark	12.4 (3.6)	15.5 (2.9)	17.6 (6.1)	21.8 (6.1)	22.4 (6.3)	24.5 (7.1)
England	12.8 (4.0)	14.4 (4.7)	13.5 (4.6)	16.4 (5.7)	17.8 (5.6)	19.4 (6.4)
Poland	11.5 (4.1)	11.5 (4.1)	13.9 (4.9)	17.1 (4.9)	18.9 (5.8)	19.8 (6.1)
Portugal	11.7 (5.2)	12.6 (4.6)	14.3 (5.1)	17.0 (5.2)	17.0 (6.5)	20.2 (5.1)
Slovenia	18.5 (6.9)	17.0 (6.3)	17.9 (6.3)	21.9 (7.2)	24.4 (7.1)	27.2 (8.4)
South Africa	9.7 (3.9)	10.0 (3.8)	10.5 (3.9)	11.8 (3.8)	14.2 (4.0)	13.6 (4.6)
Spain	12.2 (4.5)	15.4 (3.6)	14.2 (5.3)	16.8 (5.4)	18.7 (6.5)	19.9 (5.4)
US	12.9 (4.8)	15.0 (4.7)	13.8 (4.9)	17.1 (5.1)	18.5 (5.4)	20.5 (5.8)

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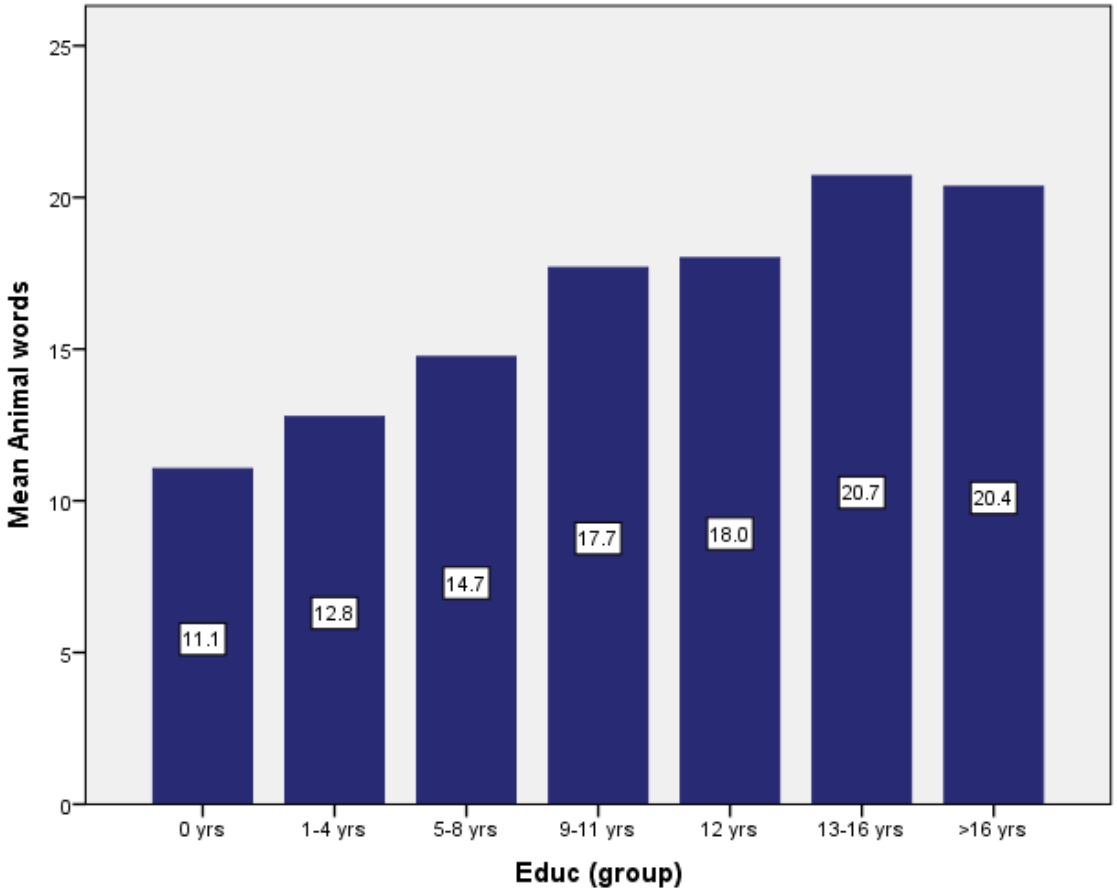
Education from the bottom up: Animal naming by education

