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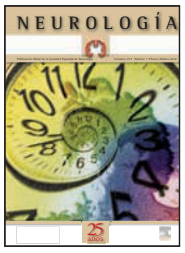

ORIGINAL ARTICLE

# Validation of the Pascual Graphomotor Test in Cuban school children

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**KEYWORDS**
Children;
Drawing;
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**Abstract**
*Introduction:* The ability to draw is a complex perception and cognition function, which is acquired in infancy and is not usually investigated in the neuropaediatric clinic.
*Objective:* To validate the Pascual graphomotor test (PGT) in 5 to 11 year-old Cuban school children.
*Patients and methods:* The PGT was performed on a total of 172 children from the city of Havana Círculo Infantil del Municipio Plaza nursery school and from the 1st to 5th year of a primary school in the same area. The sample was systematic. The test was repeated the following day. All the drawings were scored blind by a neurologist and neurology resident.
*Results:* For the validation of the test the differentiation with age and school year was taken as a validation criterion. A high correlation was obtained between the ages of the children and the scores obtained. The Spearman coefficient was −0.78 ($P$=0.01), and a there was a similar inverse correlation between the school year and the test scores (Spearman coefficient=−0.79, $P$=0.01). The test was very reliable, with an intraclass correlation coefficient (ICC) of 0.99 for inter-observer agreement and 0.97 for the test-retest.
*Conclusions:* The test was valid according to the criterion employed, differentiation with age and school year. The PGT demonstrated good temporal and inter-observer stability. We believe that it is a very useful tool in the neurological examination of Cuban school children.


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**PALABRAS CLAVE**
Niños;
Dibujo;
Maduración;
Test grafomotor;
Test psicométrico;
Trastorno visuoconstructivo

**Validación del test grafomotor de Pascual en niños escolares cubanos**

**Resumen**
*Introducción:* La capacidad para dibujar constituye una función practognósica compleja, que se adquiere en la infancia y que no suele explorarse asiduamente en la consulta neuropediátrica.
*Objetivo:* Validar el test grafomotor (TGM) de Pascual en escolares cubanos de 5 a 11 años.
*Pacientes y métodos:* Realizaron el TGM un total de 172 niños pertenecientes al preescolar de un Círculo Infantil del Municipio Plaza de Ciudad de la Habana y los que cursaban del primer al quinto grado en una escuela primaria de esta misma área. El muestreo fue sistemático. El test se repitió al siguiente día. Todos los dibujos fueron puntuados a ciegas por un neurólogo y una residente de neurología.
*Resultados:* Para la validación del test se tomó como criterio de validación la diferenciación con la edad y el curso escolar. Se obtuvo una alta correlación entre las edades de los niños y las puntuaciones obtenidas (coeficiente de Spearman = −0,78; $p < 0,01$) y similar correlación inversa entre el curso escolar y las calificaciones del test (coeficiente de Spearman = −0,79; $p < 0,01$). El test resultó muy fiable, siendo el coeficiente de correlación intraclase (CCI) para la concordancia interobservador de 0,99 y para el test-retest de 0,97.
*Conclusiones:* El test fue válido de acuerdo al criterio empleado de diferenciación con la edad y el curso escolar. El TGM demostró una gran estabilidad temporal e interobservador. Consideramos que es un instrumento muy útil en la exploración neurológica del niño en edad escolar en Cuba.


## Introduction

The basic function of psychological tests is to measure differences between individuals or within the same individual at different times. It is therefore clear that psychological tests are commonly used to solve a wide range of practical problems, as well as for important roles in research.[1]

