Repositorio Institucional de la Universidad Autónoma de Madrid

https://repositorio.uam.es

Esta es la **versión de autor** del artículo publicado en:
This is an **author produced version** of a paper published in:

Journal of Applied Developmental Psychology 56 (2018): 42-51

DOI: http://doi.org/10.1016/j.appdev.2018.02.004

Copyright: © 2018 Elsevier Inc.

El acceso a la versión del editor puede requerir la suscripción del recurso
Access to the published version may require subscription

Running Head: **Visual Search Development.**

Title: **Is there a developmental gap in visual search for children with reported attention problems?**

Authors: M.A, Quiroga & J. Santacreu

Journal of Applied Developmental Psychology 56 (2018) 42–51

Grupo de investigación PsiĐ.
Universidad Autónoma de Madrid.
m.angelesquiroga@psi.ucm.es

Abstract

We report an analysis of developmental patterns in visual search for 6 to 12 year-old children. A typically developing sample of 1442 children is compared with two samples (N=1160 and N=947) of children with teacher-reported attentional problems. Inclusion criteria for these two groups were low academic achievement and probable attention problems as the reason for the low achievement. The three groups completed DiViSA, a computerized visual search test. Obtained data show two patterns of visual search development. Children with teacher-reported attentional problems show hastiness, inaccuracy and slowness. Children with attention problems perform as if they were younger, in terms of visual search. Data show a performance lag in visual search of about two to three years at every tested grade, for the children with attentional difficulties. However the development patterns of children with and without attention problems are parallel, showing improvement with age in both groups.

Keywords: Visual Search, Attention Problems, Developmental Delay, Typically developing children, School-Age Children

Our present purpose is to study the development of schoolchildren with regard to visual selective attention. We compare the performance, in a visual-search attention test, of two samples of children from 6 to 12 years old. One sample comprises typically developing children, who have normal performance levels in school, and the other is a sample of children who, according to their teachers' criteria, could have attentional problems. Inclusion criteria have been low academic achievement and probable attentional problems as the reason for the low achievement. We will first review the concept of attention and then describe the studies designed to analyze its developmental pattern in typical children and those with purported attentional difficulties.

Attention-deficit hyperactivity disorder (ADHD) is defined as a pattern of developmentally incoherent attention and behavioral outcomes (DSMIV-TR). The term "developmentally incoherent" usually refers to a poor fit between the chronological age and the behavior being measured. Norms for school-age children are necessary to test for any developmental gap between ADHD children and their schoolmates. However, attention is a multifaceted construct and so, the tasks and tests used to assess the developmental patterns are diverse, ranging from school-type tasks, such as the Selective Attention Measures from the Test of Everyday Attention for Children (Manly, Anderson, Nimmo-Smith, Turner, Watson & Robertson, 2001) to laboratory's tasks such as the ANT battery for children (Rueda, Fan, McCandliss, Halparin, Gruber, Pappert & Posner, 2004). Each test or task employed taps one attentional facet (e.g., selective attention, attentional control, or sustained attention), which could develop in specific and perhaps independent way (Quiroga, Santacreu, Montoro, Martínez-Molina & Shih, 2011). With this diversity in mind, it is important to focus on the facets of attention most directly related to daily life. In this sense, visual search tests have been proposed to be among those with the highest ecological validity, to assess the efficient selection of relevant objects people do to attain their everyday goals (Peelen & Kastner, 2014). This high ecological validity refers to the fact that, in our daily lives, adults and children frequently direct attention toward objects to select those that are relevant or useful for their purposes, thus using their visual search ability very frequently (e.g., searching for a pair of socks, looking for the right books to put in a backpack, trying to find relevant information on a screen or chalkboard, seeking a friend during recess and so on). Therefore, measuring the typical developmental pattern of visual search performance will let us operationalize what "developmentally incoherent" means for selective attention.

To measure the visual-search developmental-pattern, Klenberg, Korkman and Lahti-Nuuttila (2001) used the neuropsychological battery NEPSY and tested 400 children aged 3 to 12 years old. In the Visual Search Test from the NEPSY, the child must search, as quickly as possible, for target pictures in a random array. The test provides an efficiency index (Score = [(Correct responses – Commission Errors) ÷ Performance Time]). Obtained age effects on the Visual Search Test were large and continuous from age 6 to 12. This monotonic developmental pattern refers to the global efficiency index, but no data were reported about the development of this score's components (i.e., correct responses, commission errors and performance time). In this way, identical efficiency-index values can be obtained with different values for correct answers, commission errors and performance time. For example, an efficiency index of .13 can result from 75 total correct answers (from a maximum of 98), 10 total commission errors and a total performance time of 300 seconds (from a maximum of 420), but it can also result from 60 total correct answers, 8 total commission errors and a total performance time of 400 seconds. In the first example, the child's performance is relatively quick with a high proportion of correct answers, while in the second the child is relatively slow and provides fewer correct answers. For this and other reasons, the increasing developmental pattern for visual search that many researchers have reported should be analyzed into its components, identifying how much of the trend is due to increasing accuracy and how much to increasing speed. Knowing about the different components' developmental-pattern would help practitioners to design and precisely focus educational or clinical interventions.

To our knowledge, no study has determined the developmental pattern for children with ADHD on the NEPSY Visual Search test. Thus, it remains to be determined whether the developmental pattern for visual search in children with attention problems differs, or not, from that of children with typical development.

From a different perspective, Lehman, Naglieri & Aquilino (2010) administered the CAS (*Cognitive Assessment System*; Naglieri & Das, 1997) to 2200 children from 5 to 15 years old. This Battery includes two genuine Attention Tests: the *Expressive Attention Test* (testing the Stroop Effect with two different tasks depending on age) and the *Number Detection Test* (a visual search task). The *Expressive Attention Test* consists of three pages. On the first one, the child reads color words, in the second page, the child names the colors of printed rectangles and on the third page, the child names the ink color of printed color words. Performance on this test is summarized with a ratio of accuracy and time taken to complete the task. The *Number Detection Test* consists of several pages of numbers printed in different formats. Child must find a target stimulus on each page. Each page contains 25% targets. Performance on this test is summarized with a ratio of accuracy to total time taken to complete the task. Lehman et al. (2010) tested for age effects, computing effect-sizes from adjacent age groups. Cohen's *d* was interpreted as a measure of rate of change. Obtained Cohen's *ds* were large for the *Number Detection Test* (from 5 to 6, *d* = 1; from 6 to 7, *d* = .80; from 9 to 11, *d* = .80; from 11 to 13, *d* = .70; from 13 to 15, *d* = .70 and from 15 to 17 *d* = -.20) but moderate for the *Expressive Attention Test* (from 5 to 6, *d* = .60; from 6 to 7, *d* = .50; from 9 to 11, *d* = .50; from 11 to 13, *d* = .60; from 13 to 15, *d* = .60 and from 15 to 17, *d* = 0). These results support the idea that different tasks measure different attentional facets and that tasks based on the Stroop Effect are not specifically assessing selective attention. Another important point is that in the study by Lehman et al. (2010) some age groups were not represented (e.g., 8, 10, 12, 14, and 16 years). Despite this limitation, the results from Lehman et al. showed a continuous change (more efficiency) in visual search from ages 5 to 15.