Report

Animal words

Educ (group)	Mean	N	Std. Deviation
0 yrs	11.05	13220	4.518
1-4 yrs	12.76	9232	5.458
5-8 yrs	14.75	28171	5.897
9-11 yrs	17.69	18877	6.394
12 yrs	18.00	18999	6.867
13-16 yrs	20.71	24049	6.971
>16 yrs	20.36	14580	6.666
Total	16.91	127128	7.043



Raw score-to-scaled score equivalents based on cumulative frequency distribution by country group

	Raw Score, Number of Animals										
Scaled score	Total *n* = 159,506	Group 1 3,077	Group 2 20,225	Group 3 5,535	Group 4 17,856	Group 5 20,302	Group 6 49,587	Group 7 7,645	Group 8 5,096	Group 9 15,040	Group 10 18,967
1	—	3-5	3	4	3-4	3	3	—	—	—	—
2	3	6	4-5	5	5	4-5	4	3	—	3	—
3	4	7-9	6	6-7	6-7	6	5	4	3-4	4	3
4	5-6	10	7-8	8-9	8	7-8	6-7	5	5	—	4
5	7	11-12	9-10	10-11	9-10	9-10	8	6	6	5	5
6	8	13-14	11-12	12	11-12	11	9-10	7	7-8	6	6
7	9-10	15-17	13-14	13-14	13-14	12-13	11	8	9	7-8	7
8	11-12	18-19	15-17	15-16	15	14-15	12-13	9-10	10-11	9	8
9	13-14	20-21	18-19	17-18	16-18	16-17	14	11-12	12	10	9
10	15-17	22-23	20-21	19-20	19-20	18-19	15-16	13-14	13-14	11-12	10
11	18-19	24-26	22-24	21-22	21-22	20-21	17-18	15	15-16	13-14	11
12	20-21	27-28	25-26	23-24	23-24	22-23	19-20	16-17	17-18	15-16	12-13
13	22-24	29-31	27-29	25-26	25-27	24-25	21-22	18-19	19-20	17-18	14-15
14	25-27	32-34	30-32	27-29	28-29	26-27	23-25	20-21	21-22	19-20	16-17
15	28-30	35-36	33-35	30-31	30-32	28-29	26-27	22-23	23-24	21-22	18-20
16	31-33	37-39	36-40	32-34	33-35	30-31	28-30	25-26	25-26	23-24	21-23
17	34-37	40-41	41-45	35-37	36-39	33-34	31-33	27-29	27-29	25-26	24-27
18	38-41	42-44	46-49	38-40	40-42	35-37	34-37	30-33	30-31	27-29	28-30
19	≥42	≥45	≥50	≥41	≥43	≥38	≥38	≥34	≥32	≥30	≥31

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Deriving RBNs for Animal Naming

- 152,556 adults aged 40–99 years who named 3 or more animals
- Comprised 30 countries in 13 groups that were created based on multiple linear equations with terms for age, age^2, education, education^2, and sex, interactions between age, sex, and education, and indicator terms for the 30 countries with animal naming data. Countries with equivalent regression coefficients defined the 13 country groups
- Terms entered in the equation to create RBNs
  1. Indicator variables for 13 country groups
  2. Age and Age^2
  3. Education and Education^2
  4. Sex
  5. Country group x education and country group x age interactions
- Adjusted R^2 for current equation = 0.35 (Multiple R = 0.59)

