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Spanish normative studies (NEURONORMA-Plus project): norms for the Delis Kaplan-Design Fluency Test, Color Trails Test, and Dual Task

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KEYWORDS
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Abstract
Introduction: Complex attention and non-verbal fluency tasks are used in neuropsychological assessments with the aim of exploring subdomains of executive function. The purpose of this study is to provide norms and age-, education-, and sex-adjusted data for the Delis Kaplan-Design Fluency Test (DK-DFT), Color Trails Test (CTT), and Dual Task (DT) as part of the NEURONORMA-Plus project.
Methods: The sample included 308 cognitively unimpaired individuals aged between 18 and 92 years. Raw scores were converted to age-adjusted scaled scores. These were further converted into education- and sex-adjusted scaled scores by applying linear regression, with 2 age groups (< 50 and ≥ 50 years).
Results: Overall, age had a negative impact on DK-DFT and CTT performance. We observed a positive effect of education on DK-DFT scores only in the older group (≥ 50 years). Moreover, younger men performed slightly better in the basic condition of this test. Education was positively associated with all CTT scores in both age groups, with the exception of the CTT-1 subtest in the younger group. Age and education did not influence DT performance, whereas sex did, with young women performing slightly better.

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Conclusions: These normative data may be useful in the interpretation of neuropsychological assessments in the Spanish population.

PALABRAS CLAVE
Estudios normativos;
Funciones ejecutivas;
Fluencia no verbal

Estudios normativos españoles (Proyecto NEURONORMA Plus): normas para las pruebas *Delis Kaplan-Design Fluency Test* (DK-DFT), *Color Trails Tests* (CTT) y *Dual Task* (DT)

Resumen
Objetivo: Las tareas de atención compleja y fluencia no verbal se utilizan en las valoraciones neuropsicológicas con el objetivo explorar subdominios de las funciones ejecutivas. El objetivo de este estudio es proporcionar datos normativos ajustados por edad, escolaridad y género de las pruebas *Delis Kaplan-Design Fluency Test* (DK-DFT), *Color Trails Tests* (CTT) y *Dual Task* (DT) como parte del Proyecto NEURONORMA-Plus.
Método: Se incluyeron 308 individuos sin deterioro cognitivo de entre 18 y 92 años de edad. Se convirtieron las puntuaciones brutas en puntuaciones escalares ajustadas por edad y se realizaron ajustes por escolaridad y género aplicando regresiones lineales estratificando en dos grupos de edad (<50 y ≥50 años).
Resultados: Globalmente, la edad tuvo un impacto negativo en el DK-DFT y el CTT. La escolaridad mostró un efecto positivo en las puntuaciones del DK-DFT sólo en el grupo de mayor edad (≥50 años) y se halló un rendimiento discretamente superior en los hombres más jóvenes en la condición básica de esta prueba. La escolaridad se asoció positivamente con todas las puntuaciones de CTT en ambos grupos de edad, excepto en la subprueba CTT-1 en el grupo de adultos jóvenes. La edad y la escolaridad no mostraron influencia sobre el rendimiento en el DT excepto en el género donde las mujeres jóvenes tuvieron un rendimiento ligeramente superior.
Conclusión: Estos datos normativos pueden resultar útiles para la interpretación de las evaluaciones neuropsicológicas en población española.

Introduction

Normative data from neuropsychological tests are essential for interpreting normal and impaired cognitive function. The impact of sociodemographic variables on cognitive test performance should also be considered. For many cognitive tools developed by English-speaking researchers, no reference data are available for non—English-speaking populations. The availability of norms for specific populations, languages, and cultures is essential to quality neuropsychological assessment. In recent years, the lack of normative data for the Spanish population has partially been solved by such normative studies as the NEURONORMA project[1,2] and the Normacog project.[3] The present study, developed in the context of the NEURONORMA-Plus project, aims to provide reference data for some neuropsychological tests that were not included in the original NEURONORMA project.

We provide age-, sex-, and education-adjusted normative data for the Delis Kaplan-Design Fluency Test (DK-DFT), Color Trails Test (CTT), and Dual Task (DT). These tests evaluate complex attention and different types of executive functions, defined as the skills that enable an adaptive response to novel situations.[4] All neuropsychological assessments should include executive function.

