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The Uniform Data Set, Czech Version: Normative Data in Older Adults from an International Perspective

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Abstract

Background: Outside of the United States, international perspectives on normative data for neuropsychological test performance, within diverse populations, have been scarce. The neuropsychological test battery from the Uniform Data Set (UDS) of the Alzheimer's Disease Centers (ADC) program of the United States National Institute on Aging (NIA) is one of the most sensitive batteries for the evaluation of both normal cognitive aging and pathological cognitive decline.

Objective: This study aimed to determine the feasibility of the Czech Neuropsychological Test Battery from the Uniform Data Set (UDS-Cz 2.0), while also evaluating the results obtained from an international perspective.

Methods: This paper describes data from 520 cognitively normal participants. Regression analyses were used to describe the influence of demographic variables on UDS-Cz test performance.

Results: Cognitive performance on all measures declined with age, with patient education level serving as a protective factor. Therefore, the present study provides normative data for the UDS-Cz, adjusted for the demographic variables of age and education.

Conclusion: The present study determines the psychometric properties of the UDS-Cz and establishes normative values in the aging Czech population, which can be used in clinical settings.

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Keywords

Aging; Alzheimer's disease; healthy subjects; normative

INTRODUCTION

Mild cognitive impairment (MCI) due to Alzheimer's disease (AD) is conceptualized as the symptomatic pre-dementia phase of AD [1]. A neuropsychological evaluation is currently the main tool used for the clinical identification and characterization of MCI [2]. Neuropsychological evaluation reliably estimates the change in cognition in patients with probable MCI and also differentiates MCI from normal aging and dementia due to AD [3]. Neuropsychological criteria for the diagnosis of MCI more accurately identify patients who progress to dementia, compared to conventional MCI diagnostic criteria [4–8]. These criteria are also less susceptible to false-positive errors [7, 9].

An optimal neuropsychological test battery with a focus on MCI should be very sensitive to subtle cognitive deficits in MCI, and should not rely on a single-measure approach [2, 10–12]. Prior efforts of the United States National Institute on Aging and the Alzheimer's Disease Centers and the National Alzheimer's Coordinating Center to standardize data collection, diagnostic procedures, and data comparability, successfully led to the development of a systematic method for the assessment of MCI. This uniform set of assessment procedures, coined the Uniform Data Set 2.0 (UDS 2.0), includes a Neuropsychological Test Battery [13, 14]. The UDS 2.0 Neuropsychological Test Battery consists of 10 brief test measures that evaluate cognitive performance in five cognitive domains: attention, speed of processing, executive function, episodic memory, and language. Rationale and procedures for the domain and test selection were described in detail, and a large normative data set of cognitively normal adults was collected [14] and compared with other methods for determining the rate of cognitive decline [15]. To be established as a proper tool for comparison, international implementation of the UDS 2.0 Neuropsychological Test Battery should support the construct's validity and diagnostic equivalence in a cross-cultural setting [16]. The implementation of unified diagnostic procedures and data collection standards on an international level is also desirable for collaborative research networks promoting data sharing, data merging, and meta-analyses on large samples [17, 18]. These meta-analytic efforts could ultimately lead to discoveries that result in an improvement in patients' quality of life.

Therefore, the primary aim of the present study was to provide normative standards for the UDS 2.0 Neuropsychological Test Battery Czech version (UDS-Cz 2.0) based on a regionally representative sample of older adults from the Czech population [19]. The secondary goal was to create a UDS-Cz 2.0 data set which would provide clinicians with a standardized instrument for the assessment of MCI [14, 20].

MATERIALS AND METHODS

Data source and recruitment

All participants were evaluated within the frame-work of the National Normative Study of Cognitive Determinants of Healthy Aging (NANOK) [19]. Patients were included based on their age (60+) and their willingness to give signed informed consent. Participants were excluded if their medical record revealed any of the following: cognitive impairment or dementia, a serious neurological disorder (e.g., AD or Parkinson's disease, epilepsy, aphasia), stroke or traumatic brain injury, impaired mobility of a dominant hand, history of substance abuse, current chemotherapy or radiotherapy treatment, and/or an acute phase of a serious mental disorder (e.g., depression). Recruitment was stratified according to age (5-year bands) and education (lower and higher, 1 : 1; lower education comprised primary or trade school, higher education comprised complete secondary with an exit graduation or tertiary education), with a gender distribution of 1 : 1. We were not able to further stratify the education variable in the present study for two reasons. Firstly, there were too many cells with too few observations, which causes statistical problems. Second, the content validity of the education variable caused problems as the Czech educational system has no sharp qualitative measure to support a triple division in the variable (e.g., low, intermediate, and high); thus, such a division would be arbitrary, and would result in smaller cell sizes. On the other hand, there is clear qualitative evidence for bifurcation of the variable based on the final exam ("maturita"), which is required for entrance to college level and higher education [19].