There are several diagnostic tests developed for the maturity level of children. Historically, the most notable among them is that of drawing human figures, created by Goodenough (1926), which has been used both as a test of mental maturity and personality.[2] In our environment, the most commonly employed are the Bender test (developed by Lauretta Bender in 1938[3,4]), the Rey test (created by Rey in 1942[5]) and the visual-motor integration (VMI) developmental test (designed by Beery in 1982[6]). All these tests require the child to copy geometric shapes and the failures or successes are then scored. The scores are given as direct scores or typical scores (making the mean 100 points and the standard deviation [SD] 15) as with psychometric tests. Using these measures, neuropsychologists can guide the rehabilitation of patients who have been affected cognitively. Neuropsychological testing is more sensitive to the functional consequences of brain injury than conventional neuroimaging studies. However, neuropsychological tests are of limited usefulness by themselves and should be interpreted in conjunction with clinical and neuroimaging information, as well as complementary laboratory tests.[7]

The act of drawing is a complex praxic-gnosic function, which is acquired during childhood. Its performance is influenced by visual perception, the integration of varied visual information (visual-motor integration), practical skills and fine motor execution. A test that measures this capability in consultation is of extraordinary neuropediatric value.[8]

Although there are tests to measure visual-perceptual and fine motor skills in children, these are applied individually and require the investment of time by the examiner for each patient, thus limiting their daily use in neuropediatric consultation. Consequently, our study aim was to validate the Pascual graphomotor test (a user-friendly tool, for both individual and collective use, that is quick (it takes less than 10 minutes), appeals to children and is easy to score) so it can be commonly used in neuropsychological examination, or even by educators, for the early detection of students with problems in the acquisition of these skills.

The Pascual graphomotor test has previously been validated in normal school populations, in Spain and Peru,[8,9] and has been used in children of different neuropsychiatric conditions.[10,11] However, as it is compared with the age criterion, it is only valid under the environmental conditions in which it was established, that is, it cannot be assumed that this criterion is universal.[1] This forces us to validate it under our own conditions if we wish to consider it as a screening instrument for these alterations.

We present the results obtained from applying the test to a number of Cuban children pf normal mental and

learning level, to demonstrate the validity, reliability and simplicity of the Pascual graphomotor test. These characteristics are necessary for the test to be useful in our environment.

## Subjects and method

We performed a prospective transversal study to ascertain the normal maturity pattern of drawings by Cuban schoolchildren through the Pascual graphomotor test (GMT) and to study the validity and reliability of the scoring methods proposed by the author of the test.[8]

### Techniques and procedures

#### Sample selection

For this purpose we used all preschool children from the nursery located in Plaza Borough, with urban population in the Cuban capital, as well as those from first to fifth grades from an elementary school in the same area. Subsequently, we excluded from the study any children who did not meet the following inclusion criteria:

1. Falling within the age group 5 to 11 years.
2. Carrying out the first and second test.
3. Having a normal school performance according to their teachers.
4. Completing all drawings in the test.

#### Application of intervention

The test was administered to all children on two occasions (test and retest) on consecutive days, under similar conditions (lighting, ventilation, noise level, guidance of teachers and test duration). The test was performed as a group by all students in each classroom and with specific instructions, as recommended by the author of the test in his original article,[8] at the start of a school day, all in unison and under the same external conditions.

Each child received a sheet with drawings (8 simple shapes: diamond, ladder, cross, flower, clock, house, cube and bicycle), which were to be copied as best as possible, according to the instructions set out by the author of the test.[8]

#### Information collection

To obtain the information needed to complete the objectives, in parallel with the implementation of the GMT, we collected the following variables in a separate record: age, gender, school year, number of application of the test and normal school performance, based on the opinion of the teacher.

We also scored the tests, independently and without knowing the above data. This was done by 2 observers: a) by a third-year neurology resident and b) by a neurology specialist.

The correction method used was that described by the author of the test,[8] which gives scores between 0 (perfect test) and 20 (worst possible test). Each figure was scored according to the type of copying error and the total test score was calculated by the sum of the scores awarded to each of them.

We excluded the test results of children whose school performance was marginal or bad, at the discretion of the teacher, and supported by the neurological and psychiatric examination, performed by a specialist in Neurology and Child Psychiatry, respectively. In this way, we could estimate that, by requiring normal school performance as a criterion for inclusion in the study, the intelligence quotient (IQ) of those tested was 85 or above.