Design fluency is the non-verbal equivalent to verbal fluency, which is widely evaluated in cognitive assessments. It is defined as fluent productivity in the non-verbal domain, and measures the ability to generate series of abstract designs without repeating them.[5,6] Some tests have been designed to evaluate design fluency, including the Design Fluency Test,[7] the Ruff Figural Fluency Test,[8] and the Five-Point Test[6]; the latter has recently been normalised for the Spanish population.[9] However, some characteristics of the DK-DFT make the test particularly useful for evaluating non-verbal fluency. This tool is included in the Delis-Kaplan Executive Function System[10] battery and assesses 3 conditions: Condition 1 involves basic design fluency,[5] whereas Condition 2 involves inhibition and control and Condition 3 involves switching.[4] Switching may be described as the ability to shift attention between different stimuli or sets of responses.[11]

Unlike verbal fluency, for which many studies have analysed the impact of age, sex, and education level on test performance, very few studies have addressed the impact of sociodemographic variables on non-verbal fluency,[12] a situation that has changed in recent years.[9,13—15]

The CTT[16] was conceived as a culturally-adapted analogue to the Trail Making Test (TMT).[17] The CTT uses coloured circles, rather than the letters used in the TMT, making it suitable for illiterate individuals or those with a low level of education. The first part of the test evaluates sustained attention, defined as the ability to maintain attention to a specific task for a period of time despite the interference of distractors.[18] The second part measures alternating attention, that is the ability to shift attentional focus between 2 or more stimuli or cognitive processes. The first part of the CTT is usually associated with basic characteristics of attention, whereas the second part focuses on a higher-order executive function linked to alternating attention and cognitive flexibility. Attention tests frequently overlap with such other functions and concepts as working memory, response inhibition, or switching.[5] Although normative studies for the CTT have been conducted in different countries, none has been conducted in Spain.

Although in alternating attention, attentional focus shifts between several processes, some tasks require simultaneous attention. This ability is known as divided attention, and consists of focusing attention on multiple stimuli or processes at the same time, through optimal allocation of attentional resources or rapid shifting of attentional focus.[19] This type of attention is typically studied with a dual task paradigm, in which 2 tasks are performed simultaneously. An individual's ability to perform multiple tasks at the same time depends on a working memory system including multiple components, with a central executive component whose role is to control and integrate the function of 2 different peripheral systems. These peripheral systems are the phonological loop and the visuospatial sketchpad, which are responsible for processing and temporarily storing verbal and visuospatial information, respectively.[20] Dysfunction of the central executive component results in impaired ability to allocate attentional resources and, consequently, reduced ability to perform several tasks simultaneously.[21] Assessing an individual's ability to perform 2 tasks simultaneously appears to be a promising screening tool for mild cognitive impairment.[22] This study provides normative data for an experimental dual task based on previous studies.[23,24]

Material and methods

Participants

We included a total of 308 participants, recruited from among the relatives/friends of patients attended at the neurology department of Hospital del Mar in Barcelona, and patients cared for at adult care centres of the city of Barcelona. Recruitment was conducted considering prespecified groups (random sampling to divide participants according to sex, age, and level of education). All participants were white, and they all lived and were raised in Spain. The project was approved by the ethics committee of the medical research institute of Hospital del Mar, in Barcelona (Spain).

The following selection criteria were applied:

1) individuals giving informed consent; *2)* men and women aged 18—95 years; *3)* Spanish speakers with sufficient ability to read and write (reported during the initial interview and confirmed by a reliable history of at least one year of formal seducation); and *4)* independent for the activities of daily living, according to the Interview for Deterioration of Daily Living Activities in Dementia (score < 37).[25]