The CAS has also been used by Naglieri, Goldstein, Iseman and Schwebach (2003) to assess a group of children with a diagnosis of ADHD, that were matched on age, gender, race, region, community and parent educational-level, with a group of children with a diagnosis of Anxiety/Depression. The whole CAS battery (including three tests of Attention: *Expressive Attention*, *Number Detection* and *Receptive Attention*) was administered to both groups. From the three attention tests, a Global Attention score was computed. As a whole, the 25 ADHD children (ranging from 7 to 12 years old) showed lower scores on Planning (*d* = .59) but not on Attention (*d* = .09), when compared to Anxiety/Depression children. Effect size was larger when ADHD children were compared with normative data on Planning (*d* = .85) than when compared with normative data on Attention (*d* = .25). These data show a similar level of efficiency in Visual Search for ADHD children when compared with normative data, which is much unexpected. As suggested by Wassenberg, Hendriksen, Hurks, Feron, Keulers, et al. (2008), tasks' features might account for this result because the authors computed a global score, from the three administered attention-tests. That score does not allow differentiating the ADHD-group performance on each task. In addition, Naglieri et al.'s groups were very small to test for developmental effects. As a result, it is not possible to know if the efficiency level is similar at all ages (from the age range considered) or is just an artifact due to the global score used (the average for the three tests). In fact, studies comparing typically developing children with those with ADHD often include small-sized groups covering a wide age range (Mullane & Klein, 2008). Such comparisons severely limit testing for developmental effects. Naglieri et al. (2003) reported a small developmental gap between ADHD children and their schoolmates. However, it needs to be clarified if this developmental gap is continuous, of equal size at all ages from 6 to 12 (parallel developmental patterns) or discontinuous, and perhaps the rate of change is higher at some developmental point, from ages 6 to 12 (nonparallel developmental patterns).

One of the most common tests of selective attention is the *d2* (Brickenkamp, 2002). It asks participants to cross out any letter "d" with two marks above it or below it. Surrounding distractors are similar to target stimulus, for example a "d" with three marks. Using this test Wassenberg et al. (2008) assessed 451 children from second to sixth grade. Their results showed a linear increase in speed (number of items processed per unit of time) by school-grade, a decrease of impulsivity (number of commission errors divided by processing speed) until fourth grade, and a stable level of inattention (number of omission errors divided by processing speed) from the second grade on. Importantly, *d2* is a test that must be completed by rows (a very organized stimulus field) with the time allowed to process each row limited to 20 seconds. The way to complete the *d*2's items does not allow for flexibility in the way children organize the visual search. Accordingly, results from this test could be different than results obtained in other tests in which children have to look for a target in an unorganized stimulus field.

Summarizing, the visual-search and attention's studies reviewed here show several limitations. Firstly, a continuous change in visual search efficiency (global score) from childhood to adolescence for typically developing children has been obtained but little is known about the developmental pattern of the various components of the efficiency index computed in the visual search tests used (correct answers, commission errors, and performance time), except for a very organized stimulus field (*d*2 Test). Secondly, a small effect-size has been obtained when comparing a typical-development group with a diagnosed ADHD children group, from very different ages, but there are no data regarding the visual-search developmental-trajectory for each age, from 6 to 12 years old, in children with attention problems. Some of these limitations might be due to ADHD children have been considered as a unique group, but consisting of children of different ages, highlighting their "clinical" feature instead of considering both, their "clinical" level and their developmental one. To overcome these two limitations, it is necessary to analyze larger samples of children. To determine the developmental patterns of both groups and to make comparisons between them, a large children-sample from ages 6 to 12 with attention problems and another large sample of school-age children from the same age range, that complete the same visual search test, are necessary. This way, effects of pertaining to one of these groups, with or without attentional problems, their respective developmental trends, and any possible interaction can be analyzed. Moreover, the selected visual search test must provide separate scores for correct answers, commission and omission errors, and performance time, to study the developmental trajectory of each one of them.

DiViSA (*Simple Visual Discrimination Test of Trees*) is a computerized visual search test (Santacreu, Shih & Quiroga, 2011) that consists of eight different trials in which children have to look for visual targets (target trees among sets of distractor trees), which differ from trial to trial. See Figure 1 for an item of DiViSA's test. Obtained scores from this test include not only an efficiency index, as for the above-mentioned NEPSY and CAS tests, but also the number of commission and omission errors, performance time and, interestingly, an organization index and a distraction-hastiness index. The efficiency index is obtained from the number of correct answers, commission errors and performance time. The Organization Index assesses the way children cope with the task of searching for trees identical to the target. The Distraction-Hastiness Index assesses whether errors are associated with long or short response times when compared with the mean response times for correct answers. Both indexes measure qualitative differences in school-age children from 6 to 12 years old. That is to say, a poorly organized performance can be found in spite of the age of the child. For the other scores, normative data show increasing attention efficiency with age and a decreasing number of commission and omission errors. It remains to be explored if these patterns are similar for children with attentional problems.

Please Insert Figure 1

The present study was designed to analyze the developmental patterns of visual search for children with and without teacher-reported attentional problems to answer three questions: (1) do children from 6 to 12 years old, with and without attentional problems differ in the developmental pattern of visual search? It is expected that the developmental pattern for children with teacher-reported attention problems would be parallel to that of typical development children but at a lower performance level for each age. A parallel developmental pattern means that visual search development will follow the same path. Being at a lower level of performance for each age means that children with attention problems will show a lower performance level at any age. The study by Berger, Slobodin, Aboud, Melamed and Cassuto (2013) assessing sustained attention, supports our hypothesis; (2) what are the specific features that define the developmental pattern of visual search in children with attentional problems? We expect that children with teacher-reported attentional problems would show a longer response time and a higher amount of errors. In this sense, Mullane and Klein (2008) obtained that ADHD children respond more slowly than typically developing children; (3) if developmental patterns for children with and without attention problems are parallel, how large is the gap at each age, between children from both groups in visual search performance? We expect large effect-sizes but there are not comparable previous results. This is the first time that children with and without attention problems, from the same grade, and from 6 to 12, are compared.

METHOD

Participants

Two groups of children with teacher-reported attentional problems and a typical development group have been included in the study. The typical development group consists of 1442 children between 6 and 12 years old. The two groups with teacher-reported attentional problems (N =1160 and N = 947 respectively) were selected from the total amount of children assessed with DiViSA, from July 2011 until December 2012 for the first group, and from February 2013 to January 2014 for the second group, through the platform managed from Spain by TEA (*TEA Ediciones*). Inclusion criteria were low academic achievement and probable attention problems as the reason for low achievement. This platform only registers the age group and school grade, but not the exact age of each child. It includes five age groups: 6-7, 8, 9, 10 and 11-12, which correspond to school grades second, third, fourth, fifth and sixth. Thus, age means and standard deviations couldn't be computed for the groups of children with teacher-reported attentional problems. For this reason, we will refer to school grades in the Results Section. Table 1 includes the frequencies of boys and girls for each grade and group.