Thus, the convenience sample had a planned structure based on strict adherence to categories. The participants were recruited through advertisements on the institutional website, local media, at post offices, general practitioners', and organizations for seniors. A sample of 568 older persons (aged 60–96 years) meeting NANOK inclusion criteria was recruited and assessed in 12 out of 14 regions of the Czech Republic. Each participant was remunerated with 200 CZK in cash (i.e., approx. 8 USD).

Sample selection

Our team decided to incorporate additional exclusion criteria based on suspected (yet undiagnosed) cognitive impairment observed in the normative analyses. As such, data was excluded if a participant displayed any of the following: performance in at least two cognitive measures that fell two standard deviations (SD) below the mean of the group, or such performance in one cognitive measure and the Functional Activities Questionnaire [21], or a score ≥10 on the short Geriatric Depression Scale [22]. The cognitive tests selected for inclusion to assess suspected cognitive impairment were the Trail Making Test B (TMT-B) [23], verbal fluency tests (composite score: categorical animal fluency and phonemic fluency; K, P, S) [24], and the Czech version of the repeatable Philadelphia Verbal Learning Test (czP(r)VLT-12) (composite score: trials 1–5 sum and delayed recall) [25]. Among the final sample, respondents who scored less than the 5% quantile in the Montreal Cognitive Assessment (MoCA) test were also excluded from the analyses [26]. Thus, the descriptive analyses were conducted on 520 respondents. Cases were subdivided into three age bands (60–69, 70–79, and 80+ years) and two education levels (lower, higher), similar to Benson et al. [27]. Means, SDs, quartiles, and ranges were calculated for data in each age and education cell.

Neuropsychological battery

For each cognitive domain we included the following UDS 2.0 Neuropsychological Tests: Mini-Mental State Examination (MMSE) for cognitive screening and dementia severity [28, 29]; Wechsler Memory Scale-Revised (WMS-R) subtests Logical Memory IA and IIA for memory and delayed recall, Digit Span Forward and Backward for attention, and Semantic Fluency (Animals and Vegetables) [24, 30, 31]; Boston Naming Test (BNT) (30 odd-item – short version) for language [32, 33]; Wechsler Adult Intelligence Scale-Revised (WAIS-R), Digit Symbol subtest; and Trail Making Test (TMT) Part A for processing speed and Part B for executive function [23, 34, 35]. TMT-A scores were limited to 150 s as the maximal possible score and TMT-B scores were limited to 300 s as the maximal possible score [14]. Each test measure was adapted and validated for use in the Czech population prior to conduct of the present research. Because the level of effort participants put into performing well on a cognitive test can influence their scores, we used the forced choice section of the czP(r)VLT-12 to assess effort levels [25]; all participants demonstrated acceptable levels of effort.

Statistical analyses

First, descriptive statistics for demographics and UDS-Cz 2.0 scores were calculated. Normality was evaluated by visual inspection of Q-Q plots and the Shapiro-Wilk test; the assumptions of normality, linearity, homoscedasticity, and independence of residuals were evaluated prior to entering each variable into the multiple regression. To assess the influence of gender, age, and education on neuropsychological test performance, regression analyses were performed. The regression analyses for the neuropsychological scores were initially conducted with a univariate model adjusted for gender, age, and education separately, followed by a multivariate model adjusted for gender, age, and education together [14, 27]. Based on this analysis, we constructed regression equations for the prediction of a population mean score for each neuropsychological test.

RESULTS

Basic demographics of the participants are presented in Table 1. Summary statistics for each of the UDS-Cz 2.0 Neuropsychological Test measures are shown in Table 2. Table 3 depicts the means and standard deviations of the UDS-Cz 2.0 tests in each age and education category. From the table, it is apparent that the mean neuropsychological scores are positively influenced by a person’s completion of higher education, and negatively influenced by increasing age. Table 4 presents the summary statistics for the Czech, English, and Spanish American normative data. Apart from the Fluency: Animals and BNT-30 tests, the English normative sample sets the strictest norm. The Czech and Spanish data are more similar across most of the tests.

According to Shirk et al. [20], and our previous study [23], we constructed both a series of normative tables (for the total sample or demographically adjusted for age and education) as well as univariate and multivariate regression models (see Supplementary Material). Accordingly, the Supplementary Material provides the constants and values of the regression coefficients for the construction of equations for the prediction of the population mean score, for each of the neuropsychological test measures, based on the univariate and multivariate linear regression models. In the regression analyses, only regression coefficients that were found to be statistically significant ($p < 0.05$) are noted. We also present a series of education (2) × age (3) analysis of variances (ANOVAs), which were performed separately for each UDS-Cz 2.0 test measure, to show the influence of age and education on each test.