The exclusion criteria were as follows: *1)* history of central nervous system disease potentially causing neuropsychological deficits (e.g., stroke, epilepsy, traumatic brain injury, movement disorders, multiple sclerosis, brain tumours, etc.); *2)* history of abuse of alcohol or other psychotropic substances; *3)* presence of active or poorly controlled systemic disorders associated with cognitive impairment (e.g., diabetes mellitus, hypothyroidism, B_{12} deficiency); *4)* history of severe psychiatric disorders (e.g., major depressive disorder, bipolar disorder, psychosis); *5)* severe sensory deficits (vision and/or hearing loss) interfering with cognitive test performance; *6)* scores < 25 points on the Mini-Mental State Examination (MMSE)[26] (version proposed by Blesa et al.[27]) or < 5 points on the Memory Impairment Screen (MIS)[28] (Spanish-language version[29]); and *7)* any other reason that, in the authors' judgement, should preclude inclusion (e.g., lack of motivation). Participants did not receive compensation for their participation in the study.

Neuropsychological measurements

Tests were administered and scored according to the published manuals, with the exception of DT, which is an experimental task that was designed ad hoc. The research group translated the original instructions from English into Spanish, with the following methodology. First, a researcher drafted the first version of the instructions for each test. A consensus meeting was subsequently held with the rest of the clinical neuropsychologists, as well as 2 linguists, and a consensus version was proposed for each test. A behavioural neurologist with experience in the development of cognitive tests reviewed the instructions and approved the final version for each test. Due to the non-verbal nature of the tests, none of their elements required linguistic adaptation. All tests were administered by trained neuropsychologists who were native Spanish speakers.

Delis Kaplan-Design Fluency Test

The DK-DFT includes 3 conditions: basic, inhibition, and switching. For each condition, the examinee is given a sheet containing 35 boxes with a set of dots, and asked to create as many different designs as possible within 60 seconds, using only 4 straight lines to connect the dots in each box. Each line must be connected to the previous line by a dot, and lines can intersect. Designs do not need to be closed patterns, and they can be abstract.

In the basic condition (filled dots), each box contains 5 black-filled dots, and examinees are asked to create different designs by connecting these dots. In the inhibition condition (empty dots), each box contains 5 black-filled dots and 5 empty dots; participants are instructed to create different designs connecting the empty dots only, ignoring the black-filled dots (these are used in the previous condition). In the switching condition, each box contains 5 black-filled dots and 5 empty dots, but in this case participants are instructed to create different designs, switching from connecting filled dots or empty dots. Before each condition is administered, the participant completes 3 boxes as a practice exercise, with the examiner giving feedback on whether responses are correct. We gathered the total number of correct designs for each condition to establish normative data.

Color Trails Test

The CTT has 2 parts, CTT-1 and CTT-2, with both including a practice task. In CTT-1, the participant must draw a line to connect a series of circles, numbered 1 to 25, in ascending order, in the shortest time possible and without lifting the pen. In CTT-2, the participant is shown 2 circles for each number, one in yellow and the other in pink, and is instructed to connect the numbered circles, alternating between pink and yellow circles. In both parts of the CTT, the main variable is the time (in seconds) taken to complete the task.

Dual Task

The DT consists of 3 parts. The first 2 tasks (single-task condition) are relatively simple. In the third task, tasks 1 and 2 must be performed simultaneously (dual condition). The first 2 tasks consist of a digit span task (using the maximum verbal span) and a cancellation task. The worksheets are available upon request from the authors.

To determine the maximum verbal span, we administered the Spanish-language adaptation of the digit span test[30] according to the standard procedure described in the WAIS-III manual,[31] that is, 2 trials are administered for each span length regardless of whether the examinee correctly completes the first trial. Subsequently, we administered the first part of the test (verbal single-task condition), in which the participant is given 60 seconds to repeat series of digits of the maximum span length achieved previously. As the number of series varies depending on span length and the time taken to repeat the series, performance is measured according to the proportion of digits repeated in the correct position (total number of digits repeated in the correct order divided by the total number of digits presented by the examiner), rather than the number of correct series.

In the cancellation task, 2 sheets containing a row of silhouettes (animals and fruits) are placed horizontally. The participant is given 60 seconds to mark with a pencil all silhouettes matching the object. The main variable is the total number of matching silhouettes marked in the allotted time.

