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How many segments are there in an orange: normative data for the new Cognitive Estimation Task in an Italian population.

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Abstract

The Cognitive Estimation Test (CET) is widely used by clinicians to assess frontal executive dysfunction. In the present work, the Italian standardization of a new version of the CET is provided. This version consists of two 9-item parallel forms (A and B) that were administered to two hundred and twenty-seven healthy Italian male and female participants aged between 19-91 years with 5–24 years of full-time education. Performance on the CET was not related to age or level of education; both forms showed a male CET advantage. The new CET is a useful tool for clinicians and researchers to administer the CET more than once without practice affects, which is considered important when assessing frontal-executive abilities.

Keywords: Neuropsychological test; Cognitive estimation; Executive Function; Frontal lobe

Introduction

Cognitive estimation refers to the ability to apply reasoning strategies in order to answer questions that individuals do not usually know the exact answer to. Producing appropriate responses is thought to rely on the ability to select an appropriate cognitive plan, carry out the selected plan and check any putative answer obtained [1]. Shallice and Evans [1] developed the first Cognitive Estimation Task (CET) in an attempt to assess these cognitive abilities, many of which are executive in nature. Other CET versions have been developed subsequently for administration in other countries [2-5]; nowadays it is a widely used test of executive function [6] in neurological and psychiatric conditions [7-22 see 23 for a review].

Recently, MacPherson et al. [7] devised an up-to-date version of the CET providing two parallel forms with 9 questions related to landmarks, people and objects that individuals from all countries should be familiar with. This new version permits repeated assessment of cognitive estimation abilities in both clinical and experimental settings (e.g., before and after a rehabilitation or pharmacological program). Moreover, it explicitly provides participants with the opportunity to change their responses if they feel the responses are inappropriate and removes the bizarreness index which was reported in the previous Italian CET version [1,5].

The aim of the present study was to provide normative data for the new version of CET [7] in a large Italian sample, to evaluate the effects of age, education and gender on performance and to calculate inferential cut-off scores.

Methods

Participants

Two hundred and twenty-seven healthy Italian volunteers (106 men, 121 women) aged between 19 and 91 years (M = 47.37 years, SD = 17.13 years) were recruited for the study. They were IRCCS Istituto Auxologico Italiano - Ospedale San Giuseppe employees and their relatives, and did not receive reimbursement for their participation. Their level of full-time education ranged between

5 and 24 years (M = 14.95 years, SD = 4.35 years). Participants were grouped into different age groups: 19–29 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years and 70–91 years, and different levels of education: 3-5 years (primary education), 6-8 years (secondary education), 9-13 years (high school education) and more than 13 years (university education). None of the participants had any previous history of neurological or psychiatric disorders or alcohol abuse. All participants were native Italian speakers. Written consent was obtained according to the Declaration of Helsinki. Table 1 provides the distribution of the demographic information of the participants according to age, education and gender.

Table 1

Procedure

Cognitive Estimation Task (CET)

Participants were administered both 9-item parallel forms of the CET [7]. Each question was read aloud by the experimenter and participants answered verbally. Participants were asked to make a sensible guess or estimate in response to each item and were told most questions did not have a precise answer but, if they did, it was unlikely participants would know the answer. Participants could take as much time as they needed to produce their estimates and answer the items using their chosen unit of measurement. Participants were given the opportunity to change their response if they decided that their first response was not a reasonable estimate.

Data Analysis

Spearman's correlation coefficients were calculated to examine the relationship between CET performance and age, gender and education. Separate linear regression analyses were then carried out to determine whether any of these demographic characteristics were significant predictors of

performance on the CET. Successively, the adjusted scores for both versions of the CET were then converted into Equivalent Scores (ES) [24].

Results

Cognitive Estimation Task (CET)

Firstly, responses were converted into the same unit of measurement. Outliers for each item's response were then removed using the interquartile range formula. Low values that fell below the lower quartile by 1.5 or more times the interquartile range and high values that fell above the upper quartile by 1.5 or more times the interquartile range were removed. Actual responses were then scored 0, 1, 2 or 3 points based on the percentiles. A score of 0 was awarded for responses that were deemed normal and fell between the 20th and 80th percentile. One point was awarded for responses considered quite extreme and were equal to or more than the 10th but less than the 20th percentile or more than the 80th percentile but less than or equal to the 90th percentile. Two points were awarded to responses considered extreme that were more than or equal to the 5th percentile but less than the 10th percentile or more than the 90th percentile but less than or equal to the 95th percentile. Finally, 3 points were awarded to very extreme responses that were less than the 5th or more than the 95th percentile. Where a response corresponded to more than one percentile category, the response was awarded the fewer number of points (e.g., a score of 8 on item 5 of CET A was awarded a score of zero rather than 1). Table 2 demonstrates the percentile ranges for the 227 healthy participants' actual responses on the individual CET A and B items.