Please insert Table 1

Groups of children with teacher-reported attentional problems show a ratio of about 2:1 for sex. This ratio reflects the fact that the number of boys is twice the number of girls, as is usually found in samples of children with attention deficits (http://www.cdc.gov/ncbddd/adhd/data.html). There is no association between sex and school grade for any group ($\chi^2_{\text{Typical Development}}$ (4, N = 1442) = 7.593, p = .108; $\chi^2_{\text{Attention Problems 1}}$ (4, N = 1160) = 3.039, p = .551; $\chi^2_{\text{Attention Problems 2}}$ (4, N = 947) = 1.731, p = .785). Both groups of children with teacher-reported attentional problems are equivalent in all the dependent variables (p > .01).

Children from the typical development group were attending state schools in the surroundings of a large city in Spain (N= 705) and in Mexico D.C. (N= 737). Parental consent was obtained for their participation prior to assessment, according to the Personal Data Protection Law and following School Board policies on use of research data from each of the public schools in which the tests were administered. Socioeconomic status (SES) data were available at school level. The five schools participating in this study showed predominantly average SES, meaning a medium to high parents-jobs-qualification and annual incomes from 20000 to 40000 Euros (http://www.ine.es/daco/daco42/sociales11/sociales.htm). Before testing, teachers completed a brief survey about the experience each child had using a computer and a mouse, and about any learning or behavioral problem each child could show. All the children in the classroom were assessed but only data from children with enough experience using a computer and without learning or behavioral problems were retained for data analyses.

For the groups of children with teacher-reported attentional problems, parental consent was obtained prior to assessment, as is usually done by the educational psychologist at the school. Children from these two groups attended public and private schools in different Spanish cities, at the levels corresponding to their ages. Data were collected through the TEA platform. In those cases, Psychologists at the schools assessed visual search skills because teachers reported that attentional problems in the classroom were the more probable reason for low academic achievement. Thus inclusion criteria were low academic achievement and probable attentional problems as the reason for low achievement, as stated by teachers. In Spain, when teachers identify a child with low academic achievement they have to answer a questionnaire before sending the child for a psychological assessment. These questions refer to family problems, interests/motivational problems and ability/skills/knowledge problems. The answers to these questions allow teachers to differentiate whether low academic achievement arises because of family, motivation or abilities problems. In other instances, teacher suggests possible attention problems and refers child for a more precise psycho-educational assessment.

No SES data were available for the group of children with teacher-reported attention problems. Before being tested, the educational psychologist completed a brief survey about the experience each child had using a computer and a mouse. Researchers were blind to every characteristic of the children except age and sex.

Instruments

DiViSA is a visual search test administered and scored online. This test requires children to click on the trees that match the target (see Figure 1), as quickly as possible. Going from one trial to the next, the child must press the "next" button when he/she considers that all trees have been selected. The target tree changes from trial to trial. A detailed description of the test can be found in Quiroga, Santacreu, López-Cavada, Capote, and Morillo, (2013). The test can be group or individually administered. The test provides five scores: 1) Global Attention Index (GAI = Total number of correct responses minus number of commission errors, divided by whole-task performance time); 2) Number of commission errors (CE); 3) Number of omission errors (OE); 4) Task Organization Index (TOI; for each correct answer, each time two consecutive clicks fall on the same row or column, a point is added; maximum score per trial is 7); and 5) Distraction-Hastiness Index (DHI; computed as Mean RT for commission errors minus Mean RT for correct responses). Number of correct answers (CA) and performance time (PT) can be computed from GAI and CE. DHI can only be computed if the child makes commission errors. A positive DHI score indicates distraction while a negative DHI score indicates hastiness.

Scores from DiViSA show a high reliability (GAI $\alpha = 0.95$; CE $\alpha = 0.86$; OE $\alpha = 0.77$; PT $\alpha = 0.93$), as described in the norms (Santacreu, Shih & Quiroga, 2011). Convergent validity has been computed from the correlations between DiViSA's GAI and Total Number of Correct Responses from the *Differences Perception Test –Faces-* (Thurstone & Yela, 1995) and from the Total Number of Symbols Processed and the Number of Correct Responses from the *d2* (Brickenkamp, 2002). Lozano, Capote and Fernández, (2015) obtained values of r = 0.647, r = 0.590 and r = 0.574, respectively. Sensitivity (81% to 93%) and specificity (79% to 90%) have been computed for each school-grade separately. Obtained data support a good predictive validity of the test for the age range considered in this study (Santacreu & Quiroga, 2015).

Procedure

For the typically developing group, DiViSA was group-administered in the school computers' classrooms during the academic schedule. Instructions for the task were projected onto a large screen. After reading the instructions and explaining the task, each child worked directly at his/her computer. Three psychologists were present in each testing session. Testing groups had a maximum of 15 participants.

For the groups of children with teacher-reported attentional problems DiViSA was individually administered, usually in the Psychologist's office by connecting to the server of *TEA editions* for testing. TEA server Data Base recorded the results of each test.

Data Analyses

Two MANOVA analyses were run to test for the association of group (typical development and attention problems) age/grade (second to sixth grade) and their interaction, with the raw scores from DiViSA, one for the first group of children with teacher-reported attentional problems and the second, for replication purposes, with the second group of children with teacher-reported attentional problems. The alpha level was set to 0.01 as an attempt to correct for the effects of the multiple comparisons.

To test for the developmental gap between typical school-age children and children with attentional problems, at each age/grade, Cohen's *ds* were computed for each score. Cohen's (1988) interpretation of *d* values as small (around .20), medium (around .50) and large (around .80) has been followed.

Results

To answer the first research question, results checking for a similar or different developmental pattern for visual search are described, from multivariate statistics. Afterwards, univariate statistics are provided to analyze for the influence of group and grade over DiViSA's scores (second research question). The first section describes the results for the first group of children with teacher-reported attentional problems, and the second section for the replication study. At the end of each results section, effect-size scores computed to estimate the gap between the children with and without teacher-reported attentional problems (third research question), are included. Dependent variables did not include the GAI score because it is a linear transformation of correct answers, commission errors and performance time.

Effects of Group and Grade (First Group with Attentional Problems)

The first MANOVA run included gender as an independent variable, plus group and grade. Obtained results showed very low eta squared values for gender and for the interactions between gender and grade, gender and group and gender, grade and group. For the multivariate statistics, eta-squared values for gender ranged from 0.001 to 0.008. As described by Llopis-Pérez (2015), values close to 0.01 show a small effect, values over 0.06 show a medium effect and values higher to 0.14 show a large effect-size. Because the obtained eta-squared values were lower than 0.01, we can reasonably accept similar developmental patterns for boys and girls from 6 to 12 years old. For this reason, gender was removed in the subsequent analysis, to simplify the interpretation of the developmental pattern by group and grade.

Afterwards we tested the assumptions for MANOVA's analysis (MA): equality of variance-covariance matrices, homogeneity of variances and absence of multicollinearity (Laerd Statistics, 2016). Box's test of equality of variance-covariance matrices was statistically significant (p = .001). Levene's tests for homogeneity of variances were statistically significant (p < .001) showing why the Box test also was: both groups differed in variability in all the dependent variables. This fact is not unusual because one of the groups is a group of children with difficulties. The large sample size of both groups minimizes the threat that lack of homogeneity of variances could pose to MA significant test (tables 2 and 3). However, Pillai's Trace is used instead of Wilks' Lambda. Pooled within-groups Pearson correlations revealed values lower than .50, thus dependent variables' multicollinearity was low enough to rely on MA results.