DISCUSSION

The normative values provided by the present study are the major outcomes of the National Normative Study of Cognitive Determinants of Healthy Aging (NANOK), which was performed between 2012 and 2015. Specifically, the normative data is based on cross-sectional data obtained from the sample in the first year of the study. Due to feasibility reasons, our recruitment strategy was based on a convenience sample. The participants are not likely to be fully representative of the general Czech population. However, the data we collected is regionally representative because it was collected in 12 of 14 regions of the Czech Republic. The inclusion criteria were set strategically so that the sample would not be a "super-sample", including only exceptionally healthy fit persons, which could then lead to super norms [36]. On the other hand, the exclusion criteria were a consensus determined by expert clinicians (board certified clinical psychiatrist MK and clinical neuropsychologists TN and OB); these criteria aimed to avoid inclusion of cognitively impaired persons in the final sample. The composition of our sample was similar in age to the aforementioned English-speaking cohort, but older than the Spanish-speaking cohort (cf. Supplementary Material) [14, 27].

Consistent with other reports and theories on cognitive aging, our sample was characterized by better performance in younger age groups [14, 27, 37]. Education seems to have a beneficial effect on performance and is protective of the detrimental effect of aging on cognitive performance [38].

From a psychometric perspective, age and education were two factors that significantly influenced variability in performance on the neuropsychological tests [14, 24, 27, 28]. Further, gender also plays a considerable role in some test measures. However, many cognitive tests do not have separate norms for women and men [27]. In the last decade, the regression approach has proven to be an efficient method for estimating the effect of age, gender, and education on neuropsychological test measures [20, 39–41]. Both approaches (tabular and regression) may be clinically useful. For example, a 65-yearold man who completed higher education should, according to the normative table in the current study, achieve an average score of 44.5 (SD = 9.0) in the WAIS-R Digit Symbol; this score becomes 42.6 when applying the multivariate regression equation (80.40–3.22*1–0.64*65 + 7.03*1 = 42.6), which is similar to the value of 47.0 (12.5) indicated by the original

SUPPLEMENTARY MATERIAL

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American study [14], and the value of 41.59 as indicated by the Spanish normative study [27]. For a more systematic comparison between Czech, English, and Spanish UDS 2.0 normative data, with regard to the convergent validity of each measure, see Table 4. These normative data sets are essential for actuarial decision making, as they enable clinicians to perform evidence-based practice in clinical neuropsychology, and are of importance for international comparisons of normative data sets [27, 42].

There are several limitations of our study that should be noted. Although our exclusion criteria were carefully formulated to minimize the chance of including individuals with pathological aging, our research sample did not undergo a thorough medical/neurological evaluation, including structural brain imaging, to exclude individuals with significant brain atrophy or vascular changes. We used a conservative approach for the definition of healthy normative group (not less than 2 SD below the mean) because many cases of dementia are unrecognized in the incipient phase and because we relied on the personal history of subjects, which could not always be clarified. A conservative approach has reduced the possibility that a person with dementia could influence the normative results. Further, in addition to a thorough clinical interview with an experienced psychiatrist (MK), we used three different neuropsychological tests (czP(r)VLT-12, TMT-B, and verbal fluency tests [23–25]) that represent different cognitive domains impaired in patients with dementia. We excluded all subjects that were impaired in at least two of the three cognitive domains, or in the MoCA [43]. The combination of these two domains reduced the possibility that we excluded cognitively healthy subjects and unknowingly inflated impairment rates among healthy adults. However, we acknowledge that, using this approach, some cases of singledomain MCI could have been included in the study. All participants in our study were Caucasian, and thus, the generalizability of the results to other ethnic groups is limited. However, this skew in demographic representation is consistent with the original study, in which the majority (81.8%) of participants were also Caucasian [14]. Finally, the UDS 2.0 is no longer the version used by the Alzheimer’s Disease Centers. Investigating the norms for the UDS 3.0 could be a future direction in our research.

In conclusion, notwithstanding these limitations, the normative data for the UDS-Cz 2.0, based on a large, representative sample of older Czech adults, shows a consistent decline in cognitive performance with age and concurrently reveals the protective effect that education has on cognitive performance. Overall, the UDS-Cz 2.0 data set reinforces and converges with the data found in earlier studies conducted in the United States. We presented age- and educationadjusted norms for the Czech population to support clinical decision-making. These findings should be taken into account when interpreting the UDS 2.0 battery, in order to improve diagnostic accuracy.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

[1]. Albert MS, DeKosky ST, Dickson D, Dubois B, Feldman HH, Fox NC, Gamst A, Holtzman DM, Jagust WJ, Petersen RC, Snyder PJ, Carrillo MC, Thies B, Phelps CH (2011) The diagnosis of mild cognitive impairment due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimers Dement 7, 270–279. [PubMed: 21514249]

