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# Descriptive analysis of the Test of Everyday Attention for Children in a Spanish Normative Sample

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**Introduction.** Test of Everyday Attention for Children (TEA-Ch) has been validated in different countries demonstrating that it is an instrument with a correct balance between reliability and duration. Given the shortage of trustworthy instruments of evaluation in our language for infantile population we decide to explore the Spanish version of the TEA-Ch.

**Methods.** We administered TEA-Ch (version A) to a sample control of 133 Spanish children from 6 to 11 years enrolled in school in the Community of Madrid. Four children were selected at random by course of Primary Education, distributing the sex of equivalent form. Descriptive analysis and comparison by ages and sex in each of the TEA-Ch´s subtests were conducted to establish a profile of the sample. In order to analyze the effect of the age, subjects were grouped in six sub-samples: 6, 7, 8, 9, 10 and 11 years-old.

**Results.** This first descriptive analysis demonstrates age exerted a significant effect on each measure, due to an important "jump" in children´s performance between 6 and 7 years-old. The effect of sex was significant only in two visual attention measures *(Sky Search & Map)* and interaction age and sex exerted a significant effect only in the dual task *(Score DT)*.

**Conclusions.** The results suggest that the Spanish version of the TEA-Ch (A) might be a useful instrument to evaluate attentional processes in Spanish child population.

**Keywords:** TEA-Ch, Attention, Maturation, Executive functions, ADHD, Attention Deficit

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## Análisis descriptivo de la batería Test of Everyday Attention (TEA-Ch) en población infantil española de Educación Primaria

**Introducción.** La batería *Test of Everyday Attention for Children* (TEA-Ch) ha sido validada en distintos países demostrando que es un instrumento con un correcto equilibrio entre fiabilidad y tiempo. Dada la escasez de instrumentos de evaluación fiables en nuestro idioma para población infantil decidimos explorar la versión española de la TEA-Ch.

**Metodología.** Se administró la *versión A* de la TEA-Ch a una muestra control de 133 niños españoles de 6 a 11 años, escolarizados en la Comunidad de Madrid. Se seleccionaron al azar cuatro niños por curso de Educación Primaria, distribuyendo el sexo de forma equivalente. Para establecer un perfil de la muestra, se realizó un análisis descriptivo y una comparación por edades y sexo en cada una de las subpruebas de la TEA-Ch (A). Para analizar el efecto de la edad, los sujetos fueron agrupados en seis grupos: 6, 7, 8, 9, 10 y 11 años.

**Resultados.** Este primer análisis descriptivo demuestra la presencia de efectos de la edad en todas las variables, debidos a un "salto" importante en el rendimiento de los niños entre los 6 y los 7 años. El efecto del factor sexo sólo fue significativo en dos pruebas de atención visual *(Caza de naves* y *Mapa)* y el de la interacción edad y sexo en la prueba de doble tarea *(Hacer dos cosas a la vez)*.

**Conclusiones.** Los resultados sugieren que la versión española de la TEA-Ch (A) podría ser un instrumento útil para evaluar las funciones atencionales en población infantil española.

**Palabras Clave:** TEA-Ch, Atención, Maduración, Función ejecutiva, TDAH, Déficit de Atención

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## INTRODUCTION

Attention problems associated with diverse pathologies are key challenges to neuropsychiatry. Nowadays, attention is considered a multidimensional process which comprises several interconnected and hierarchized subsystems[1-3]. According to this perspective, attention is a system or network which controls various processes contributing to greater performance on the task. In this regard, evaluating attention in adults is a research topic with a long tradition[4-6], however, fewer research in children is found[7] and even less in Spanish. In addition, the absence of an unified theoretical model and the variety of tests intended to evaluate attention, makes it difficult to collect reliable data. Nevertheless, although apparently the tests vary, their results can be compared finding effects of age on all measures (with breaks at 6-7 years and 10-12 years) and an evolutionary pattern in which motor inhibition matures first, then impulse control and finally sustained and selective attention.[2,8]

As for the clinical population, although attentional difficulties are common in many disorders, in recent years research has been primarily focused on the Attention Deficit Hyperactivity Disorder (ADHD), finding that those diagnosed children display problems with sustained attention and execution control[9]. Within this field of study, it can be appreciated an increased use of Posner and Petersen model-based batteries[2] which attempt to measure each of the three basic types of attentional processes with different tests[10,11]. Most commonly used tests can be divided into three groups: self-reports or assessment scales (for parents and teachers), continuous performance tests (CPT) and visual discrimination tests.