Please Insert Table 2

Table 2 includes means and standard deviations for DiViSA's test scores by group and grade. Data for GAI have been included for descriptive purposes but were not included in the MANOVA as was explained before. Obtained results for the multivariate and univariate analyses of variance for the first group of children with teacher-reported attention problems compared to children with typical development are shown in Table 3.

Multivariate statistics for the attention pattern, show that group (Pillai's Trace $_{group}$ (6, 2517) = .374, p < .0001, η^2_p = .374), grade (Pillai's Trace $_{grade}$ (24, 10080) = .234, p < .0001, η^2_p = .058) and their interaction (Pillai's Trace $_{interaction}$ (24, 10080) = .087, p < .0001, $\eta^2{}_p$ = .022) are statistically significant, but with very different contributions. The Group factor explains 37%, the Grade factor 6% and the Interaction 2%, of the differences in the multivariate attention pattern. That is to say that, the majority of the differences in the attention pattern come from the type of group (children with teacher-reported attentional problems versus children with typical development), and these differences are six times higher than the differences due to grade in terms of variance accounted for. Children with attentional problems show a developmental pattern in visual search parallel to that of typically developing children.

Please Insert Table 3

Univariate statistics indicate that differences in visual search, due to the group factor, appear for the six DiViSA's scores (p < .0001). The interpretation of partial etas-squared (following Llopis Pérez, 2015, values lower than .06 are small; from .06 to .13 are medium, and over .14 are large), indicate that main differences come from DHI (η^2 = .26), PT (η^2 = .12) and CE (η^2 = .10). Thus, children with teacher-reported attentional problems show a visual search pattern characterized by hastiness, longer performance time (slowness) and greater number of commission errors (inaccuracy).

For the grade factor, univariate statistics show statistically significant effects (p < .0001) for DiViSA's scores except for DHI. Partial etas-squared indicate that main differences due to age (increasing grade course) come from PT (η2 = .13), OE (η2 = .10) and CE (η2 = .08). Post hoc tests (Bonferroni, p < .001) indicate that the number of CEs falls from second to fifth grade and afterwards remains stable; PT decreases from second to third grade and from fourth to sixth grade (there is a plateau between fourth and fifth grades); and OE decreases from second to fourth grade. Younger children spend more time completing the task and produce a greater number of omission and commission errors. This age pattern appears in each of the two groups (attentional problems and typical development).

Effect-size results (η^2) for the Interaction are very low (from .01 to .04). The nature of the interaction consists in that the differences between the two groups decrease with grade for commission errors, omission errors, correct answers, task organization index and distraction-hastiness index. Thus, children with attentional problems develop their visual search performance in a way like that of typical developing children, but at a slower pace (almost parallel developmental-patterns).

Means from Table 2 show that the children with teacher-reported attentional problems have: (1) a higher number of CEs (inaccuracy); (2) a shorter response time for errors (hastiness), while children with typical development show a higher response time for errors (distraction), and (3) a longer performance time (slowness). These data show for the first time, that children with teacher-reported attentional problems, even when being slower overall than their typically-developing mates, make more mistakes because they answer precipitously more frequently; that is, they do not spend the time they need to properly check items from the task at hand (trees in DiViSA's test).

To calculate the gap between the group of children with teacher-reported attentional problems and the typical development group at each age, in the attention pattern, Cohen's *ds* were computed for each grade and for the three scores above mentioned (CE, DHI and PT). Table 4 includes the results. Cohen's *ds* for the GAI were also computed because the groups differed in two of its components (commission errors and performance time). Following Cohen's interpretation for the *d* statistic (Cohen, 1988), there is a developmental gap from large (at grade two) to medium (from grade three and on) for the number of commission errors (CE); large for the distraction-hastiness index (DHI) at every grade and from medium (grade two) to large (from grade three to six) for performance time. As a result, the gap is large for the global attention index at every grade. This gap is equivalent to two grades. This means that, in terms of visual search efficiency, children from the sixth grade with teacher-reported attentional problems perform like the children from the fourth grade in the typical development group, and so on in the other age groups studied here.

Please insert Table 4

Being that these results are so impressive, a second group of children with teacher-reported attentional problems was tested for replication purposes.

Effects of Group and Grade (Second Group with Attentional Problems)

As in the first study, the first MANOVA run included gender as an independent variable, plus group and grade. Obtained results showed low eta-squared values for the interactions between gender and grade, gender and group, and gender, grade and group. However eta-squared value for gender, at the multivariate level, was 0.015, slightly higher than the .01 low level cutoff defined by Llopis-Pérez (2015). Therefore, gender was included as covariate in the subsequent analysis.

As with the comparison between typical development children and the first group of children with teacher-reported attentional problems, the assumptions for the MANOVA analysis (MA) were tested. As expected, again Box's test of equality of variance-covariance matrices was statistically significant (p = .001) as were Levene´s tests for homogeneity of variances (p < .001), but pooled within-groups Pearson correlations revealed values lower than .45, thus multicollinearity of the dependent variables was low enough to rely on MA results. As with the first group of children with teacher-reported attention problems, Pillai’s trace was used instead of Wilks’ Lambda.

Table 5 includes means and standard deviations for DiViSA’s test scores by group and grade. Data for GAI have been included for descriptive purposes but were not included in the MANOVA as was explained before. Obtained results for the multivariate and univariate analyses of variance for the second group of children with teacher-reported attentional problems compared to the children with typical development are shown in Table 6, including the effect of the covariate (gender).

Please Insert Table 5

Multivariate statistics show that group (Pillai’s Trace $_{group}$ (5, 2327) = .387, p < .0001, η^2_p = .383), grade (Pillai’s Trace $_{grade}$ (20, 9320) = .398, p < .0001, η^2_p = .100) and their interaction are statistically significant (Pillai’s Trace $_{interaction}$ (20, 9320) = .044, p < .0001, η^2_p = .011), but with very different contributions. The Group factor explains 38%, the Grade factor 10% and the Interaction 1%, of the differences in the multivariate attention pattern. That is, the obtained differences in the attention pattern come mainly from the type of group (attention problems versus typical development), and these differences are almost four times the differences due to grade, in terms of variance accounted for. Children with attentional problems as reported by teachers, differ in their developmental pattern in visual search when compared to typically developing children. This is the same result as the one obtained for the first group of children reported by teachers as having attentional problems.

Please Insert Table 6

Univariate statistics indicate that differences in visual search due to the group factor appeared for the six DiViSA's scores (p < .0001). The interpretation of partial etas-squared, (following Llopis Pérez, 2015) indicate that the main differences come from DHI (η^2 = .23), PT (η^2 = .14) and CE (η^2 = .15). Thus, children with attentional problems from the second group also show a visual search pattern characterized by hastiness, longer performance times (slowness) and greater numbers of commission errors (inaccuracy).