[2]. Bondi MW, Smith GE (2014) Mild cognitive impairment: A concept and diagnostic entity in need of input from neuropsychology. J Int Neuropsychol Soc 20, 129–134. [PubMed: 24490866]

[3]. McKhann GM, Knopman DS, Chertkow H, Hyman BT, Jack CR Jr, Kawas CH, Klunk WE, Koroshetz WJ, Manly JJ, Mayeux R, Mohs RC, Morris JC, Rossor MN, Scheltens P, Carrillo MC, Thies B, Weintraub S, Phelps CH (2011) The diagnosis of dementia due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimers Dement 7, 263–269. [PubMed: 21514250]

[4]. Petersen RC (2004) Mild cognitive impairment as a diagnostic entity. J Intern Med 256, 183–194. [PubMed: 15324362]

[5]. Petersen RC, Smith GE, Waring SC, Ivnik RJ, Tangalos EG, Kokmen E (1999) Mild cognitive impairment: Clinical characterization and outcome. Arch Neurol 56, 303–308. [PubMed: 10190820]

[6]. Bondi MW, Edmonds EC, Jak AJ, Clark LR, Delano-Wood L, McDonald CR, Nation DA, Libon DJ, Au R, Galasko D, Salmon DP (2014) Neuropsychological criteria for mild cognitive impairment improves diagnostic precision, biomarker associations, and progression rates. J Alzheimers Dis 42, 275–289. [PubMed: 24844687]

[7]. Edmonds EC, Delano-Wood L, Clark LR, Jak AJ, Nation DA, McDonald CR, Libon DJ, Au R, Galasko D, Salmon DP, Bondi MW, Alzheimer's Disease Neuroimaging Initiative (2015) Susceptibility of the conventional criteria for mild cognitive impairment to false-positive diagnostic errors. Alzheimers Dement 11, 415–424. [PubMed: 24857234]

[8]. Edmonds EC, Delano-Wood L, Jak AJ, Galasko DR, Salmon DP, Bondi MW (2016) "Missed" mild cognitive impairment: High false-negative error rate based on conventional diagnostic criteria. J Alzheimers Dis 52, 685–691. [PubMed: 27031477]

[9]. Clark LR, Delano-Wood L, Libon DJ, McDonald CR, Nation DA, Bangen KJ, Jak AJ, Au R, Salmon DP, Bondi MW (2013) Are empirically-derived subtypes of mild cognitive impairment consistent with conventional subtypes? J Int Neuropsychol Soc 19, 635–645. [PubMed: 23552486]

[10]. Rabin LA, Pare N, Saykin AJ, Brown MJ, Wishart HA, Flashman LA, Santulli RB (2009) Differential memory test sensitivity for diagnosing amnestic mild cognitive impairment and predicting conversion to Alzheimer's disease. Neuropsychol Dev Cogn B Aging Neuropsychol Cogn 16, 357–376. [PubMed: 19353345]

[11]. Libon DJ, Bondi MW, Price CC, Lamar M, Eppig J, Wambach DM, Nieves C, Delano-Wood L, Giovannetti T, Lippa C, Kabasakalian A, Cosentino S, Swenson R, Penney DL (2011) Verbal serial list learning in mild cognitive impairment: A profile analysis of interference, forgetting, and errors. J Int Neuropsychol Soc 17, 905–914. [PubMed: 21880171]

[12]. Chang YL, Bondi MW, McEvoy LK, Fennema-Notestine C, Salmon DP, Galasko D, Hagler DJ Jr, Dale AM (2011) Global clinical dementia rating of 0.5 in MCI masks variability related to level of function. Neurology 76, 652–659. [PubMed: 21321338]

[13]. Morris JC, Weintraub S, Chui HC, Cummings J, Decarli C, Ferris S, Foster NL, Galasko D, Graff-Radford N, Peskind ER, Beekly D, Ramos EM, Kukull WA (2006) The Uniform Data Set (UDS): Clinical and cognitive variables and descriptive data from Alzheimer Disease Centers. Alzheimer Dis Assoc Disord 20, 210–216. [PubMed: 17132964]

[14]. Weintraub S, Salmon D, Mercaldo N, Ferris S, Graff-Radford NR, Chui H, Cummings J, DeCarli C, Foster NL, Galasko D, Peskind E, Dietrich W, Beekly DL, Kukull WA, Morris JC (2009) The Alzheimer's Disease Centers' Uniform Data Set (UDS): The neuropsychologic test battery. Alzheimer Dis Assoc Disord 23, 91–101. [PubMed: 19474567]