Hitherto, diagnosing attentional difficulties associated with various clinical conditions is done by observing symptoms, supported by psychometric tests in some cases. Scales or questionnaires are most commonly used in qualitative evaluation[12] and CPT tests are the most frequently objective assessment instruments used in clinical population. Although over the years the number of tests that attempt to measure each type of attention separately has increased, the truth is that there is a lack of good measuring instruments. Hence the increasing need to develop reliable, valid, and above all, effective and well-suited to the daily life of children (ecological) evaluation methods. The translation of auditory attention tests to our language is insufficient, as well as the high cost or lack of ecological validity of some computerized CPT tests, being the most commonly used tests in our country the ones measuring only selective and sustained visual attention. Moreover, within this situation the evaluation of other attentional processes (such as attentional control or switching) is left aside, and auditory sensory modality tests are too boring and away from children's daily life. Therefore the main purpose of this study was to translate and descriptively analyze in healthy pediatric Spanish population one of the most known and used test in the rest of Europe, the U.S. and Canada or Asia: TEA-Ch (Test of Everyday Attention for Children) Manly et al.[13]. This is a battery whose external validity and reliability has been proved in previous studies[13,14] which can also be administered in an "enjoyable" way despite being a test of attention.

## MATERIAL AND METHODS

### Participants

Our study sample consisted of 133 Spanish children aged 6 to 11 years (8.36±1.64 years, 68 boys and 65 girls), enrolled in six schools in Madrid (Table 1). An age and sex-balanced study was designed in order to avoid potential bias. Accordingly, 2 girls and 2 boys were randomly selected per course and school. From the initial sample a significant number of children were excluded, according to the following inclusion and exclusion criteria: 1. Lack of previous history of peripheral sensory impairments (blindness, deafness) and neurological and/or psychiatric illnesses; 2. No consumption of tobacco, alcohol or other drugs during pregnancy that could influence the development of attention processes; 3. Pregnancy to term and normal weight; 4. Lack of perinatal complications; 5. Normal psychomotor development; 6. Not be taking antihistamines or antiviral drugs; 7. Do not rate in clinical ranges in the BASC questionnaire (Behavior Assessment System for children of Reynold and Kamphaus, in Spanish version, 15) or CPT-II (Continuous Performance Test-II, Conners, 16); 7. Parents or guardians consent.

### Materials

Children of the sample completed two tests of attention and parents (and some teachers) fulfilled a behavior scale: 1. The attention test TEA-Ch previously translated into Spanish. The adaptation process was carried by means of a double translation, first English to Spanish and subsequently Spanish to English (performed by another person). Afterwards, both Spanish versions were compared with the initial and final English versions to ensure that the correct meanings were preserved; 2. CPT-II[16]; 3. The BASC behavioral scales for parents and /or guardians[15]. The BASC Developmental Scale was used only to verify the inclusion-exclusion criteria.

### TEA-Ch

In view of the fact that heretofore there is no Spanish version of the TEA-Ch standard battery, we move on to conduct a detailed description thereof[13]. The evaluation time is approximately 40 minutes. The battery consists of 9

**Table 1** Children´s characteristics in the sample

| Age ranges in control groups | n (TOTAL) | % Boys |
|---|---|---|
| **G1** (6 years) | 14 | 50% |
| **G2** (7 years) | 27 | 48% |
| **G3** (8 years) | 22 | 54% |
| **G4** (9 years) | 23 | 43% |
| **G5** (10 years) | 24 | 58% |
| **G6** (11 years) | 23 | 52% |
| **Total** | 133 | 51% |

Distribution of subjects by sex in each of the six groups in which the sample was divided according to age.

subtests involving clear attentional demands, minimizing the involvement of other skills such as memory, language or understanding or motor component. Subtests comprising TEA-Ch are:

## Subtests of Sustained Attention

- **"Score":** this subtest score is a measure of counting tones in 10 items based on a task originally described by Wilkins and colleagues[17]. In each trial, 9 to 15 identical tones are presented, resembling shoots of 345 ms, with an interstimulus period separated by silent intervals of variable duration (between 500 and 5000 ms). Children are requested to count them quietly (without fingers help) and tell the total number at the end of each trial. The score is the number of trials in which the child gave the correct answer and therefore the maximum is 10.

- **"Score DT":** this subtest scores were designed to increase the sensitivity of the punctuation in the *Score* task by including a distractor. Children are asked to complete two tasks at once: one similar to the *Score* task and another which involves listening to a news program and come across the animal previously mentioned. They are requested to report the number of counted tones and the animal mentioned in the news program. The score depends on the number of correct tones and animal responses. There are two practice trials and 10 trials in the formal test.