Lastly, in the dual-task condition, participants must perform the digit span task (maximum span) and the cancellation task simultaneously for 60 seconds. The variables included in our normalisation study were number of digits repeated in the correct order and number of correctly identified silhouettes.

Proportional performance in the digit span task (P digits) was estimated by measuring the change between performance on the single-task condition (p single-task) and the performance on the dual-task condition (p dual-task) using the following formula, where p is the proportion of digits repeated in the correct order divided by the digit span presented by the examiner:

Formula for P digits:

$$Pdigits = \frac{(psingle - pdual) \times 100}{psingle} \tag{1}$$

Proportional performance on the cancellation task (P cancellation) was estimated by calculating the change in performance between the single-task condition (t single) and the dual-task condition (t dual, defined as the total number of silhouettes correctly identified), using the following formula:

Formula for P cancellation:

$$Pcancellation = \frac{(tsingle - tdual) \times 100}{tsingle} \tag{2}$$

The proportional performance of the combination of both tasks (P dual), which is the main outcome variable considered in the normative data, was calculated with the following formula:

Formula for P dual:

$$Pdual = \frac{(Pdigits - Pcancellation)}{2} \tag{3}$$

Procedures

All assessments were conducted in a single session, in which participants were informed about the study and gave written informed consent. After that, they underwent an initial interview and were screened for eligibility. The cognitive test battery was administered to individuals meeting all the inclusion criteria and none of the exclusion criteria. Assessment took approximately 2 hours.

Statistical analysis

Normative data were calculated according to the procedures described in the NEURONORMA project,[1,2] although with slight variations, such as the use of semi-partial rather than univariate correlations to study associations with sociodemographic variables, and the use of the mean number of years of schooling of each group to adjust for level of education. To analyse the effect of sociodemographic variables on cognitive test performance, the sample was classified into 2 groups: individuals aged < 50 years (n = 118) and those aged $\geq$ 50 years (n = 190). This ensures the comparability of our data with those reported in previous normative studies within the NEURONORMA project, and achieves a more precise differentiation of the effect of ageing and level of education among younger and older adults.

Table 1 Sociodemographic characteristics for the total sample and by age group (< 50 and ≥ 50 years).

	Total (*n* = 308)	< 50 years (*n* = 118)	≥ 50 years (*n* = 190)
Age in years, mean (SD)	54.11 (19.17)	34.34 (9.32)	67.67 (10.35)
Years of schooling, mean (SD)	11.42 (4.24)	13.01 (3.49)	10.34 (4.38)
Sex (women), n (%)	167 (54.2%)	61 (51.70%)	106 (55.80%)

SD: standard deviation.

Table 2 Descriptive data of cognitive variables for the total sample and by age group (< 50 and ≥ 50 years).

	Total	< 50 years	≥ 50 years
DK-DFT			
Basic condition (total no. correct designs), mean (SD)	9.05 (3.29)	11.02 (2.81)	7.82 (2.97)
Inhibition condition (total no. correct designs), mean (SD)	9.89 (3.72)	12.32 (3.21)	8.38 (3.17)
Switching condition (total no. correct designs), mean (SD)	7.54 (3.13)	9.35 (2.86)	6.43 (2.75)
CTT			
CTT-1 (seconds), mean (SD)	51.17 (25.44)	33.87 (10.97)	61.91 (25.97)
CTT-2 (seconds), mean (SD)	109.84 (57.28)	67.07 (18.49)	136.41 (57.15)
DT			
Dual-task condition, mean (SD)	90.43 (15.11)	89.78 (14.56)	90.83 (15.46)

CTT: Color Trails Test; DK-DFT: Delis Kaplan-Design Fluency Test; DT: Dual Task; SD: standard deviation.

We applied the overlapping interval strategy to maximise the number of participants included in each normative group.[32] We considered 10 age groups for the creation of normative data (mid-points): 18—29 years (*n* = 41), 23—36 (*n* = 59), 30—43 (*n* = 48), 37—50 (*n* = 53), 44—57 (*n* = 61), 51—64 (*n* = 71), 58—71 (*n* = 83), 65—78 (*n* = 74), 72—85 (*n* = 68), and 79—92 (*n* = 40). We also established 10 new age ranges to study the applicability of normative data: 18—26, 27—33, 34—40, 41—47, 48—54, 55—61, 62—68, 69—75, 76—82, and 83—92.