[15]. Monsell SE, Liu D, Weintraub S, Kukull WA (2012) Comparing measures of decline to dementia in amnestic MCI subjects in the National Alzheimer's Coordinating Center (NACC) Uniform Data Set. Int Psychogeriatr 24, 1553–1560. [PubMed: 22717299]

[16]. Pedraza O, Mungas D (2008) Measurement in cross-cultural neuropsychology. Neuropsychol Rev 18, 184–193. [PubMed: 18814034]

[17]. Khachaturian AS, Meranus DH, Kukull WA, Khachaturian ZS (2013) Big data, aging, and dementia: Pathways for international harmonization on data sharing. Alzheimers Dement 9, S61–62. [PubMed: 24125464]

[18]. Mitrushina M, Boone KB, Razani J, D'Elia LF (2005) Handbook of Normative Data for Neuropsychological Assessment, Oxford University Press, Oxford.

[19]. Stepankova H, Bezdicek O, Nikolai T, Horakova K, Lukavsky J, Kopecek M (2015) Zprava o projektu Narodni normativni studie kognitivnich determinant zdraveho starnuti [National Normative Study of Cognitive Determinants of Healthy Ageing – status report]. E-psychologie 9, 43–46.

[20]. Shirk SD, Mitchell MB, Shaughnessy LW, Sherman JC, Locascio JJ, Weintraub S, Atri A (2011) A web-based normative calculator for the uniform data set (UDS) neuropsychological test battery. Alzheimers Res Ther 3, 32. [PubMed: 22078663]

[21]. Bezdicek O, Stepankova H, Martinec Novakova L, Kopecek M (2016) Toward the processing speed theory of activities of daily living in healthy aging: Normative data of the Functional Activities Questionnaire. Aging Clin Exp Res 28, 239–247. [PubMed: 26231091]

[22]. Yesavage JA, Brink TL, Rose TL, Lum O, Huang V, Adey M, Leirer VO (1983) Development and validation of a geriatric depression screening scale - a preliminary-report. J Psychiatr Res 17, 37–49.

[23]. Bezdicek O, Moták L, Axelrod BN, Preiss M, Nikolai T, Vyhnálek M, Poreh A, Růžička E (2012) Czech version of the Trail Making Test: Normative data and clinical utility. Arch Clin Neuropsychol 27, 906–914. [PubMed: 23027441]

[24]. Nikolai T, Štěpánková H, Michalec J, Bezdíček O, Horáková K, Marková H, Růžička E, Kopeček M (2015) Testy verbální fluence, česká normativní studie pro osoby vyššího věku [Verbal fluency tests. Czech normative study for older persons]. Cesk Slov Neurol N 78/111, 292–299.

[25]. Bezdicek O, Libon DJ, Stepankova H, Panenkova E, Lukavsky J, Garrett KD, Lamar M, Price CC, Kopecek M (2014) Development, validity, and normative data study for the 12-word Philadelphia Verbal Learning Test [czP(r)VLT-12] among older and very old Czech adults. Clin Neuropsychol 28, 1162–1181. [PubMed: 25247611]

[26]. Kopecek M, Stepankova H, Lukavsky J, Ripova D, Nikolai T, Bezdicek O (2017) Montreal cognitive assessment (MoCA): Normative data for old and very old Czech adults. Appl Neuropsychol Adult 24, 23–29. [PubMed: 27144665]

[27]. Benson G, de Felipe J, Xiaodong, Sano M (2014) Performance of Spanish-speaking community-dwelling elders in the United States on the Uniform Data Set. Alzheimers Dement 10, S338–343. [PubMed: 24418057]

[28]. Štěpánková H, Nikolai T, Lukavský J, Bezdíček O, Vrajová M, Kopeček M (2015) Mini-Mental State Examination – Czech normative study. Cesk Slov Neurol N 78/111, 57–63.

[29]. Folstein MF, Folstein SE, McHugh PR (1975) "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 12, 189–198. [PubMed: 1202204]

[30]. Benton AL, Hamsher KdeS, Sivan AB (1994) Multilingual Aphasia Examination. The Psychological Corporation, San Antonio, TX.

[31]. Wechsler D (2011) Wechslerova zkrácená pamět’ová škála - WMS-IIIa, Hogrefe - Testcentrum, Praha.

[32]. Zemanová N, Bezdíček O, Michalec J, Nikolai T, Roth J, Jech R, Růžička E (2016) Validity Study of the Boston Naming Test Czech Version. Cesk Slov Neurol N 79/112, 307–316.

[33]. Kaplan E, Goodglass H, Weintraub S (1983) The Boston Naming Test, Lea and Febiger, Philidelphia.

[34]. Reitan RM, Wolfson D (1985) The Halstead-Reitan Neuropsychological Test Battery: Theory and interpretation, Neuropsychology Press, Tucson, AZ.