- **Code Transmission:** measures the level of hearing surveillance. Children are asked to listen to a monotonous audio-digit presentation (presented at a rate of one every 2 seconds) paying special attention to the occurrence of a target within a sequence of digits ("5, 5") and say as quickly as possible the digit presented just before the target sequence (the preceding number before "5, 5"). After a sequence of practice to ensure understanding, 40 goals are presented during 12 minutes. The score is the number of digits correctly announced by the participant.

- **Walk don't walk:** this is an adaptation of the SART test of sustained attention (Robertson, Manly, Andrade et al.,[18]). In the *Walk don´t walk* subtest, children are given an A4 sheet showing "paths", each consisting of 14 squares. They are asked to listen to a tape playing two types of sounds: one corresponding to the tone of "walk" to the next square on the path and another corresponding to the "don´t walk" tone. The movements are carried by putting points on each square with a pen, holding the pen 2 cm. above the page between each tone. The tones of "walk" and "don´t walk" are identical the first 208 ms (329.6 Hz sinusoidal tone), but the tone of "don´t walk" differs from the previous one in its end, so that the task requires children to be listening all the sound before giving his answer. The tones of "walk" were presented in a regular rhythmic way with "don´t walk" tones, which occur unpredictably within the sequence. There are two demonstration trials and two practice trials before the 20 test items. The score is the number of hits.

## Selective Attention subtests

- **Sky Search**: children are presented with an A3 sheet with rows of paired spacecrafts, most couples being mixed or different type. The task is to find and circle all target items, defined by a pair of identical spacecrafts, as quickly as possible (cancellation task). Twenty target stimuli among 108 distractors are randomly distributed. The time of completion of the task is self-determined by the child, marking a cross on a square in the lower left corner when finished. Before completing the main test, children complete an A4 practice sheet. In order to control differences that are attributable to the visual selection and not the motor speed, children complete another version of the same test called "motor control". The A3 sheet is identical to the *Sky Search* subtest with the exception that no distractions are displayed. Therefore, the task consists in surrounding all target items (20) as fast as possible. Subtracting the time spent on the "motor control", to the time spent in the *Sky Search* task (with more attentional demand), an attention score relatively free of motor speed is obtained.

- **Map mission:** in this task, children are given a map of the city of Philadelphia (A3 size) with eighty target

goals (knife and fork restaurant symbols, 4 mm x 3 mm) randomly distributed among distractors of a similar size (supermarket trolleys, cups and cars). Then, they are asked to circle the greatest number of target symbols within 1 minute (time in which the detection of the 80 target symbols is extremely unlikely). The score is based on the number of target objectives correctly circled.

### Attentional Control subtests

- **Creature Counting:** a variable number of "creatures" are represented in their burrow on each page of the *Creature Counting* stimulus subtest booklet. Among the creatures, up and down arrows are interleaved. The children are requested to count the creatures from top to bottom, following the path in which they are, but using the arrows as a signal to switch the direction of their count. Before starting the test their ability to count up to and down 15 was assessed. After two practice trials with feedback on their performance the seven formal trials are completed, being registered the number of correct answers and the time required to complete the test. Finally, the time needed to respond and total number of switches is calculated.

- **Opposite Worlds:** this is a task of verbal inhibition. A sheet is presented with a quasi-randomized mixed matrix of the digits 1 and 2. In the *Sameworld* condition the child has to appoint the sequences of digits that appear in the sheet, following them with his/her finger. While in the *Oppositeworld* condition, when it appears 1 the child should say "2" and when it appears 2, the child should read "1" as quickly as possible, inhibiting the automatic verbal response. In the *Oppositeworld* condition, you can only go to the next trial if a correct answer is given, thus incurring a time penalty each time a mistake is made. The final score is the total time needed to complete the *Oppositeworld* task.

### Double-Task subtests

- **Sky Search DT:** in this subtest, a parallel version of the *Sky Search* Task (differing the target´s location), is requested to be completed. At the same time, they are asked to silently count the number of tones as they did during the *Score* subtest, giving the total number of tones at the end of each item. After the practice trials, the task and timekeeping is initiated by a countdown heard through a tape. The test is completed and the time stops when the child indicates that he has finished the visual search task. The time required to complete the subtest, the number of tones correctly answered and the number of correctly surrounded pairs are registered.

## PROCEDURE

In order to apply the exclusion criteria, **BASC** questionnaires (Developmental and parent/teacher) were delivered to teachers to be filled and transmitted to the families. During the evaluation phase, all tests were administered individually in a quiet classroom from each school. The total duration of the test was about 1h 30min, with a short break between tasks used for the examiner to prepare the next test. In addition to the *TEA-Ch battery*, children in the sample were also assessed with the Conners Continous Performance Test (CPT). After completing the tasks, an exploratory analysis was carried out evincing atypical behavior from certain subjects in some tasks so that the removal of the analysis of these children and those who did not meet the inclusion criteria was considered. Those subjects with scores that can be considered as "outliers" were included within the atypical behavior label. After test correction and data analysis, a report was given to the school or parents if they did not want to give the data to the school.