Normative data were established according to the following procedure: *1)* Descriptive analysis (mean, standard deviation, and percentages for the total sample and for each age group). *2)* Determination of the effect of age, sex, and level of education with semi-partial correlations and the coefficient of determination (r^2). *3)* Creation of age-adjusted normative tables, assigning percentile ranks to NEURONORMA (age-adjusted) scaled scores (SS); this conversion resulted in a normal distribution of scores (range, 2—18; mean = 10; SD = 3). *4)* For the purposes of adjusting data for level of education, we performed linear regression analyses between SS and level of education. We calculated the correlation coefficient (r) and the coefficient of determination (r^2) of SS for each age group (< 50/≥ 50 years). When the explained variance was greater than 5% and β showed a significant effect (P < .05), data were corrected using the formula developed by Mungas et al.[33] Age- and education-adjusted NEURONORMA SS were calculated using the formulae education-adjusted SS = age-adjusted SS — (β* [years of schooling — 13]), for the group of participants aged < 50 years, and education-adjusted SS = age-adjusted SS — (β* [years of schooling — 10]), for participants aged ≥ 50 years, with the values 13 and 10 being the mean number of years of schooling in each group. *5)* To adjust for sex, we compared mean raw scores between men and women. When significant differences were found, a regression analysis was performed using age-adjusted or age- and education-adjusted SS as the dependent variable and sex as predictor; the criteria r^2 ≥ 5% and β (P < .05) were used to decide whether adjustment for sex was needed. Thus, age-, sex-, and education-adjusted SS were calculated with the following formulae: Age- and education-adjusted SS — (β* sex), or age-adjusted SS — (β* sex), depending on which factors showed a significant association. Statistical analysis was completed using the Statistical Package for Social Sciences (SPSS) software, version 22.

Results

Table 1 shows the sociodemographic characteristics for the total sample and by age group (< 50/≥ 50 years). Table 2 summarises the cognitive test results for the total sample and by age group (< 50/≥ 50 years).

Table 3 presents semi-partial correlations and coefficients of determination between raw DK-DFT, CTT, and DT scores and age, level of education, and sex. In the group of younger adults, age was found not to influence performance in any test. In the group of older adults, in contrast, age explained a high percentage of variance in the DK-DFT and CTT. Level of education was found not to influence DK-DFT and DT performance among younger adults, with the excep-

Table 3 Semi-partial correlations and coefficients of determination (r^2) between raw test scores and the variables age, level of education, and sex in our sample, by age group.

	Age (years)		Schooling (years)		Sex	
	Semi-partial correlation	r^2	Semi-partial correlation	r^2	Semi-partial correlation	r^2
< 50 years						
DK-DFT						
Basic condition (total no. correct designs)	−0.020	0.000	−0.019	0.000	−0.034	0.001
Inhibition condition (total no. correct designs)	−0.111	0.012	0.075	0.006	−0.226	0.051
Switching condition (total no. correct designs)	−0.208	0.043	0.109	0.012	−0.160	0.026
CTT						
CTT-1 (seconds)	0.047	0.002	−0.153	0.023	0.002	0.000
CTT-2 (seconds)	0.183	0.033	−0.291	0.085	−0.057	0.003
DT						
Dual-task condition	0.134	0.018	0.001	0.000	0.210	0.044
≥ 50 years						
DK-DFT						
Basic condition (total no. correct designs)	−0.388	0.151	0.336	0.113	0.027	0.001
Inhibition condition (total no. correct designs)	−0.449	0.202	0.287	0.082	−0.010	0.000
Switching condition (total no. correct designs)	−0.465	0.216	0.281	0.079	−0.032	0.001
CTT						
CTT-1 (seconds)	0.486	0.236	−0.191	0.036	−0.062	0.004
CTT-2 (seconds)	0.463	0.214	−0.291	0.085	0.066	0.004
DT						
Dual-task condition	0.019	0.000	0.005	0.000	0.189	0.036

CTT: Color Trails Test; DK-DFT: Delis Kaplan-Design Fluency Test; DT: Dual Task.

tion of the CTT-2, in which it explained 8.5% of variance. In the group of older adults, level of education explained between 3.6% and 11.3% of variance for all DK-DFT and CTT variables. Overall, sex did not influence any score, with the exception of the inhibition condition of the DK-DFT in young adults, for which it explained 5.1% of variance.