Table 2

Participants could obtain a total score between 0 and 27 for each 9-item CET where the higher the score, the greater the number of responses that deviated from the group. The mean error score for

the CET A for the entire sample was 5.66 out of a possible 27 (SD = 3.90, median = 5.00, range = 0-18) and the mean error score for the CET B for the entire sample was 5.36 out of a possible 27 (SD = 3.31, median = 5.00, range = 0-19). The means, standard deviations, and the minimum and maximum values for the actual responses provided for each CET version are shown in Table 3. Both versions A and B of the CET had low reliability, Cronbach's α = .28 and .23 respectively. The Guttman split-half reliability coefficient was .31 and .26 respectively. Spearman's rank order correlations showed that performance on versions A and B of the CET correlated significantly ($r = .30$, $p<.0001$).

Table 3

Tables 4 and 5 demonstrate the means and standard deviations for the 227 participants performing both versions of the CET according to age group, gender and level of education. Spearman's rank order correlations revealed that performance on the CET did not correlate with age (version A: $p=.24$; version B: $p=.80$). Performance on the CET did significantly correlate with education on version A of the CET ($r = -.14$, $p<.05$) and approached significance with version B ($p=.07$). In terms of gender, Mann-Whitney U-Tests revealed a significant main effect of gender on CET A ($U = 5060.50$, $z = -2.75$, $p<.01$) and CET B ($U = 4842.50$, $z = -3.20$, $p<.01$) where male participants produced significantly lower CET scores than female participants (version A: M = 4.98, SD = 3.17; M = 6.26, SD = 3.65 respectively; and version B: M = 4.58, SD = 2.88; M = 6.05, SD = 3.51 respectively).

- Insert Table 4 around here -

Linear regression analyses were then conducted for each version of the CET to examine whether age, gender and years of education significantly contributed to performance on the task. For

version A, the analysis revealed a statistically significant model that explains 6.3% of the variance on the CET with only gender significantly that influencing performance ($p<.05$). The linear regression equation upon gender is y = 1.17 x (1 = male or 2 = female) + 4.36. For version B, a statistically significant model explained 6.0% of the variance on the CET again with only gender significantly influencing performance ($p<.01$). The linear model that explains the variance on the CET is y = 1.40 x (1 = male or 2 = female) + 3.92. A correction for gender should be applied to scores on both versions of the CET as the correction is adequate to move an individual's score from the normal to the impaired range, and vice versa. The correction to achieve adjusted gender scores is calculated as: - the unstandardized regression coefficient for gender x (gender – mean gender). In version A, the adjustment for gender is + 0.62 for males and - 0.55 for females. The distribution of the CET error scores for version A of the CET adjusted for gender is as follows: mean = 5.66, median = 5.45, SD = 3.43, minimum = -1, maximum = 17, interquartile range = 4.00. In version B, the adjustment for gender is + 0.74 for males and - 0.66 for females. The distribution of the CET error scores for version B of the CET adjusted for gender is as follows: mean = 5.36, median = 5.34, SD = 3.22, minimum = -1, maximum = 18, interquartile range = 5.00.

For CET version A, any raw score above the 95th percentile (above 12) should be considered impaired. For CET version B, any gender adjusted score above the 95th percentile (above 11) should be considered impaired. Table 6 provides the percentiles of the distribution of the CET A and the CET B scores adjusted for gender.

Table 5

The adjusted scores for both versions of the CET were then converted into Equivalent Scores (ES) to allow comparison between CET performance and other clinical tests normed on the Italian population [24, 25]. Given that the CET involves error scores where the higher the score, the poorer the performance, pathological performance was derived by scores higher than the one-sided nonparametric tolerance limit of adjusted scores for 95% of the population with 95% confidence [26] and scored 0. In CET version A, this separates 5 participants from the total of 227 (i.e., 2% of the sample). Adjusted scores below the median value were awarded an ES of 4. The deviation between the 95% tolerance limit and the median on the normal curve was 2.38 which was divided into 3 sections: 0 to 0.79; 0.79 to 1.58 and 1.58 to 2.38 containing 27%, 16% and 5% respectively of the normal distribution. Again, in CET version B, the one-sided nonparametric tolerance limit of adjusted scores for 95% of the population with 95% confidence separated 5 participants from the total of 227 (i.e., 2% of the sample). Adjusted scores below the median value were awarded an ES of 4. The deviation between the 95% tolerance limit and the median on the normal curve was 2.29 which was divided into 3 sections: 0 to 0.76; 0.76 to 1.52 and 1.52 to 2.29 containing 27%, 15% and 6% respectively of the normal distribution. Table 6 provides the ES scores for the CET A and B.