To demonstrate the validity of the test, we used the criterion of differentiation with age and school year, to determine whether scores improved progressively with advancing age and school year respectively, as would be expected of skills acquired with maturity, during childhood.[1], Whether there were statistically-significant differences in the scores obtained by each gender was also determined.

Test reliability was evaluated by showing that the scores were stable over time, that is, that they behaved similarly in the first and second applications of the test (test-retest). Moreover, the scores given by both observers should also be similar, thus implying that the test should be evaluated by 2 examiners.[1]

We compiled an Excel database with the information obtained. For the statistical analysis, we used the SPSS software package. Descriptive statistics were calculated: means, standard deviations, variances and percentiles. Comparisons of results between two quantitative variables were carried out by analysing the means of independent samples or of paired samples with the Student t-test; for comparisons between two qualitative variables, we used the Mann Whitney nonparametric U test. Comparisons of more than two independent means were performed using the Kruskal Wallis test and Tamhane's *a posteriori* test for multiple comparisons.

The relationships between two or more variables were analysed using the Spearman correlation coefficient. To calculate the test-retest and interobserver correlation, we used the intra-class correlation coefficient (ICC).

## Results

The aim of this study was to identify the maturity pattern of the ability to draw in normal school children. Therefore, to determine the validity and reliability of the GMT, we excluded those subjects with poor school performance and others who could not complete the test (see inclusion criteria).

### Sample characteristics

From a total of 205 children who took the test, we excluded 33 (4 due to not performing the second test, 27 due to presenting poor school performance and 2 due to personal history of epilepsy or ADHD). Consequently, the sample finally consisted of 172 children (344 tests). Of these, 82 were male and 90 female.

The ages were within the interval of 5.33 years to 11.35 years, with a mean of 8.32 years, SD of 1.78 years and

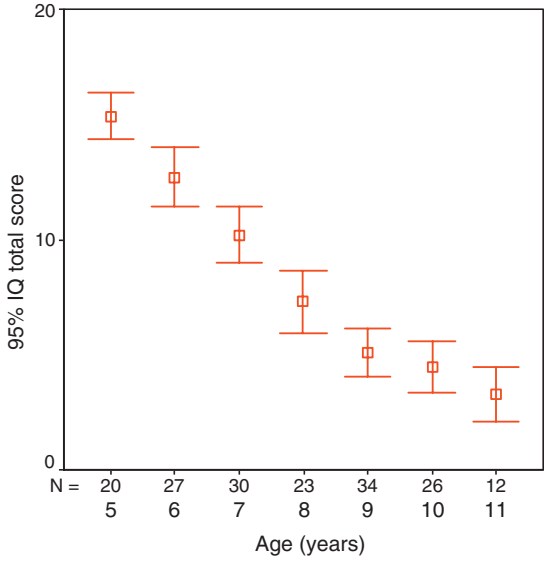


**Figure 1** Mean score by age groups. Spearman correlation coefficient = −0.78. Source: Data collection forms.

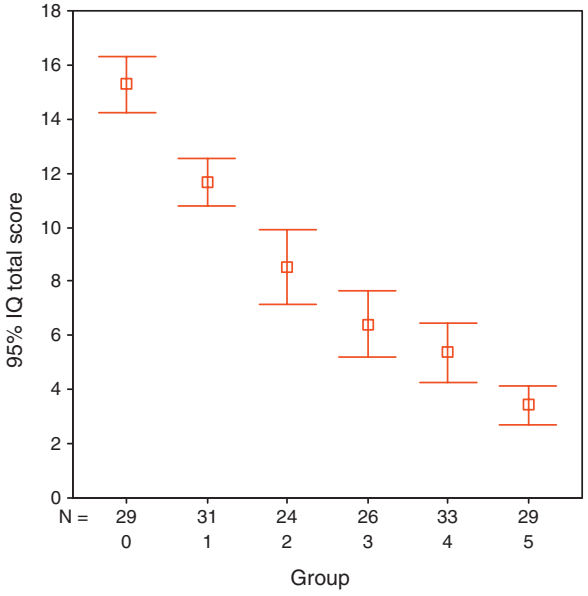


**Figure 2** Mean score by school years. Spearman correlation coefficient = −0.79. Source: Data collection forms.

P50 of 8.33 years. From this we can infer that, as the median (P50) and the mean were very similar, the different age groups were equally represented in the sample. This has great relevance, given that the criterion of differentiation with age was precisely one of those employed in the validation of the GMT.