[35]. Wechsler D (2010) Wechslerova inteligenční škála pro dospě., Hogrefe - Testcentrum.

[36]. Hassenstab J, Chasse R, Grabow P, Benzinger TL, Fagan AM, Xiong C, Jasielec M, Grant E, Morris JC (2016) Certified normal: Alzheimer’s disease biomarkers and normative estimates of cognitive functioning. Neurobiol Aging 43, 23–33. [PubMed: 27255812]

[37]. Salthouse TA (1996) The processing-speed theory of adult age differences in cognition. Psychol Rev 103, 403–428. [PubMed: 8759042]

[38]. Stern Y (2009) Cognitive reserve. Neuropsychologia 47, 2015–2028. [PubMed: 19467352]

[39]. Bezdicek O, Sulc Z, Nikolai T, Stepankova H, Kopecek M, Jech R, Ruzicka E (2017) A parsimonious scoring and normative calculator for the Parkinson’s disease mild cognitive impairment battery. Clin Neuropsychol 31, 1231–1247. [PubMed: 28276860]

[40]. Drozdova K, Stepankova H, Lukavsky J, Bezdicek O, Kopecek M (2015) Normative data for the Rey-Osterrieth Complex Figure Test in older Czech adults. Cesk Slov Neurol N 78, 542–549.

[41]. Schretlen DJ, Testa SM, Winicki JM, Pearlson GD, Gordon B (2008) Frequency and bases of abnormal performance by healthy adults on neuropsychological testing. J Int Neuropsychol Soc 14, 436–445. [PubMed: 18419842]

[42]. Chelune GJ (2010) Evidence-based research and practice in clinical neuropsychology. Clin Neuropsychol 24, 454–467. [PubMed: 18821179]

[43]. Backman L, Jones S, Berger AK, Laukka EJ, Small BJ (2005) Cognitive impairment in preclinical Alzheimer’s disease: A meta-analysis. Neuropsychology 19, 520–531. [PubMed: 16060827]

Table 1

Demographic characteristics of Czech participants (*n* = 520)

		Frequency (*n*)	%	Mean (SD)
Age	60–69	153	29.4%	64.4 (2.9)
	70–79	169	32.5%	74.3 (2.9)
	80–97	198	38.1%	85.1 (3.9)
Handedness	right-handed	482	92.7%	
	others	38	7.3%	
Gender	woman	282	54.2%	
	man	238	45.8%	
Civil status	single	13	2.5%	
	with partner	20	3.8%	
	married	228	43.8%	
	widowed	205	39.4%	
	divorced	54	10.4%	
Education	lower (8–13)	237	45.6%	10.2 (2.1)
	higher (13–22)	283	54.4%	14.9 (3.0)

Age and Education range in years.

Table 2

Summary statistics for UDS-Cz 2.0 test scores in cognitively normal Czech participants

	n	Mean (SD)	Q_{25}	Median	Q_{75}	Range
MMSE: Orientation (Total Score)	520	9.5 (0.7)	9	10	10	(7, 10)
MMSE (Total Score)	520	27.5 (1.9)	26	28	29	(20, 30)
Logical Memory A Immediate (Total Units)	520	9.8 (3.6)	7	10	12	(1, 21)
Logical Memory A Delayed (Total Units)	520	8.6 (3.5)	6	9	11	(0, 20)
Digit Span-Forward (Total Trials)	520	8.5 (2.1)	7	8	10	(4, 16)
Digit Span-Forward (Longest Sequence)	520	5.8 (1.2)	5	6	7	(3, 9)
Digit Span-Backward (Total Trials)	520	5.5 (1.9)	4	5	7	(2, 13)
Digit Span-Backward (Longest Sequence)	520	4.2 (1.2)	3	4	5	(2, 8)
Cat. Fluency: Animals (Total in 60 s)	520	20.3 (5.9)	16	20	25	(4, 40)
Cat. Fluency: Vegetables (Total in 60 s)	515*	13.4 (3.3)	11	13	15	(5, 24)
Trail Making: A (Time in s)	520	58.3 (28.4)	38.25	50	70	(11, 150)
Trail Making: B (Time in s)	514*	141.4 (64.3)	88	127.5	185.25	(38, 300)
WAIS-R Digit Symbol (Total Items in 90 s)	519*	35.2 (10.1)	29	34	42	(7, 70)
Boston Naming Test (Total Score)	520	28.6 (1.9)	28	29	30	(16, 30)

n indicates the number of subjects with data. The range includes minimum and maximum score. Q_{25} indicates the 25th percentile and Q_{75} indicates the 75th percentile. UDS-Cz 2.0, Uniform Data Set Czech version 2.0; MMSE, Mini-Mental State Examination; WAIS-R, Wechsler Adult Intelligence Scale-Revised.