## STATISTICAL ANALYSIS

The aim of the study was to establish a profile for the "normal" children development considering the studied sample. For this purpose, a descriptive and comparative analysis of the scores of each of the subtests that integrate the TEA-Ch scale was performed considering age and sex factors.

In order to allow a comparison with previous results[13,14], the Age factor was grouped into 6 groups: 6 years, 7 years, 8 years, 9 years, 10 years and 11 years. Chi-square tests of sample homogeneity were utilized to assess the equivalence of sex distribution within each age group. The normality of each subtest scores was assessed by means of the Shapiro-Wilk test.

The investigation of the potential influence of sex and age on those scores not matching normality criteria was performed by means of the Kruskal-Wallis (H) test, while the Dunn correction was used for "a posteriori" comparisons. An analysis of variance (ANOVA, F) with two factors, Age and Sex, was used for the remaining variables with a normal distribution, then "a posteriori" comparisons were calculated given the Bonferroni correction. The realization of all these analysis was done with statistical packages SPSS22 and MedCalc.

## RESULTS

Table 1 show the distribution of subjects by Sex in each of the six groups in which the sample was divided based on

Age. The analysis obtained by Chi-square statistics indicates that, despite slight variations within groups, the Sex factor is distributed homogeneously. As noted in the previous section, the Sex factor was included in each analysis to explore potential differences in test performance between boys and girls.

## Subtests of Sustained Attention

- **Score:** the mean value in this subtest is 8.29 with a typical deviation of 1.88 (median value 9, first quartile 7, and third quartile 10). In this subtest no significant sex differences were found (p=0.982) but we found the significant effect of the variable Age Group (H=29.033, p=0.00001). As we shall see, in general those tasks quantified as number of hits show a trend of increasing scores based on age. This effect explains results obtained in the *Score task*, but it can be described more accurately. In Figure 1, the increasing scores depending on age can be intuitively appreciated. There are significant differences between the group of 6 years old and the other groups (all p-values <0.05). This indicates that there is a "break" in the number of hits between 6 and 7 years old, but from this age on scores tend to stabilize.

- **Score DT:** the mean value in this subtest is 14.60 with a typical deviation of 4.02 (median value 15, first quartile 11.75, and third quartile 18). Again, it is a variable in which the number of hits is considered and therefore another example of apparent gradual increase of scores. As in the previous case, the Sex effect is not significant (p=0.666) but significant results are found for the Age Group effect (H=48.306, p<0.000001). In this case 6 year olds show significant differences with other ages (all p-values <0.05). From 7 years old onwards, values increase gradually with significant differences, not the following year but two years after.