Table 6

Discussion

The main aim of this study was to provide Italian normative data for the new parallel versions of the CET which allow participants to be assessed on more than one occasion without practice effects [7]. According to the analyses, no correction for age or years of education is necessary for either version of the CET; however it is necessary to adjust a participant's error score for gender in versions A and B. Any gender adjusted score above 12 (for version A) and above 11 (for version B) should be considered impaired.

Unlike the British normative data [7], the successful performance of Italian participants on the new CET parallel forms was not associated with increasing age or years of education. While these findings differ from British individuals performing the same CET versions [7], they are in line with the previous Italian version of the CET [5], where performance was associated only with gender, but not with age or education. Other studies in the literature have also reported no influence of age on CET performance [27-29]. It may be that cognitive estimation preservation with age is related to the durability of crystallized intelligence in aging [30]. Recently, Gansler and colleagues [31] administered a revised version of the original CET [1] to 216 healthy participants and found that crystallized intelligence best predicted CET performance, but further work is needed to clarify this issue.

The CET advantage found in our Italian male participants has previously been reported in other CET studies [5,8,31], including the British sample administered the same CET [7]. While previous CET studies have shown that higher levels of education are associated with lower CET error scores [5,7,8], performance on this Italian version was not related to education. This is surprising given that our participants had a wide range of educational levels (ranging from 5 years to 18 years and more) compared to previous studies that have tended to recruit individuals that do not have as low a level of education [7], have only high or low education levels [2, 27] or the participants' education levels are not specified [28] and do report education effects. The current study cannot rule out the possibility that CET performance in the Italian sample is related to general intellectual abilities given that educational level is only a crude measure of intellect. Future work should investigate the role of general intellectual abilities on CET performance in an Italian sample.

The internal consistency of the items within the CET was very low, as have also been found in other studies [28,32], suggesting that the items essentially measure different constructs and the complex nature of the CET. There is also the ongoing debate in the literature regarding whether the CET should be considered a measure of global cognitive abilities rather than frontal executive abilities [8]. For the moment, given that clinicians and researchers continue to widely use the CET as a quick and easy

assessment of executive dysfunction, the provision of Italian normative data for these new parallel CET versions is timely.

Conflict of Interest. The Authors declare that they have no conflict of interest.

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Table 1. Distribution of the participants' demographic characteristics according to age, education and gender. Age and Education were reported in years.

		Age						
		19-29	30-39	40-49	50-59	60-69	70-91	Total
Education								
3-5	M	0	0	0	0	0	1	1
	F	0	0	0	1	1	3	5
6-8	M	0	1	0	4	5	0	10
	F	0	1	2	5	4	2	14
9-13	M	6	6	3	8	9	3	35
	F	5	2	6	16	5	6	40
> 13	M	13	18	6	17	4	2	60
	F	23	14	9	10	4	2	62
Total	M	19	25	9	29	18	6	106
	F	28	17	17	32	14	13	121

M = Male; F = Female

Table 2. Percentiles for individual items on versions A and B of the CET.

	CET A Percentiles						CET B Percentiles					
Item	5th	10th	20th	80th	90th	95th	5th	10th	20th	80th	90th	95th
1	100.00	118.00	130.00	200.00	250.00	250.00	2.00	3.00	3.00	6.00	10.00	10.00
2	30.00	35.00	40.00	50.00	60.00	60.00	25.00	34.00	40.00	120.00	130.00	150.00
3	30.00	40.00	50.00	80.00	85.00	100.00	15.75	30.00	50.00	200.00	210.00	230.00
4	5.00	6.00	8.00	20.00	25.00	30.00	30.00	31.60	40.00	84.40	100.00	110.00
5	7.00	8.00	8.00	12.00	12.00	16.00	103.00	104.00	105.00	114.00	115.00	120.00
6	10.00	11.00	15.00	20.00	24.00	25.00	44.50	50.00	60.00	90.00	100.00	100.00
7	50.00	60.00	80.00	120.00	130.00	150.00	30.00	40.00	50.00	100.00	107.00	120.00
8	100.00	120.00	130.00	180.00	200.00	200.00	6.00	10.00	15.00	50.00	60.00	70.30
9	30.00	35.00	40.00	60.00	70.00	80.00	250.00	280.00	300.00	350.00	360.00	380.00

Table 3. The means, standard deviations and minimum and maximum values for versions A and B of the CET.