*Due to technical problems, 6 (1.2%) participants were missing 1 or 2 test scores, and another 1 (0.2%) were missing 3 test scores.

Table 3

Frequencies, means and standard deviations by age and education category for the cognitively normal Czech participants

Age	**≤69**				**70–79**				**≥80**			
Education	**lower**		**higher**		**lower**		**higher**		**lower**		**higher**	
	n	**Mean (SD)**	***n***	**Mean (SD)**	***n***	**Mean (SD)**	***n***	**Mean (SD)**	***n***	**Mean (SD)**	***n***	**Mean (SD)**
MMSE: Orientation	71	9.7 (0.6)	82	9.7 (0.5)	73	9.5 (0.7)	96	9.8 (0.6)	93	9.2 (0.7)	105	9.4 (0.8)
MMSE (Total)	71	27.9 (1.6)	82	28.3 (1.4)	73	27.0 (2.1)	96	28.1 (1.6)	93	26.4 (2.1)	105	27.2 (1.8)
LM-A Immediate	71	9.5 (3.7)	82	11.6 (3.8)	73	8.5 (3.5)	96	10.4 (3.4)	93	8.2 (3.3)	105	10.2 (3.1)
LM-A Delayed	71	8.6 (3.7)	82	10.6 (3.5)	73	7.4 (3.2)	96	9.4 (3.3)	93	6.8 (2.9)	105	8.6 (3.2)
DS-Forward (Total)	71	8.4 (2.0)	82	9.7 (2.3)	73	8.1 (1.5)	96	8.8 (2.3)	93	7.7 (1.8)	105	8.3 (2.0)
DS-Forward (Seq.)	71	5.7 (1.2)	82	6.4 (1.3)	73	5.5 (1.0)	96	5.9 (1.3)	93	5.3 (1.1)	105	5.8 (1.2)
DS-Backward (Total)	71	5.5 (2.1)	82	6.7 (2.2)	73	5.1 (1.7)	96	5.8 (2.0)	93	4.9 (1.4)	105	5.3 (1.6)
DS-Backward (Seq.)	71	4.2 (1.4)	82	4.8 (1.3)	73	4.0 (1.0)	96	4.3 (1.2)	93	3.8 (0.8)	105	4.0 (1.0)
Fluency: Animals	71	21.1 (4.6)	82	24.3 (4.9)	73	19.1 (5.6)	96	21.8 (6)	93	16.7 (5.0)	105	19.2 (5.9)
Fluency: Vegetables	71	14.2 (3.0)	80	14.5 (3.2)	72	13.2 (3.2)	95	13.9 (3.5)	92	12.3 (2.8)	105	12.7 (3.2)
TMT-A	71	50.2 (21.9)	82	41.9 (16.8)	73	60.6 (25.6)	96	48.7 (17.2)	93	78.2 (35.3)	105	66.1 (29.7)
TMT-B	71	124.1 (56.8)	82	99.4 (48.5)	72	151.0 (58.2)	95	119.9 (51.6)	89	189.4 (60.0)	105	157.9 (65.5)
WAIS-R-DS	71	37.7 (9.8)	82	44.5 (9.0)	73	31.8 (7.6)	96	38.5 (9.0)	92	26.8 (8.4)	105	32.9 (7.2)
BNT-30	71	28.5 (1.6)	82	29.4 (0.8)	73	28.1 (2.5)	96	29.0 (1.1)	93	27.7 (2.7)	105	28.8 (1.5)

MMSE: Orientation, MMSE: Orientation (Total Score); MMSE (Total), MMSE (Total Score); LM-A Immediate, Logical Memory A Immediate (Total Units); LM-A Delayed, Logical Memory A Delayed (Total Units); DS-Forward (Total), Digit Span-Forward (Total Trials); DS-Forward (Seq.), Digit Span-Forward (Longest Sequence); DS-Backward (Total), Digit Span-Backward (Total Trials); DS-Backward (Seq.), Digit Span-Backward (Longest Sequence); Fluency: Animals, Category Fluency: Animals (Total in 60 s); Fluency: Vegetables, Category Fluency: Vegetables (Total in 60 s); TMT-A, Trail Making Test: A (Time in s); TMT-B, Trail Making Test: B (Time in s)-higher scores on Trails A and B are suggestive of poorer performance whereas lower scores are suggestive of no cognitive impairment); WAIS-R DS, WAIS-R Digit Symbol (Total Items in 90 s); BNT-30, Boston Naming Test, 30 items (Total Score).