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Regression-based norms for Animal Naming

Raw score	15
Unadj. scaled score (SS)	10
Adjusted SS	11.71
Discrepancy score	1.71
Z score	0.70
T score	57.02
% tile	24.1

DEMOGRAPHICS	
Age	60
Sex	1
Years of education	18
Country Group	7

Country Groups

1. Finland, Sweden
2. Austria, Czech Republic, Estonia, Slovenia
3. Germany, Denmark, France
4. Belgium, Switzerland, The Netherlands
5. Ireland
6. Israel
7. Hungary, Poland, Mexico
8. United Kingdom, United States
9. Uganda, Brazil, Spain
10. Ghana, Portugal
11. Greece, Italy
12. China
13. India, Russia, South Africa

Sex

1. Male
2. Female

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Limitations: many and daunting

- Sampling differences across countries
- Confounding effects of unaccounted variables
  - Malnutrition and other environmental exposures
  - Differences in availability and quality of education
  - Variability in health status of participants
- Differences in birth cohort & age → life expectancy (extent, trajectories, lags & unevenness (e.g., due to war, famine)
- Co-norming tests not feasible
- Quality control (e.g., test admin/scoring, translations, data)
- Some cog abilities difficult to norm globally (e.g., naming)

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Conclusion

- Through INNDI we have received neuropsychological normative data for 307,458 people from 52 countries tested in 85 different languages
- We have begun analyzing MMSE and Animal Naming test data to develop regression-based norms
- Preliminary results suggest it is possible to pool data across countries despite differences in sampling, test forms, etc.
- INNDI data could help answer basic questions about how to best conceptualize age and disentangle the effects of nationality, language, education, and literacy on cognitive performance