Age-adjusted NEURONORMA SS for the main variables of the DK-DFT, CTT, and DT are presented in the Supplementary material (Tables A1—A6). The scaled scores and percentiles associated to the raw scores for specific age ranges are presented in the first and second columns.

Table 4 displays the correlation coefficients (r) and coefficients of determination (r^2) of DK-DFT, CTT, and DT scores for age, education, and sex. As described in the methods section, data were adjusted for level of education when the explained variance was ≥ 5% and β was significant. Supplementary Material Tables B1-B6 present education-adjusted SS and the corresponding β values for each SS (left column) and level of education (top row).

Regarding adjustment for sex, an additional point must be added to age-adjusted SS for the inhibition condition of the DK-DFT in women and for the DT in men (Tables B7 and B8, respectively).

Discussion

The purpose of this study was to provide normative data for the DK-DFT, CTT, and DT, which are included in the NEURONORMA-Plus neuropsychological test battery, in the Spanish population aged 18—92 years. The sample was divided into 2 age groups (younger adults [< 50 years] vs older adults [≥ 50 years]) to ensure homogeneity with respect to the data reported in previous studies. We present age-adjusted normative data, as well as education- and sex-adjusted data, calculated with linear regression analysis.

Delis Kaplan-Design Fluency Test

Age showed a negative effect on DK-DFT performance. Scores were significantly lower in the group of older adults. These findings support the data presented by the authors of the test.[10] Our results are consistent with those reported by previous studies on the effect of sociodemographic variables on other neuropsychological tests evaluating non-verbal fluency.[4—15] Individuals with higher levels of education performed better on the test. This finding is also consistent with previous research on the effect of education on other tests for non-verbal fluency.[8,9] In the group of younger adults, sex was found to have a discrete effect on one condition only (inhibition), with men performing better than women, as reported by Harter et al.[34]

Color Trails Test

As described in previous normative studies,[16,35—39] age had a negative effect on the time taken to complete both CTT-1 and CTT-2 in the older group, but had no effect on CTT-

Table 4 Correlation coefficients (r) and coefficients of determination (r^2) of the scaled scores by age, education, and sex.

	Age (years)		Schooling (years)		Sex	
	r	r^2	r	r^2	r	r^2
< 50 years						
DK-DFT						
Basic condition (total no. correct designs)	0.05	0.002	0.005	0.000	0.017	0.000
Inhibition condition (total no. correct designs)	0.015	0.000	0.023	0.001	0.234	0.055
Switching condition (total no. correct designs)	0.055	0.003	0.095	0.009	0.167	0.028
CTT						
CTT-1 (seconds)	0.026	0.0007	0.148	0.022	0.007	0.00005
CTT-2 (seconds)	0.049	0.0024	0.259	0.067	0.025	0.0006
DT						
Dual-task condition	0.040	0.002	0.005	0.000	0.232	0.054
< 50 years						
DK-DFT						
Basic condition (total no. correct designs)	0.036	0.001	0.333	0.111	0.025	0.001
Inhibition condition (total no. correct designs)	0.036	0.001	0.308	0.095	0.070	0.005
Switching condition (total no. correct designs)	0.06	0.004	0.293	0.086	0.042	0.002
CTT						
CTT-1 (seconds)	−0.038	0.0014	0.253	0.064	−0.013	0.0002
CTT-2 (seconds)	−0.039	0.0015	0.357	0.127	−0.124	0.015
DT						
Dual-task condition	0.038	0.001	0.020	0.000	0.195	0.038

CTT: Color Trails Test; DK-DFT: Delis Kaplan-Design Fluency Test; DT: Dual Task.