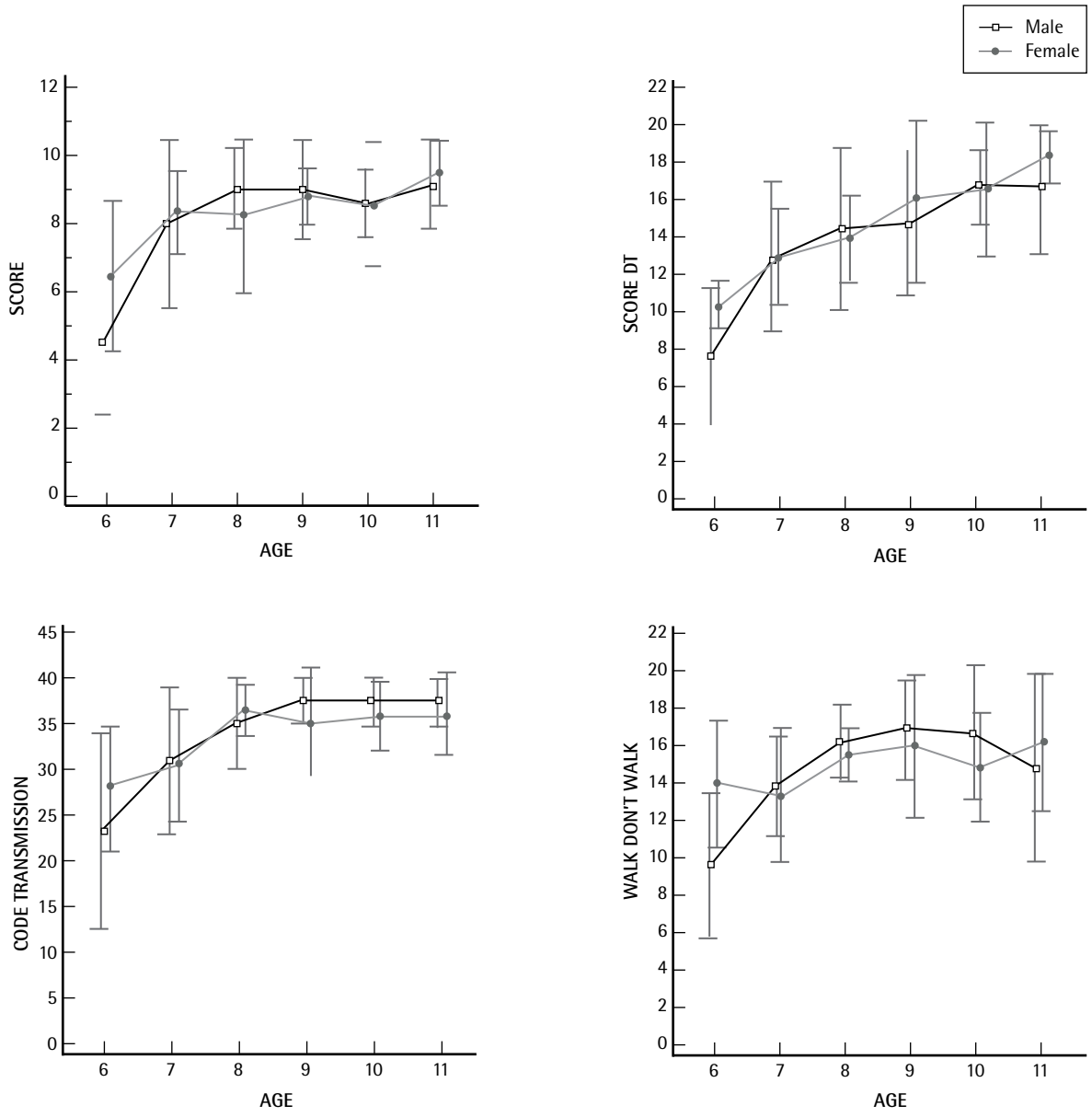
- **Code transmission:** the mean value in this subtest is 33.98 with a typical deviation of 6.42 (median value 33.5, first quartile 31 and third quartile 39). This variable counts the number of hits and shows a new progressive increase in scores. Sex effect is not significant (p=0.464) but significant differences are found due to the Age Group effect (H=39.647, p<0.000001), and again the apparent gradual increase of scores is actually a "break" down taking by reference the values obtained by groups of 6 and 7 years old. In this case groups of 6 and 7 years old are not statistically significant from each other. Both groups show significantly lower values in comparison with the other groups (all p-values <0.05). From 8 years on, the values stabilize and no significant differences are found.

- **Walk, Don´t Walk:** the mean value in this subtest is 15.02 with a typical deviation of 3.59 (median value 15.50, first quartile 13 and third quartile 17). We find the Sex effect is not significant (p=0.747) but statistical differences are found for the Age Group effect (H=21.135, p=0.000675). This is a new example of scores "break" considering as reference 6 and 7 year olds (see Figure 1) who have no significant differences between them but they do with the other groups (all p-values <0.05) and again here, from 8 years old onwards, the values stabilize (differences are not significant). In Figure 1 sustained attention results are summarized.

## Selective Attention subtests

- **Sky Search:** the mean value in this subtest is 5.38 with a typical deviation of 2.76 (median value 4.66, first quartile 3.73 and third quartile 6.18). In this subtest we find significant effects in both variables, Age Group (F=12.602, p<0.01) and Sex (F=5.607, p<0.05). The interaction effect was not significant. The post hoc analysis indicated, in the first place, that boys generically obtained higher scores than girls, regardless of age, meaning that boys needed more time to complete the test. The results of the Age Group effect were more complex. The most important evidence shows significant higher scores for 6 year olds than all other groups, regardless of sex (all p-values <0.001), indicating that younger children need more time to complete the test. Similarly, 7 year olds showed significantly higher scores than those children aged 10 and 11 (p<0.05), also indicating a greater need for time to complete the test. There were no more significant differences between age groups.