INNDI

Thanks to INNDI contributors

Contributor	Country	Contributor	Country
Anita Liberalesso Neri, PhD	Brazil	Kathleen Welsh-Bohmer, PhD	US
Annerine Roos, PhD	South Africa	Kathryn Brown-Yung, PhD	Australia
Ben Schmand, PhD	The Netherlands	Ki Woong Kim, MD, PhD	South Korea
Beth Snitz, PhD	US	Liu Yuzhi, PhD	China
Carol Brayne, PhD	England	Mark Sager, MD	US
David Bennett, MD	US	Mary Ganguli, MD, MPH	US
Eli Vakil, PhD	Israel	Mary Kosmidis, PhD	Greece
Érico Castro-Costa, PhD	Brazil	Mônica Sanches Yassuda, PhD	Brazil
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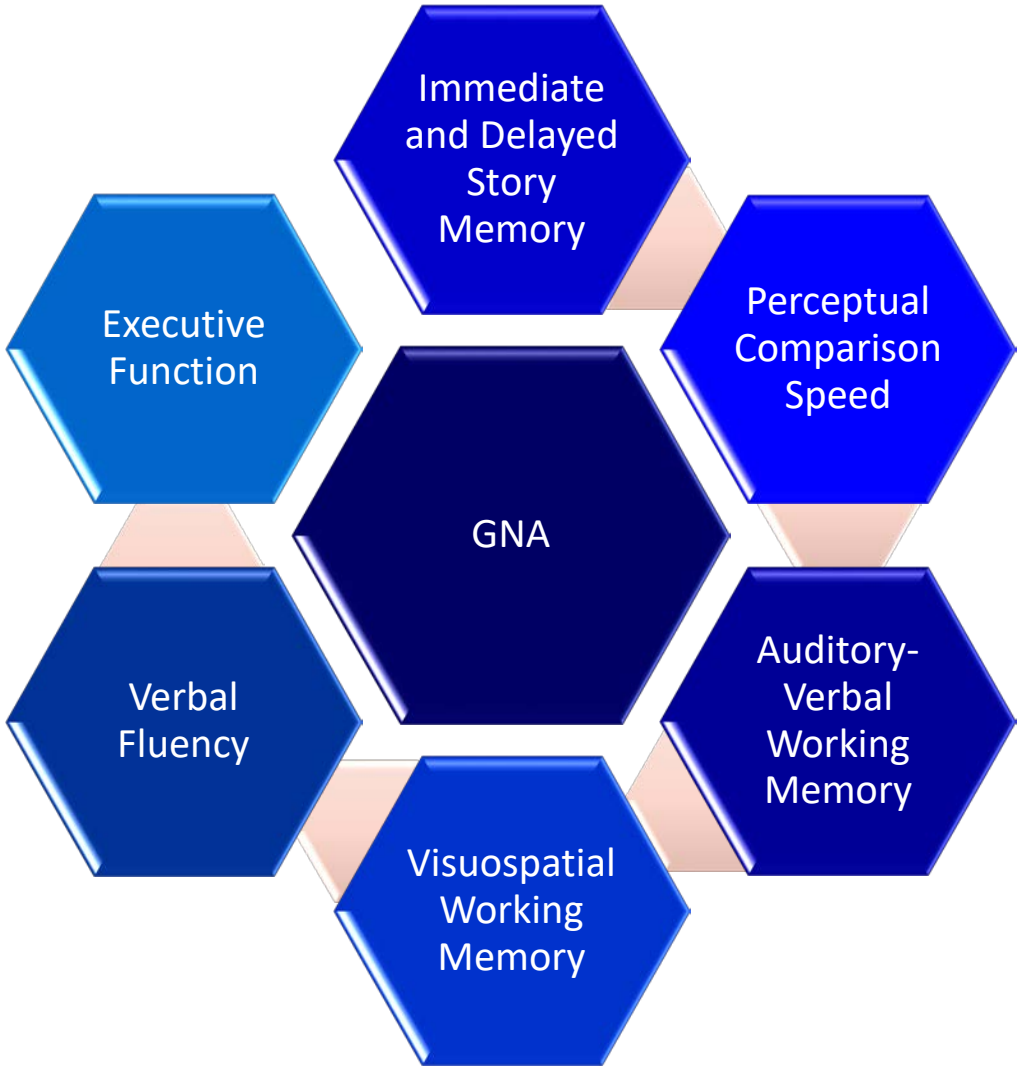
Jordi Peña-Casanova, MD, PhD	Spain	Tomáš Nikolai, PhD	Czech Republic

Global Neuropsychological Assessment (GNA)

JOHNS HOPKINS MEDICINE

- A cognitive test battery with 4 equivalent forms that:
  - Uses adaptive methods & can be administered in ≤20 minutes
  - Minimizes culture-specific contents
  - Does not require literacy
  - Assesses cognitive functions disrupted by many conditions
  - Has good reliability and validity
  - To be translated & normed for deriving global RBNs
  - Will be provided free of charge to collaborators/contributors

GNA Test Battery



18–20 minutes

Adaptive

4 Equivalent Forms

Multi-lingual

Global-calibration

Auditory-verbal immediate & delayed story memory

- Universal themes and parts of speech
  - Every story has 14 target words to be remembered verbatim
  - Every story consists of 28-32 words and includes 8 pronouns, 3 adjectives, and 4 verbs

- *The old lady was distressed about her cat after he injured his paw a few days earlier. She took care of him and was relieved when it healed.*

Conclusions

- Relevance 2050 aims to do what is ethically right, socially just, and economically smart
- Not only will working toward the ends Dr. Postal envisioned improve practice in the U.S., it could position us to lead test development for multi-national RCTs and global practice
- There are many ways to develop tests and methods to increase the suitability of our toolkit for diverse populations
- From translating and norming existing tests, or stratifying norms by ethnic, linguistic, cultural, and national subgroups to pooling data from diverse sources to create RBNs for already published instruments to entirely new ones

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