Table 4

A juxtaposition between Czech (CZ), English (ENG), and Spanish American (SPA) normative data based on mean, standard deviation (SD), median, range, and quartiles (Q_{25}–Q_{75})

	Lang.	*n*	Mean (SD)	Q_{25}	Median	Q_{75}	Range
MMSE: Orientation	CZ	520	9.5 (0.7)	9	10	10	(7, 10)
	ENG	3258	9.7 (0.9)	10	10	10	(0, 10)
	SPA	273	9.3 (1.0)	9	10	10	(5, 10)
MMSE (Total)	CZ	520	27.5 (1.9)	26	28	29	(20, 30)
	ENG	3257	29.0 (1.3)	28	29	30	(17, 30)
	SPA	273	27.9 (1.3)	27	29	29	(17, 30)
LM-A Immediate	CZ	520	9.8 (3.6)	7	10	12	(1, 21)
	ENG	3181	13.9 (3.9)	11	14	17	(0, 25)
	SPA	232	11.0 (3.8)	9	11	13.5	(0, 21)
LM-A Delayed	CZ	520	8.6 (3.5)	6	9	11	(0, 20)
	ENG	3181	12.6 (4.3)	10	13	16	(0, 25)
	SPA	232	9.3 (4.1)	6	9	12	(0, 19)
DS-Forward (Total)	CZ	520	8.5 (2.1)	7	8	10	(4, 16)
	ENG	3203	8.6 (2.1)	7	9	10	(1, 12)
	SPA	252	5.9 (2.1)	5	6	7	(0, 12)
DS-Forward (Seq.)	CZ	520	5.8 (1.2)	5	6	7	(3, 9)
	ENG	3201	6.7 (1.1)	6	7	8	(0, 8)
	SPA	252	5.4 (1.2)	5	5	6	(0, 8)
DS-Backward (Total)	CZ	520	5.5 (1.9)	4	5	7	(2, 13)
	ENG	3202	6.9 (2.2)	5	7	8	(0, 12)
	SPA	252	4.7 (1.8)	3	5	6	(0, 11)
DS-Backward (Seq.)	CZ	520	4.2 (1.2)	3	4	5	(2, 8)
	ENG	3202	5.0 (1.2)	4	5	6	(1, 7)
	SPA	252	3.7 (1.1)	3	4	4	(0, 7)
Fluency: Animals	CZ	520	20.3 (5.9)	16	20	25	(4, 40)
	ENG	3232	20.0 (5.6)	16	20	24	(1, 54)
	SPA	256	16.6 (4.6)	13	17	20	(5, 31)

	Lang.	*n*	Mean (SD)	Q_{25}	Median	Q_{75}	Range
Fluency: Vegetables	CZ	515	13.4 (3.3)	11	13	15	(5, 24)
	ENG	3232	14.7 (4.4)	12	15	17	(1, 63)
	SPA	256	11.6 (3.3)	9	11	14	(3, 21)
TMT-A	CZ	520	58.3 (28.4)	38.25	50	70	(11, 150)
	ENG	3216	34.6 (15.4)	25	31	40	(11, 150)
	SPA	259	53.4 (29)	33	44	66	(15, 150)
TMT-B	CZ	514	141.4 (64.3)	88	127.5	185.25	(38, 300)
	ENG	3195	90.3 (50.0)	59	77	105	(10, 300)
	SPA	246	155.7 (79.7)	89	130	215	(40, 300)
WAIS-R DS	CZ	519	35.2 (10.1)	29	34	42	(7, 70)
	ENG	2995	47.0 (12.5)	39	47	55	(3, 93)
	SPA	260	31.5 (12.9)	23	30	40	(2, 64)
BNT-30	CZ	520	28.6 (1.9)	28	29	30	(16, 30)
	ENG	3204	27.2 (3.2)	26	28	29	(2, 30)
	SPA	252	23.3 (4.2)	21	24	26	(9, 30)

MMSE: Orientation, MMSE: Orientation (Total Score); MMSE (Total), MMSE (Total Score); LM-A Immediate, Logical Memory A Immediate (Total Units); LM-A Delayed, Logical Memory A Delayed (Total Units); DS-Forward (Total), Digit Span-Forward (Total Trials); DS-Forward (Seq.), Digit Span-Forward (Longest Sequence); DS-Backward (Total), Digit Span-Backward (Total Trials); DS-Backward (Seq.), Digit Span-Backward (Longest Sequence); Fluency: Animals, Category Fluency: Animals (Total in 60 s); Fluency: Vegetables, Category Fluency: Vegetables (Total in 60 s); TMT-A, Trail Making Test: A (Time in s); TMT-B, Trail Making Test: B (Time in s)-higher scores on Trails A and B are suggestive of poorer performance whereas lower scores are suggestive of no cognitive impairment); WAIS-R DS, WAIS-R Digit Symbol (Total Items in 90 s); BNT-30, Boston Naming Test, 30 items (Total Score).