For the grade factor, univariate statistics show statistically significant effects (p < .0001) for DiViSA's scores except for DHI. Partial etas-squared indicate that the main differences associated with age (course grade) come from PT (η^2 = .30), OE (η^2 = .11), CA (η^2 = .11) and CE (η^2 = .09). Post hoc tests (Bonferroni, p < .001) indicate that PT decreases continuously from grade two to six; OE reduces from grade two to four; CA increases from grade two to four and CE reduces from grade two to four. Younger children spend more time to complete the task, obtain a greater number of correct answers but also make more omission and commission errors.

Effect size statistics (η^2) for the Interaction are very low (from .01 to .04). The nature of the interaction consists in that the differences between the two groups slightly decrease with grade for commission errors, omission errors, correct answers, task organization index and distraction-hastiness index. Thus, children with attentional problems mostly develop their visual search pattern as typically developing children do, but at a lower rate (almost parallel developmental patterns).

Cohen's *ds* were computed for each grade and for the three scores that differentiate the visual search pattern between children with probable attentional problems from that of children with a typical development (DHI, CE and PT). Table 7 includes the results. We have also computed the *ds* for the GAI because groups differ in two of its components (commission errors and performance time). Following Cohen's interpretation for the *d* statistic (Cohen, 1988), there is a developmental large gap between the two groups analyzed in the number of commission errors (CE) and in the distraction-hastiness index (DHI). For performance time, there is no gap at grade two between the two groups but afterwards, the gap is medium-sized at grades three and four and becomes large at grades five and six. As a result the gap is large for the global attention index at every grade. This gap is equivalent to two grades. This means that, in terms of visual search efficiency, children from the sixth grade with teacher-reported attentional problems perform like the children from the fourth grade in the typical development group, and so on in the other age groups. To visually capture these features, Figure 2 displays the developmental pattern by group and score.

Please Insert Table 7

Please Insert Figure 2

Obtained results with this second group of children with teacher-reported attentional problems, clearly replicate the ones obtained for the first group, as could be expected due to their similarity in the referral reason.

Discussion

The main goal of the present study was to analyze the developmental pattern of visual search behavior for children with and without teacher-reported attentional problems. For the first time a variety of different performance components (correct responses, commission errors, omission errors, performance time, distraction-hastiness balance and level of organization when completing the task) was studied separately to determine the developmental patterns in both groups of children from ages 6 to 12.

Interestingly, results have shown very small effects for gender and its interactions with group and grade, which led us to conclude that for both groups and the five grades considered boys and girls show a very similar visual search pattern.

Multivariate statistics have shown that the two studied groups of children with teacher-reported attentional problems have longer performance times (slowness), make a greater number of commission errors (inaccuracy) and show response hastiness, relative to age-matched control children. Response hastiness is the main reason for their higher level of commission errors. The difference in mean response-times between children with attentional problems and children with typical development increases across the age range studied. Moreover, children with attention problems show at every grade level (from two to six) that their mistakes are a product of hastiness (lower response times for errors than for correct answers) and not from distraction (higher response times for errors than for correct answers). The difference in the Distraction-Hastiness-Index average, between children with attentional problems and children with typical development, is very important because the mistakes made by the children with typical development, at every course-grade, come mainly from distraction. The fact that correct responses were slower than errors (hasty answers), in the groups of children with teacher-reported attentional problems, must be highlighted because parents tend to associate a hasty behavior to quickness but children with attentional problems have shown that they need more time to answer correctly. Children with attentional problems make mistakes if they do not spend the time they need to complete the visual search task (comparing the stimulus with the target, and deciding whether they are identical, or not).

In the first group of children with teacher-reported attentional problems, the developmental gap observed at grade two for the commission errors is reduced by grade three and four but then increased again by grade five. In the second group, this pattern was even clearer: the development gap was large at grade two, was reduced slightly at grades three and four and it became even larger at grades five and six.

Obtained data for grade-level show increasing performance levels with age for both groups in some aspects (commission errors, omission errors and performance time) but not in others (distraction-hastiness index and task organization index). Whereas some aspects of attention and visual search develop slowly in children with attentional problems compared to children with typical development, other cognitive aspects do not (hastiness is pervasive in children with attentional problems). Berger, Slobodin, Aboud, Melamed and Cassuto (2013) obtained similar results but for sustained attention, in children from 6 to 11 years old. Both ADHD children (*N*=559) and their unaffected peers (*N*=365) were assessed with a Continuous Performance Test. These researchers found that performance of children with attentional problems matched that of typically developing children one to three years younger, with the difference being larger for older children.

As reported by Mullane and Klein (2008) ADHD children respond more slowly than typically developing children, but for the first time we have shown that this relative slowness increases with age from grade two to six. This is important because time requirements increase in schoolwork with age. Thus, one of the reasons for hastiness and increased commission errors for children with attention problems could be a mismatch between their slowness and the time requirements at school, even for the youngest children. Moreover, the groups of children with teacher-reported attentional problems analyzed here do not have an ADHD diagnosis, extending the obtained results to children with poor academic achievement and poor attention levels and not only those diagnosed as with ADHD.

Contrary to Naglieri et al. (2003), our results show a large performance difference between children with attentional problems and children with typical development, at every grade, for each of the three relevant scores: performance time, commission errors and distraction-hastiness. Importantly, the developmental gap for correct answers is small in the visual search task used here, except for children from grade two from the first group of children with attentional problems. Thus, differences between children with and without teacher-reported attentional problems do not refer to ability differences.

The results also have shown that there is not a very important interaction between the group factor (attentional problems versus typical development) and the grade either in the multivariate pattern or in any one of the six individual measures. As the graphs in Figure 2 show, patterns from the groups with attentional problems and the one from children with typical development are almost parallel across the considered age range. Thus, it can be stated that visual search development is continuous both for typically developing children (as obtained by Klenberg et al., 2001) and for children with attentional problems. As far as we know this is the first time that a continuous behavioral development pattern, in visual search, has been obtained for children with attentional problems. For sustained attention, Barkley, Karlsson, Polland and Murphy (1985) showed a continuous developmental change in children with ADHD, but only from 5 to 9 years old. Summarizing, selective attention shows a continuous developmental pattern in children with attentional problems, but at a lower rate than the one deployed by typical developing children.

It is important to underscore that the present study follows a cross-sectional design: psychologists assessed children from the groups with attentional problems when teachers referred them for assessment. It means that, if not detected, attentional problems persist and children will progressively have more difficulties at school because they perform as younger students while school requirements, in terms of performance speed to complete assignments, increase for every successive grade. The obtained developmental gap remains stable, from 6 to 12 years old, being already relatively large for hastiness, and increasing somewhat for performance time and commission errors.

In summary, in a large cross-sectional study including a replication sample of children with teacher-reported attentional problems, we have found that children with attentional problems show a visual search pattern characterized by hastiness, slowness (long performance times) and inaccuracy (high rates of commission errors) relative to age-matched controls. For these three aspects of visual search behavior, there is a large developmental gap between children with typical development and children with attention deficits that remains so from the second to the sixth grade.