- **Map Mission:** the mean value in this subtest is 27.49 with a typical deviation of 11.24 (median value 26, first quartile 20 and third quartile 34.25). This is a test in which the number of hits is considered, the wide range of values and prior contrast of normality (all p-values >0.082) allows it to be studied by ANOVA. Thus, a progressive increase in scores is appreciated. In this case, Age Group (F=20.916, p<0.01) and Sex (F=5.910, p<0.01) effects are significant but not their interaction. Hence, as shown in Figure 2, girls generally showed higher hits than boys (p<0.05). Again we find that 6 years old have significantly lower values than other groups except 7 years old (all p<0.001), but in this case the increase is observed staggered. Lower values are shown in 7 year olds if comparing with children aged 9, 10 and 11( all p<0.01), while the group of 8 years shows significantly lower values when comparing to groups of 10 and 11 years (all p<0.01). From 9-10 years onwards, scores tend to stabilize. Figure 2 shows the summarized results of selective attention.

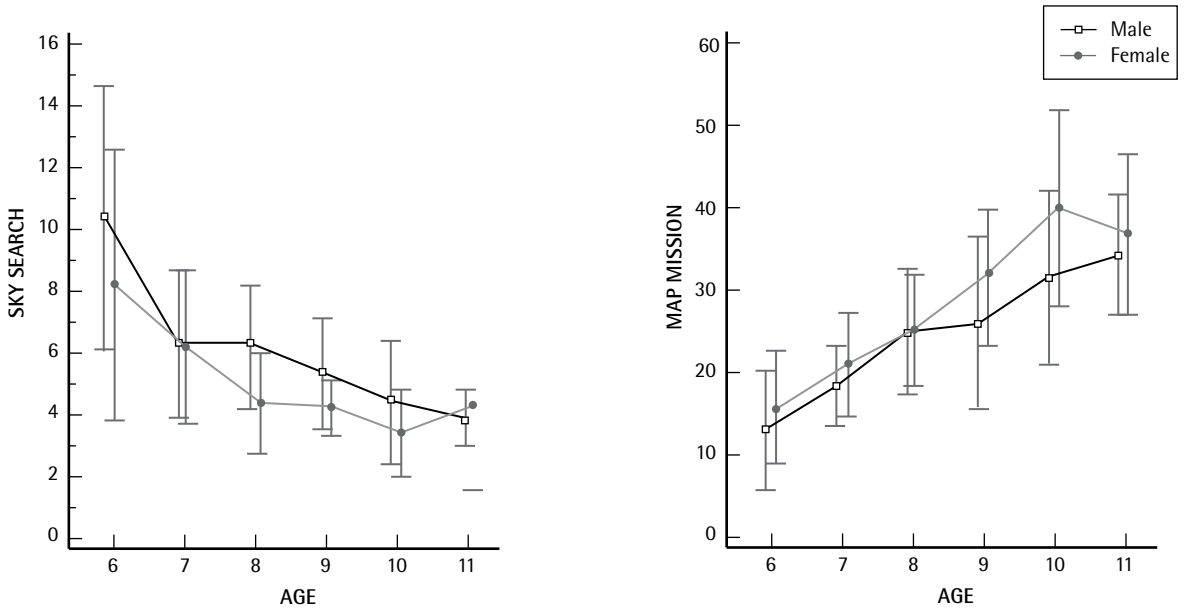



Means and standard deviations of sustained attention tests where significant effects of Age can be observed, being a "break" of the scores if using 6 and 7 year olds as a reference.