1 performance in younger adults. Level of education had a moderate effect on CTT-2 performance but not on CTT-1 performance in both age groups, which suggests that completing the CTT-2 requires a higher educational level. No sex-related significant differences were found between groups; this is consistent with most published studies,[16,36–39] with the sole exception of the study by Sant'Ana Rabelo et al.,[35] who found that men scored higher in both parts of the CTT. In that study, which included nearly 2000 participants, only 19% of whom were men, the authors suggest that the higher level of education of men as compared to women may constitute a source of bias. In fact, this factor, together with the study's great statistical power as a result of its large sample size, may explain why the researchers found significant sex differences despite the small effect sizes.

Despite the differences between the CTT and the TMT, it is interesting to compare our results on the CTT against those presented for the TMT in previous NEURONORMA studies.[40,41] In general terms, the time taken to complete the CTT is similar, though slightly shorter than the time needed to complete the TMT (e.g., for scores around the median); for example, in the CTT-1, a scaled score of 10 corresponds to 35—40 seconds taken to complete the test in the 48—54 years age group, whereas in the TMT-A, the same scaled score corresponds to 36—46 seconds in individuals aged 50—56 years.[40] The differences in test completion times are more apparent in the second, more complex, part of the CTT. According to normative data, participants consistently took less time to complete the CTT-2 than the TMT-B; for example, a scaled score of 10 corresponds to 66—84 seconds on the CTT-2 and 80—107 seconds on the TMT-B. Although these data are from different samples, which makes the tests only partially comparable, they suggest that the TMT-B is more complex than the CTT-2. We may therefore hypothesise that this added complexity is derived from the need to know the alphabet to complete the test and the fact that the TMT-B requires the examinee to alternate between numbers and letters, whereas in the CTT-2, the examinee must alternate between numbers and 2 colours. Regarding the effect of sociodemographic variables, both age and, especially, level of education had a greater impact on TMT performance[40] than on CTT performance (for example, for individuals older than 50 years, the TMT-B showed a correlation with the education level of $r = 0.52$, compared to $r = 0.35$ in the case of the CTT-2). This further supports the superiority of the CTT for evaluating individuals with low levels of schooling or literacy.

Dual Task

As expected, our results revealed slightly poorer performance for the dual-task condition. As in previous studies, age was found to have no effect, which suggests that the skills evaluated with this paradigm are not affected by ageing.[20,23,42,43] However, these results stand in contrast with those of other studies reporting poorer performance on dual tasks in older adults.[44–46] Level of education was found not to influence test performance, whereas sex did have a small effect, with women performing slightly better; as a result, scores were adjusted in the group of men under the age of 50 years. This finding stands in contrast with those of previous studies[23] reporting level of education to have a positive influence and sex to have no effect. This may be explained by differences in the nature of the tasks and the characteristics of the samples. The difficulty of the task used in this study is adjusted to the capacities of each participant, focusing on intraindividual differences between single- and dual-task performance; this is one of the strengths of our study and may explain the lack of differences in performance between age groups.

Limitations

Our study is not without limitations. Sample size is a particularly relevant factor in normative studies. Our study evaluated over 300 individuals; to maximise the sample, we applied the overlapping interval strategy for developing age-adjusted norms. However, the wide age range of our sample resulted in smaller age subgroups, ranging from 40 to 83 participants. This size is considered sufficient; according to recent studies, the estimates of means and standard deviations are stable for a minimum size of 30—80 subjects, depending of the level of skewness.[47] Another limitation of our study concerns the applicability of these data to other Spanish-speaking populations. Professionals in Spanish-speaking countries other than Spain should use these normative data with caution as cultural differences may have significant impact on test performance.

Conclusions

This study provides normative data for the DK-DFT, CTT, and DT in the Spanish population. The DK-DFT is a useful measure of non-verbal fluency that complements the data obtained from a thorough executive function evaluation. The CTT is also useful in evaluating executive function, and is less affected by level of education. Lastly, the DT is a novel, simple-to-use tool for the assessment of divided attention. These normative data and the associated sociodemographic adjustments enable more reliable interpretation of the results of these cognitive tools in our setting.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi: https://doi.org/10.1016/j.nrleng.2021.05.013.

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