References

Barkley, R.A., Karlsson, J., Pollard, S. & Murphy, J.V. (1985). Developmental changes in the mother-child interactions of hyperactive boys: Effects of two dose levels of ritalin. *Journal of Child Psychology and Psychiatry, 26*(5), 705-715. http://dx.doi.org/10.1111/j.1469-7610.1985.tb00585.x

Berger, I., Slobodin, O., Aboud, M., Melamed, J. & Cassuto, H. (2013). Maturational delay in ADHD: Evidence from CPT. *Frontiers in Human Neuroscience,* 7(691), 1-11. http://dx.doi.org/10.3389/fnhum.2013.00691

Brickenkamp, R. (2002). *d2, test de atención* [d2, test of attention]. Madrid, Spain: TEA Ediciones. (Original work published 1962).

Klenberg, L., Korkman, M. & Lahti-Nuuttila, P. (2001). Differential Development of Attention and Executive Functions in 3 to 12-Tear-Old Finnish Children. *Developmental Neuropsychology, 20*(1), 407-428.

Laerd Statistics (2016). The ultimate IBM SPSS guides. https://statistics.laerd.com/

Lehman, E.B., Naglieri, J.A., & Aquilino, S.A. (2010). A National Study on the Development of Visual Attention Using the Cognitive Assessment System. *Journal of Attention Disorders*, *14*(1), 15-24. http://dx.doi.org/10.1177/1087054709332473

Llopis Pérez, J. (2015). La estadística: una orquesta hecha instrumento. Downloaded on June 26th 2016 from: https://estadisticaorquestainstrumento.wordpress.com

Lozano, J.H., Capote, E., y Fernández, M.P. (2015). Convergent validity of the measures of attention and impulsivity in the Trees Simple Visual Discrimination Test (DiViSA-UAM). *Anales de Psicología, 31*(1), 74-83. http://dx.doi.org/10.6018/analesps.31.1.161371

Manly, T., Anderson, V., Nimmo-Smith, I., Turner, A., Watson, P. & Robertson, I.H. (2001). The differential assessment of children's attention: The Test of Everyday Attention for Children (TEA-Ch), normative sample and ADHD performance. *Journal of Child Psychology, Psychiatry and Allied Disciplines, 42*(8), 1065-1081.

Mullane, J.C. & Klein, R.M. (2008). Visual search by children with and without ADHD. *Journal of Attention Disorders, 12*(1), 44-53.

Naglieri, J.A. & Das, J.P. (1997). *Cognitive Assessment System.* Itasca, IL: Riverside.

Peelen, M.V., y Kastner, S. (2014). Attention in the real world: Toward understanding its neural basis. *Trends in Cognitive Science*, *18*(5): 242-50. http://dx.doi.org/10.1016/j.tics.2014.02.004

Quiroga, M.A., Santacreu, J., Montoro, A., Martínez-Molina, A. & Shih, P.Ch. (2011). Computerized Assessment of Attention for Children from 7 to 11 Years Old: DiViSA-UAM and TACI-UAM. *Clínica y Salud, 22*(1), 3-20. http://dx.doi.org/10.5093/cl2011v22n1a1

Quiroga, M. A., Santacreu, J., López-Cavada, C., Capote, E., & Morillo, D. (2013). Effect of external irrelevant distracters on a visual search test in school-age children: Computerized assessment. *Journal of Attention Disorders*, http://dx.doi.org/10.1177/1087054713497397

Rueda, M.R., Fan, J., McCandliss, B.D., Halparin, J.D., Gruber, D.B., Lercari, L.P. & Posner, M.I. (2004). Development of attentional networks in childhood. *Neuropsychologia, 42*, 1029-1040. http://dx.doi.org/10.1016/j.neuropsychologia.2003.12.012

Santacreu, J., & Quiroga, M.A. (2015). Divisa's predictive validity developmentally computed: An online objective test of attention. *The Spanish Journal of Psychology, 18,* e98, 1-11. http://dx-doi.org/10.1017/sjp.2015.103

Santacreu, J., Shih, P.Ch. & Quiroga, M.A. (2011). *DiViSA, Trees Simple Visual Discrimination Test. Manual.* Madrid: Tea Ediciones. http://web.teaediciones.com/DIVISA--Trees-Simple-Visual-Discrimination-Test.aspx

Thurstone, L.L. & Yela, M. (1995). *Test de percepción de diferencias (Caras)* [*Differences Perception Test (Faces)*]. Madrid: TEA Ediciones.

Wassenberg, R., Hendriksen, J.G.M., Hurks, P.P.M., Feron, F.J.M., Keulers, E.H.H., Vles, J.S.H. & Jolles, J. (2008). Development of inattention, impulsivity, and processing speed as measured by the d2 test: Results of a large cross-sectional study in children aged 7 to 13. *Child Neuropsychology, 14,* 195-210. http://dx.doi.org/10.1080/09297040601187940

Table 1

Number of boys and girls for each grade and group tested

		First Group of children with teacher-reported attentional problems.			Second Group of children with teacher-reported attentional problems.			Typical Development Group		
		Sex			Sex			Sex		
		Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
School Grades (Age Groups)	Two	114	273	387	102	237	339	84	101	185
	Three	62	146	208	49	128	177	138	153	291
	Four	52	112	164	425	89	131	124	127	251
	Five	50	89	139	31	77	108	130	166	296
	Six	89	173	262	64	128	192	166	253	419
Total		367	793	1160	288	659	947	642	800	1442

Table 2

Mean scores and standard deviations for DiViSA's scores as a function of group (children with teacher-reported attentional problems and children with typical development) and grade

	CA		CE		OE		TOI	
Group	M	SD	M	SD	M	SD	M	SD
Att. Prob.								
Two	87	10.58	22.40	16.03	10.21	10.55	15.32	4.30
Three	92	7.67	14.98	13.08	5.75	7.03	16.46	4.36
Four	94	5.39	13.23	12.79	4.18	5.73	16.86	4.51
Five	95	4.15	11.42	11.85	3.77	6.98	18.53	5.52
Six	95	5.22	10.25	13.43	2.53	4.13	18.03	6.48
Typ. Dev.								
Two	93	4.35	9.88	8.17	4.77	4.35	17.57	3.40
Three	94	4.28	8.46	10.76	4.31	4.28	17.52	3.29
Four	95	3.03	6.39	6.86	2.86	3.03	17.71	3.30
Five	96	2.25	4.59	3.83	2.24	2.25	17.41	3.61
Six	96	1.88	4.43	4.11	1.88	1.88	17.85	3.68

	DHI		PT		GAI	
Group	M	SD	M	SD	M	SD
Att. Prob.						
Two	-.74	.91	223	68.62	.28	.10
Three	-.66	.69	205	59.44	.39	.12
Four	-.65	.64	201	50.01	.43	.11
Five	-.60	.68	200	68.95	.48	.13
Six	-.60	.87	192	71.20	.58	.18
Typ. Dev.						
Two	.71	1.31	212	50.02	.45	.12
Three	.54	1.22	176	39.86	.54	.14
Four	.57	1.38	171	41.82	.57	.15
Five	.55	.97	144	31.20	.69	.15
Six	.53	.79	126	24.53	.79	.15

Note: Att. Prob.: Attention Problems; Typ. Dev.: Typical Development; CA: Number of Correct Answers; CE: Number of Commission Errors; OE: Number of Omission Errors; TOI: Task Organization Index; DHI: Distraction-Hastiness Index; PT: Performance Time in seconds; GAI: Global Attention Index.