## Validity of the Pascual Graphomotor Test

Looking at figures 1 and 2, it is clear that scores decrease with increasing age or school year, that is, the copying of the drawings is perfected. This is also demonstrated by the high correlation between the ages of children and the scores obtained, yielding a Spearman coefficient =−0.78 ($P<.01$), which shows a very close negative correlation. In addition, it also shows a high inverse correlation between school year and the scores obtained in the test (Spearman coefficient =−0.79, $P<.01$).

There were significant differences between the mean scores of each age group as a whole (Kruskal Wallis =111.668 and $P<.01$). The multiple comparison tests also yielded significant differences between the means of scores obtained between consecutive age groups, or between two age groups (table 1).

Similar results were obtained on analysing the differences between the mean scores obtained per school year, which were globally significant (Kruskal Wallis =116.257 and $P<.01$). Likewise, multiple comparison tests showed significant differences between the mean scores obtained by children in consecutive school years or every two years (table 2).

## Interobserver and test-retest reliability

The ICC result for interobserver agreement was 0.99. For the test-retest, the ICC result was 0.97.

## Comparison of results in both genders

The mean age in the sample studied was 8.3 years for females and 8.4 years for males, with t= −0.27, $P=.78$. This shows that there was no statistically-significant difference between middle ages, that is, both genders were equally represented in the various age groups studied.

**Table 1** Differences between the mean scores by age

| Age (years) | 5.0-5.99 | 6.0-6.99 | 7.0-7.99 | 8.0-8.99 | 9.0-9.99 | 10.0-10.99 | 11.0-11.99 |
|---|---|---|---|---|---|---|---|
| 5.0-5.99 | -------- | * | ** | ** | ** | ** | ** |
| 6.0-6.99 | * | ---------- | NS | ** | ** | ** | ** |
| 7.0-7.99 | ** | NS | ---------- | * | ** | ** | ** |
| 8.0-8.99 | ** | ** | * | ---------- | NS | * | ** |
| 9.0-9.99 | ** | ** | ** | NS | ---------- | NS | NS |
| 10.0-10.99 | ** | ** | ** | * | NS | ---------- | NS |
| 11.0-11.99 | ** | ** | ** | ** | NS | NS | ---------- |

** $P<.01$; NS: not significant.

**Table 2** Differences between the mean scores by school grades

| School grade | Preschool | First | Second | Third | Fourth | Fifth |
|---|---|---|---|---|---|---|
| Preschool | ---------- | ** | ** | ** | ** | ** |
| First | ** | ---------- | ** | ** | ** | ** |
| Second | ** | ** | ---------- | NS | ** | ** |
| Third | ** | ** | NS | ---------- | NS | ** |
| Fourth | ** | ** | ** | NS | ---------- | NS |
| Fifth | ** | ** | ** | ** | NS | ---------- |

* $P<.05$; ** $P<.01$; NS: not significant.

**Table 3** Percentile of Pascual graphomotor test scores in a normal Cuban school population by age groups.

| Age (years) | P25 | P50 | P75 |
|---|---|---|---|
| 5.0-5.99 | 14.63 | 15.75 | 16.88 |
| 6.0-6.99 | 10.75 | 12.25 | 14.00 |
| 7.0-7.99 | 7.81 | 9.75 | 12.50 |
| 8.0-8.99 | 4.75 | 7.00 | 9.25 |
| 9.0-9.99 | 3.12 | 4.78 | 6.75 |
| 10.0-10.99 | 2.00 | 4.00 | 6.56 |
| 11.0-11.99 | 1.56 | 3.88 | 4.88 |

Source: Data collection forms.