*Figure 1* | *Sustained Attention*

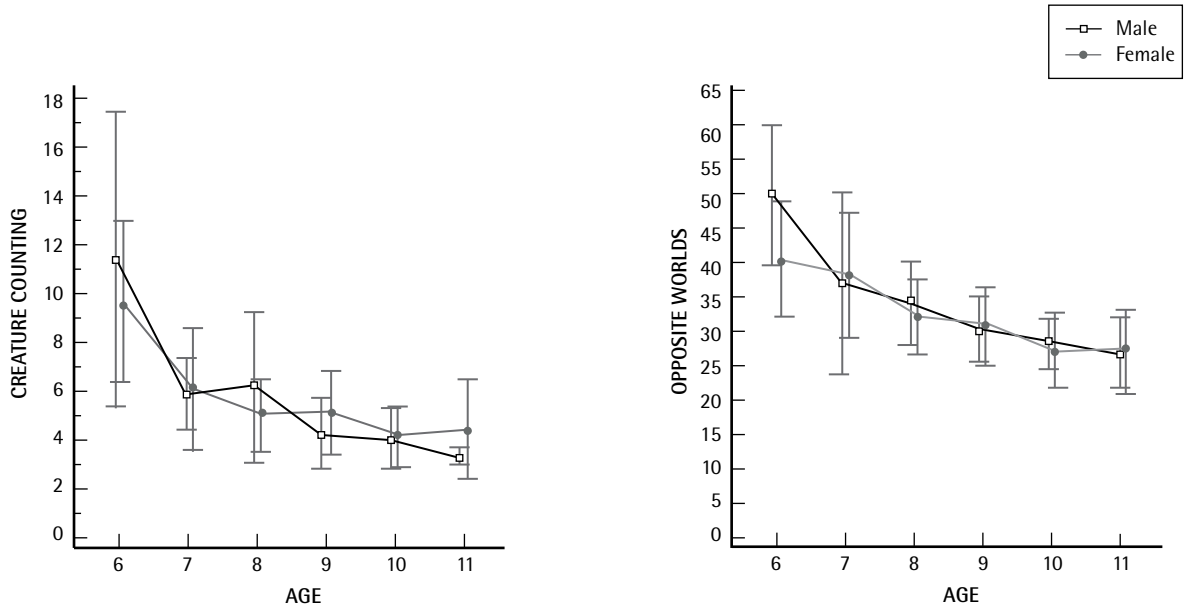
## Attentional Control subtests

- **Creature Counting:** the mean value in this subtest is 5.33 with a typical deviation of 2.95 (median value 4.73, first quartile 3.60 and third quartile 6.22), the creature counting task behaves similarly to previous tests (Figure 3), within the meaning that only significant differences were observed due to the Age Group effect (F=16.988, p<0.0001). Again we find a "break" in scores from the group of 6 years showing lower scores than the other groups (all p<0.001) and a stabilization of scores from 7 years onwards. There are also significant differences between groups of 7 and 11 years (p<0.05).




Means and standard deviations of selective attention tests where significant effects of Age and Sex can be observed: again a "break" of the scores if considering as reference 6 and 7 year olds. Girls performed better than boys being faster in execution and getting more hits.

*Figure 2* | *Selective Attention*



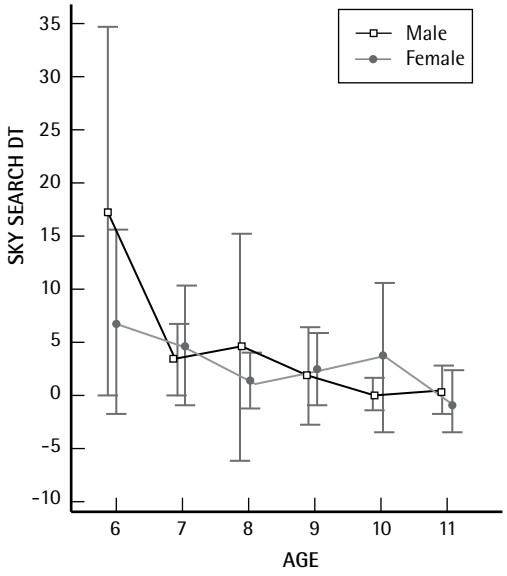

Means and standard deviations of attentional control tests where significant effects of Age can be appreciated: Another example of "break" in the scores where 6 years old display lower scores than the other groups. Scores tend to stabilize from 7 years onwards.

*Figure 3* | *Attentional Control*

- **Opposite Worlds:** the mean value in this subtest is 32.86 with a typical deviation of 19.37 (median value 31.50, first quartile 26 and third quartile 37). Once again, as seen in Figure 3, Sex effect is not significant (p=0.832) but statistical differences are found because of the Age Group effect (H=51.528, p<0.000001) effect. The group of six years has significantly higher scores (indicating they require more time to complete the test) than the other groups (all p-values <0.05). From age 7, scores increase gradually, implying significant differences do not occur in the following year (8 years compared to 9 years, for example) but two years on (8 years vs. to 10 years). In Figure 3 summarized results of attentional control are displayed.

## Double-Task subtests

- **Sky Search DT:** the mean value in this subtest is 3.24 with a typical deviation of 7.18 (median value 1.22, first quartile 0.46 and third quartile 4.21). The analysis of this task may conclude with much more complex results. Thus, there are significant differences due to the Age Group effect (F=6.984, p<0.001) and the interaction effect between Age Group and Sex (F=2.372, p<0.05). As can be clearly seen in Figure 4, the Age Group effect shows a very sharp decrease when comparing scores from 6 years old and other groups (in all cases p<0.001). However this effect should be interpreted considering the interaction with the sex variable. In fact, this very sharp drop in scores from 6 year olds is exclusively due to the group of boys, who obtained higher scores in comparison to the group of girls (p<0.01). Whereas in the group of girls a slight decrease in scores can be seen between 6 and 7 years old and then scores get stabilized, in the group of boys scores suffer a very sharp decrease, then match with those of the girls and get stabilized from 7 years onwards.