Table 3

Multivariate and univariate analyses of Variance for DiViSA's scores, for the first group of children with teacher-reported attentional problems (N = 1160) and the typical development group (N = 1442)

	Multivariate			Univariate								
				CA			CE			OE		
Source	F^a	p	η^2	$F^{b, c}$	p	η^2	$F^{b, c}$	p	η^2	$F^{b, c}$	p	η^2
Group (Gr)	358.61	.0001	.42	90.06	.0001	.03	289.24	.0001	.10	74.71	.0001	.03
Grade (G)	59.78	.0001	.11	15.60	.0001	.02	54.18	.0001	.08	68.06	.0001	.10
Gr x G	6.47	.0001	.01	4.06	.003	.01	8.04	.0001	.01	14.2	.0001	.02

	Univariate								
	TOI			*DHI*			PT		
Source	$F^{b, c}$	p	η^2	$F^{b, c}$	p	η^2	$F^{b, c}$	p	η^2
Group (Gr)	10.25	.001	.00	880.37	.0001	.26	328.60	.0001	.12
Grade (G)	11.37	.0001	.02	0.13	.971	.00	93.84	.0001	.13
Gr x G	10.07	.0001	.02	2.16	.071	.00	23.34	.0001	.04

Note: Multivariate F ratios were generated from Pillai's statistic. [a] Multivariate *df* = 6, 2526 . [b] Univariate Group *df* =1, 2522 . [c] Univariate Grade *df* = 4, 2522. CA = Number of Correct Answers; CE = Commission Errors; OE = Omission Errors; TOI = Task Organization Index; DHI = Distraction-Hastiness Index; PT = Performance Time.

Table 4

Cohen's d for each grade and DiViSA's scores between the first group of children with teacher-reported attentional problems, and the typical development group

Grade	CE	DHI	PT	GAI
Two	-.98	1.29	-.59	1.54
Three	-.54	1.21	-.88	1.15
Four	-.66	1.13	-.82	1.06
Five	-.77	1.37	-1.26	1.49
Six	-.58	1.36	-.95	1.27

Note: CE = Number of Commission Errors; DHI = Distraction-Hastiness Index;
PT = Performance Time; GAI = Global Attention Index.
d index positive value reflects a higher value for typical development children while a negative value reflects a higher value for children with teacher-reported attentional problems.

Table 5
Mean scores and standard deviations for DiViSA's scores as a function of group (children with teacher-reported attentional problems and children with typical development) and grade

	CA		CE		OE		TOI	
Group	M	SD	M	SD	M	SD	M	SD
Att. Prob.								
Two	91	8.03	20.34	12.72	10.73	10.57	15.02	3.95
Three	93	7.29	17.36	13.93	6.46	7.66	16.18	3.74
Four	92	8.19	13.52	10.78	3.98	5.39	16.95	4.09
Five	94	6.84	13.73	11.08	3.28	4.15	17.13	4.52
Six	93	7.19	10.19	8.53	3.03	5.22	17.18	4.18
Typ. Dev.								
Two	93	4.35	9.88	8.17	4.77	4.35	17.57	3.40
Three	94	4.28	8.46	10.76	4.31	4.28	17.52	3.29
Four	95	3.03	6.39	6.86	2.86	3.03	17.71	3.30
Five	96	2.25	4.59	3.83	2.24	2.25	17.41	3.61
Six	96	1.88	4.43	4.11	1.88	1.88	17.85	3.68

	DHI		PT		GAI	
Group	M	SD	M	SD	M	SD
Att. Prob.						
Two	-.67	.84	246	66.65	.29	.10
Three	-.65	.65	219	56.57	.36	.12
Four	-.67	.68	208	49.03	.41	.10
Five	-.43	.67	196	48.29	.44	.13
Six	-.47	.58	159	42.83	.57	.17
Typ. Dev.						
Two	.71	1.31	212	50.02	.45	.12
Three	.54	1.22	176	39.86	.54	.14
Four	.57	1.38	171	41.97	.57	.15
Five	.55	.97	144	31.20	.69	.15
Six	.53	.79	126	24.53	.79	.15

Note: Att. Prob.: Attention Problems; Typ. Dev.: Typical Development; CA: Number of Correct Answers; CE: Number of Commission Errors; OE: Number of Omission Errors; TOI: Task Organization Index; DHI: Distraction-Hastiness Index; PT: Performance Time; GAI: Global Attention Index.

Table 6

Multivariate and univariate analyses of variance for DiViSA's scores, for the second group of children with teacher-reported attentional problems (N = 947) and the typical development group (N = 1442)

	Multivariate			Univariate								
				CA			CE			OE		
Source	F^a	p	η^2	$F^{b, c, d}$	p	η^2	$F^{b, c, d}$	p	η^2	$F^{b, c, d}$	p	η^2
Gender	6.26	.0001	.013	9.34	.002	.004	10.52	.001	.004	9.34	.002	.004
Group (Gr)	289.11	.0001	.375	84.07	.0001	.04	411,7	.0001	.15	84,08	.0001	.04
Grade (G)	51.52	.0001	.100	71.37	.0001	.11	54,24	.0001	.09	71,38	.0001	.11
Gr x G	5.14	.0001	.011	16.09	.0001	.03	4,77	.001	.01	16,1	.0001	.03

	Univariate								
	TOI			DHI			PT		
Source	$F^{b, c, d}$	p	η^2	$F^{b, c, d}$	p	η^2	$F^{b, c, d}$	p	η^2
Gender	1.74	.188	.001	1.12	.289	.000	3.19	.074	.001
Group (Gr)	45.24	.0001	.02	711,38	.0001	.23	386.24	.0001	.14
Grade (G)	7.94	.0001	.01	1,09	.360	.00	245.26	.0001	.30
Gr x G	6.05	.0001	.01	3.19	.013	.01	2.29	.057	.00

Note: Multivariate F ratios were generated from Pillai's statistic. [a] Multivariate df = 5, 2331. [b]Univariate Gender df =1, 2331. [c] Univariate Group df =1, 2331 . [d] Univariate Grade df = 4, 2331. CA = Number of Correct Answers; CE = Commission Errors; OE = Omission Errors; TOI = Task Organization Index; DHI = Distraction-Hastiness Index; PT = Performance Time.

Table 7

Cohen's d for each grade and DiViSA's scores between the second group of children with teacher-reported attentional problems, and the typical development group.

Grade	CE	DHI	PT	GAI
Two	-.98	1.25	-.18	1.45
Three	-.72	1.22	-.57	1.38
Four	-.79	1.14	-.67	1.25
Five	-1.10	1.23	-1.07	1.78
Six	-.86	1.44	-1.26	1.37

Note: CE: Commission Errors; DHI: Distraction-Hastiness Index; PT: Performance Time; GAI: Global Attention Index.

d index positive value reflects a higher value for typical development children while a negative value reflects a higher value for the group with teacher-reported attentional problems.

Figure 1

DiViSA-Test example.