Moreover, the mean score was 8.52 in girls and 8.36 in boys and no statistically-significant differences were obtained when applying the Mann-Whitney U test (value 3630.00 and $P=.854$). Consequently, graphomotor maturity was similar in both genders.

Table 3 shows the values corresponding to percentiles 25 to 75 for each age group, obtained by the children studied (who were normal schoolchildren), and which we propose as the normality range.

## Discussion

The aim of this research was to validate the Pascual GMT in normal Cuban children, with a view to its subsequent use in everyday neuropediatric consultations as part of the neuropsychological examination of infants.

To validate the test, we examined children between 5 and 11 years of age from a normal school population. For validating a test as a diagnostic tool, it must be demonstrated that it truly measures the quality that it is intended to evaluate. In our study, we could not perform psychometric or visual-perceptual tests, so the results of the GMT cannot be compared with them. We believe that the validity with respect to other neuropsychological tests is not important in our work, given that the studied population was of normal intelligence (inclusion criteria: that school performance was normal), and that Dr. Pascual[8] already demonstrated this type of validity. We also took as a reference the fact that the graphomotor test had been validated previously against the Wechsler Intelligence Scale in Spanish schoolchildren,[10,11] showing high sensitivity but low specificity. Consequently, we took the relationship between test scores and age/school year as validation criteria, since a test to measure a function or quality that undergoes maturation with age should improve its score as both age and school year increase.

In our study, the GMT showed a high inverse correlation between the test scores and the age of the children, as well as the school year. These results are comparable with those of other tests, such as the Beery[6] and Bruininks-Oseretsky[12] tests; our results are also similar to the findings of Pascual and Bojórquez when applying this same test in other children populations.[8,9] The correlation was negative because the test counts errors and these decrease as age increases. Furthermore, the school grade had great influence on the performance of the test. This might have been because teaching becomes different as children pass each course, with educational requirements becoming progressively higher, so it is not surprising that the functions that depend on the maturity of the individual are related largely to schooling achieved until that time.

The comparison between the mean scores in each age group and each school year showed statistically-significant differences globally. There were significant differences between the mean scores in successive age groups, or two age groups, and between the mean scores obtained by the children of consecutive school years or every two years. This shows that the GMT is very sensitive when measuring how visuomotor functions mature year by year in children between 5 and 11 years of age. Very similar results were reported previously by the authors when they applied the GMT in Spain and Peru.[8,9]

In our study, visual-graphomotor maturity was similar in males and females. These results are consistent with those found by the authors when they validated the test in other populations previously.[8,9]

The test proved to be reliable in our population, with ICC greater than 0.90, considered high or excellent (minimal or no error). This is a very important quality because it indicates that it can be repeated without fear that the outcome will be altered by learning or by being assessed by different professionals, maintaining its usefulness as a measure of graphomotor maturity.[8,9,13,14]

We do emphasise that the scores obtained by Cuban schoolchildren were higher than those reported in the series of Spanish and Peruvian children.[8,9] In the absence of a

psychometric study of the participating children, we cannot be sure if there is some selection bias by teachers with respect to what they consider normal school performance. In any case, normal performance assures us that intelligence is normal, most likely above IC 85, and it must be taken into account that the validation of the GMT in Spain also selected cases by this approach. In our study we excluded 27 out of 205 cases (13%) due to poor performance, which corresponds to a normal distribution of the population in terms of intelligence, with a mean of 100 to almost one standard deviation, that is, IC 70-85. We therefore consider that we ruled out reasonably a selection bias of children who were more or less intelligent than the average population.

The slight differences in scores between school populations from different countries highlights the importance of carrying out the validation of the test prior to its final implementation in a specific population.

## Conclusions

1. The test was valid according to the criteria used for differentiation by age and school year.
2. Development of graphomotor maturity was similar in both genders.
3. The GMT showed great temporal and interobserver stability.

## Conflict of interest

The authors declare no conflict of interest.

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