Means and standard deviations of the dual task test where significant effects of Age and the effect of interaction between Age and Sex can be observed: the sharp decline of the values in 6 year olds can exclusively be seen in the male group.

*Figure 4* | *Double Task*

## CONCLUSIONS

The main conclusion of this study is that the Spanish version of the battery TEA-Ch (A), being tested in a sample of healthy children has been proved to be a useful tool for assessing attentional functions in Spanish infant population. The results obtained from the first descriptive analysis carried out of each subtest scores demonstrate the presence of the Age effect on every variable and the Sex effect on some of them.

As for the Age effect, generally and as expected, the results obtained in every subtest of the TEA-Ch battery measuring reaction times indicate a general decrease of those with age, whereas results obtained from those subtests that measured correct responses indicate a significant increase thereof. In general, we can interpret these results in line with other authors[14,19]: throughout childhood, certain functional changes in the attentional capacity and executive control are produced (greater number of successes and faster reaction times) that could be reflecting structural changes in cortical development and myelination. Indeed, during brain development in childhood stages there are increases in cortical thickness and an increased volume of white matter[20,21] as well as significant increases of myelin in the pathways that connect the corpus callosum with the basal ganglia and these with the thalamus, the frontal cortex and the anterior cingulate[22]. These pathways are involved in both the anterior and posterior attentional networks and in the regulation of motor, emotional or learning and memory processes[23,24].

In addition, the fact that young children can perform the tests which compose the TEA-Ch battery shows that the stimuli used for both visual and auditory perceptual tests, are valid and ecological (not too boring neither too stimulating) at least for Spanish children aged 6-11 years. On the other hand, the experimental design of the TEA-Ch (using the first trials as practice allowing basic knowledge of the task before evaluation or by discarding the motor factor from the tests pretended to measure visual attention in cancellation tasks) is key so that children can perform the attention tasks requested.

The great variability of scores -which could reduce the statistical power of the data analysis- is explained by a significant Age effect characterized by an important "break" in performance of children between 6 and 7 year olds. This "break" would suggest an early emergency of attention capacities and attentional control confirmed by the analysis of variance of the Age factor. In addition, the fact that the Age effect tends to decrease in the groups of older children may suggest the presence of some "ceiling effects" or "flat" evolutionary periods. These results corroborate previous studies[13,14].

Regarding the Sex effect, results indicate similar trends of evolution between genders. However significant differences between children are appreciated in those subtests that measure visual selective attention *(Sky Search and Map Mission)* and in the dual task involving attentional control *(Sky Search DT)* where girls obtained better results than boys only when they are 6, unifying or even reversing the response patterns with 7 year olds and onwards. These results slightly differ from previous studies[13], which despite having a much larger sample (147 girls and 146 boys), only found significant differences in the attentional control (or switch) task *(Creature counting)*. Studying the Sex effect for each age range they also obtained differences in the *Sky Search* test which measures visual selective attention in groups of 9-11 and 13-15 years. These differences could be interpreted by educational and cultural differences influencing cognitive processes.

Likewise, the results obtained fall within Posner´s theoretical model[2-3] of attentional networks and show that the tri-factorial structure of the TEA-Ch battery appears to be stable in populations of different nationalities and different development stages. Thus, the relevance of this theoretical model has been confirmed by other similar research done in different cultures (Australian and Chinese) and both children and adults[13,14].

However, the comprehensive study carried out with the original TEA-Ch has also allowed us to observe some limitations. Indeed, it is important to remember that the authors themselves acknowledge that the subtests are not pure measures of attention but measures of visual and auditory detection, counting, reaction time and hits[13]. Therefore, despite being an ecological test which minimizes variability due to non-attentional factors such as memory, language, reasoning, or motor control, the TEA-Ch battery still involves perceptual and executives factors, attentional control or switch and inhibition. We therefore propose some suggestions to gain greater measurement accuracy, for example accounting errors in addition to the hits and optimize auditory subtests, creating a score of selective attention in this sensory modality. It might also be useful to select some subtests to create a shorter version aimed at younger children.

In conclusion, the findings of this exploratory study corroborate the trifactorial nature (sustained, selective and attentional control) of the subtests comprising the TEA-Ch battery in Spanish population and highlight the advantages of its experimental design, which simplifies the variability due to non attentional factors, by making this battery a possible instrument of effective measure that provides stable measurements for clinical and research use. The main strength of this study is providing data on attentional skills in Spanish children (control population) and subsequent possible application to pharmacological treatment or cognitive behavioural therapy in children with difficulties (ADHD). Finally, in this lays the foundation for future studies with samples consisting of national population and using instruments adapted to measure evolutionary factors and anchored in everyday life (ecological validity).

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