	Category	Unit	Mean	SD	Min	Max
Version A						
What is the maximum speed of a Harley-Davidson motorbike?	Speed	km/h	169.89	47.25	60	300
What is the length of the average newborn baby?	Length	cm	47.06	8.16	25	65
How fast do race horses run?	Speed	km/h	62.09	20.97	7	120
What is the average jogging speed?	Speed	km/h	13.65	7.18	3	30
How many segments are there in an orange?	Quantity	segments	10.28	2.39	4	18
What is the length of a new pencil?	Length	cm	17.40	4.26	8	25
What is the maximum speed of a cheetah?	Speed	km/h	100.35	29.60	20	180
What is the length of an average men's mountain bike?	Length	cm	158.54	30.72	100	240
How many keys are there on a standard computer keyboard?	Quantity	keys	48.63	13.61	15	90
Version B						
What is the average walking speed of the typical healthy adult man?	Speed	km/h	5.24	2.24	1	10

How long is the average tie?	Length	cm	83.33	38.59	1	200
What is the fastest tennis serve?	Speed	km/h	117.08	70.80	1	360
How many keys are there on a standard piano?	Quantity	keys	63.24	26.09	11	140
What is the age of the oldest person in your country?	Quantity	age	109.69	4.68	100	121
What is the length of an average man's spine?	Length	cm	71.29	17.89	30	110
What is the maximum speed of a cyclist?	Speed	km/h	71.55	27.96	10	150
How many strings are there on a harp?	Quantity	strings	31.56	19.88	3	90
What is the maximum speed of a Formula 1 car?	Speed	km/h	321.40	36.07	230	400

Table 4. Means with standard deviations in parentheses per age, gender and education group for 227 Italian participants performing version A and B of the CET. Age and Education were reported in years.

		CET A						CET B					
		Age						Age					
Education	Gender	19-29	30-39	40-49	50-59	60-69	70-91	19-29	30-39	40-49	50-59	60-69	70-91
3-5	M	- -	- -	- -	- -	- -	3.00 -	- -	- -	- -	- -	- -	4.00 -
	F	- -	- -	- -	5.00 -	4.00 -	13.33 (4.04)	- -	- -	- -	6.00 -	8.00 -	9.67 (5.51)
6-8	M	- -	1.00 -	- -	4.00 (2.00)	7.40 (5.50)	- -	- -	5.00 -	- -	4.50 (4.12)	4.40 (2.70)	- -
	F	- -	7.00 -	4.00 (1.41)	4.40 (2.07)	7.00 (5.94)	9.50 (4.95)	- -	9.00 -	3.50 (3.54)	6.20 (2.17)	8.75 (2.22)	6.50 (0.71)
9-13	M	6.67 (3.20)	5.83 (2.99)	4.33 (3.21)	3.88 (2.30)	5.78 (2.64)	4.00 (4.00)	5.83 (4.31)	4.50 (2.17)	3.33 (3.06)	5.63 (3.29)	2.89 (2.32)	4.33 (1.53)

	F	7.60 (4.62)	5.50 (2.12)	5.83 (2.48)	5.25 (2.21)	7.80 (3.96)	9.50 (4.68)	9.40 (1.95)	2.50 (0.71)	6.17 (2.99)	5.94 (2.64)	5.20 (2.49)	8.83 (5.42)
> 13	M	6.15 (3.26)	4.17 (2.57)	4.17 (2.40)	4.24 (3.46)	6.50 (3.00)	5.00 (7.07)	5.08 (2.75)	4.78 (3.17)	4.67 (3.88)	4.41 (2.40)	3.50 (3.00)	5.50 (3.54)
	F	5.96 (3.27)	4.86 (3.72)	5.22 (3.19)	5.50 (3.21)	7.50 (2.38)	11.50 (4.95)	5.17 (3.08)	6.00 (4.61)	4.33 (3.24)	5.60 (3.50)	4.00 (3.74)	8.50 (3.54)

Table 5. Percentiles of the distribution of the adjusted for gender error scores on the parallel versions of the CET. The possible scores range from zero (best performance) to 27 (worst performance).

Percentiles	CET A	CET B	Percentiles	CET A	CET B
5th	0	1	55th	5	5
10th	2	1	60th	6	6
15th	2	2	65th	6	6
20th	3	2	70th	7	7
25th	3	3	75th	8	7
30th	4	3	80th	8	8
35th	4	4	85th	9	9
40th	4	4	90th	10	9
45th	5	5	95th	12	11
50th	5	5	100th	17	18

Table 6.

Equivalent scores for the parallel versions of the CET. An equivalent score of 0 is considered impaired and an equivalent score of 1 is considered borderline.

Equivalent Score	CET A	CET B
0	14	13
1	11-13	11-12
2	9-10	8-10
3	6-8	6-7
4	≤5	≤5