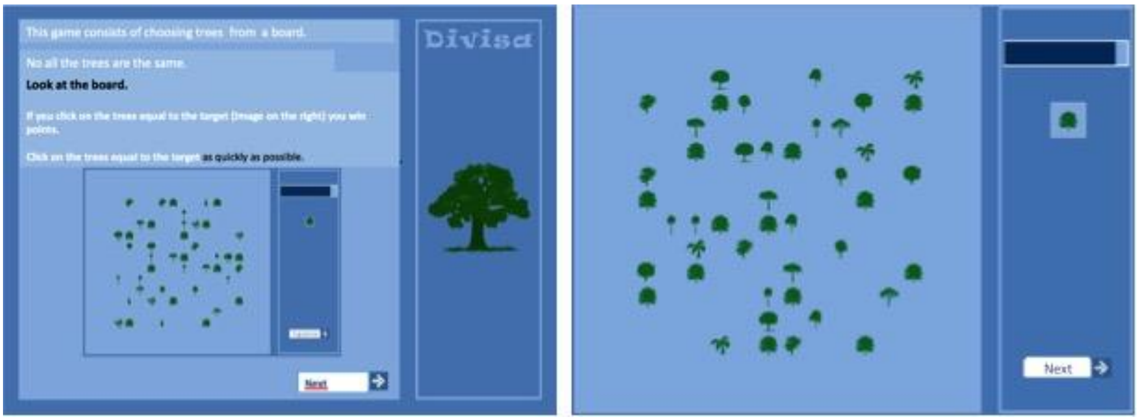
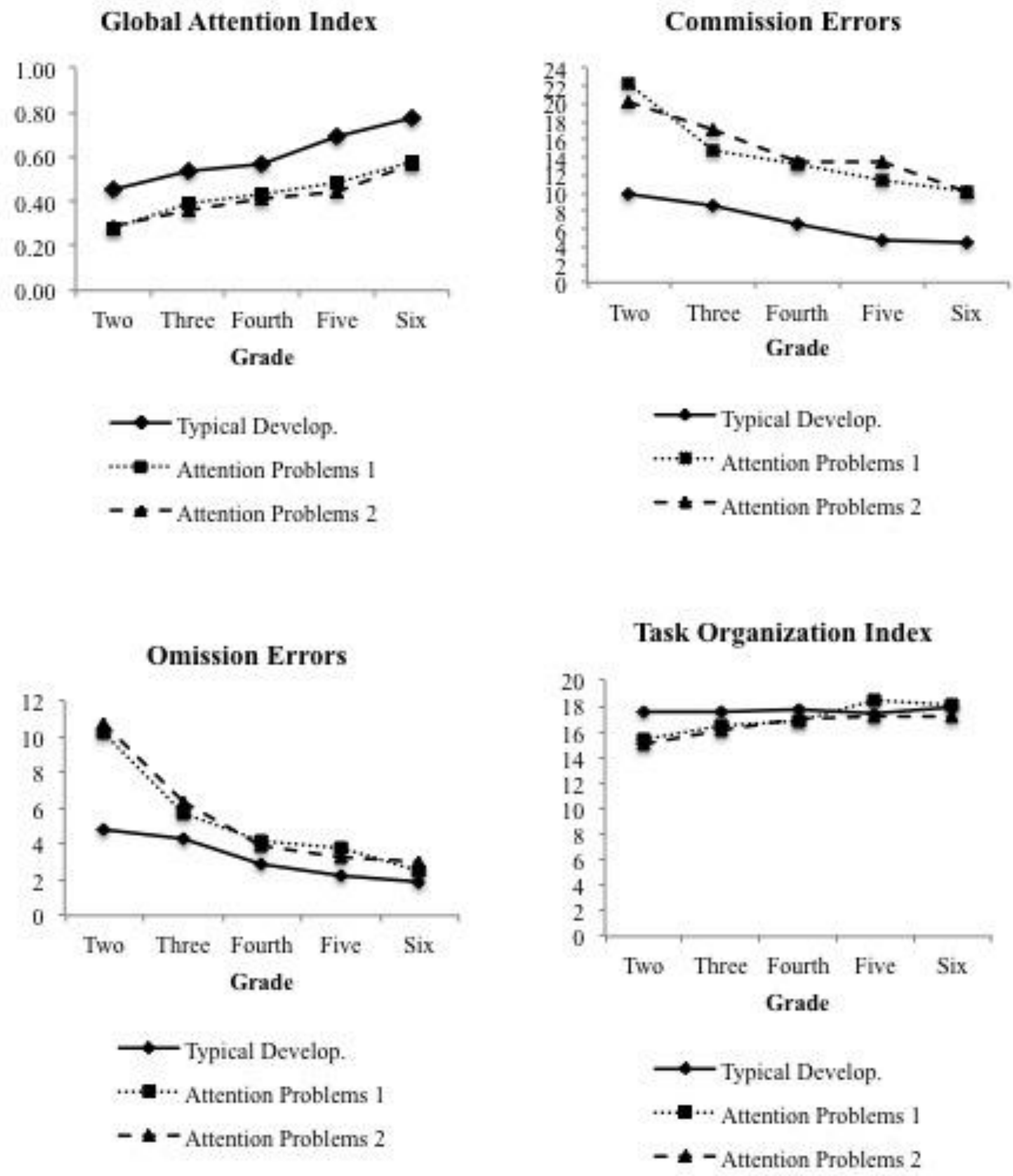
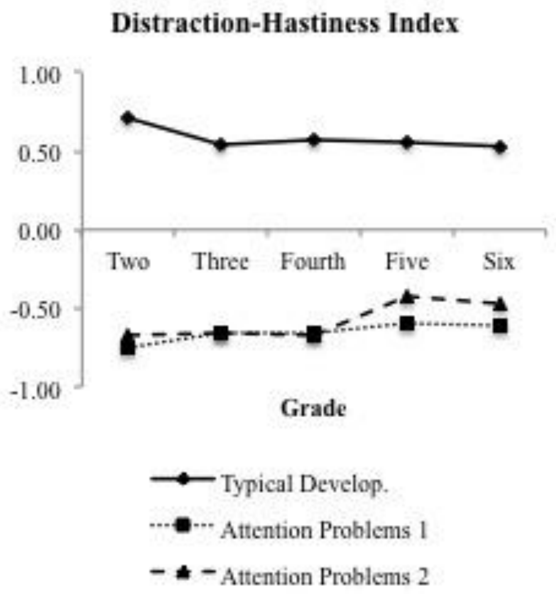
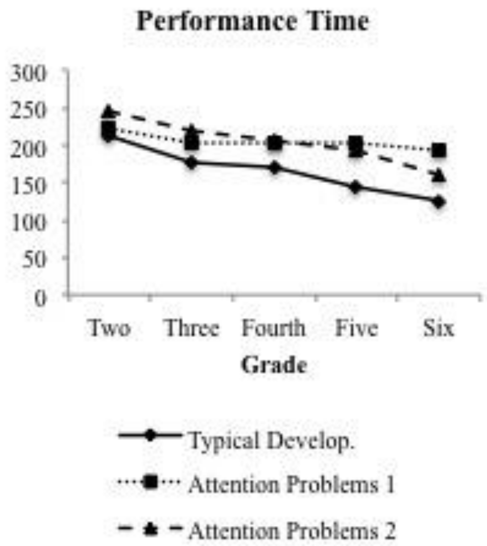
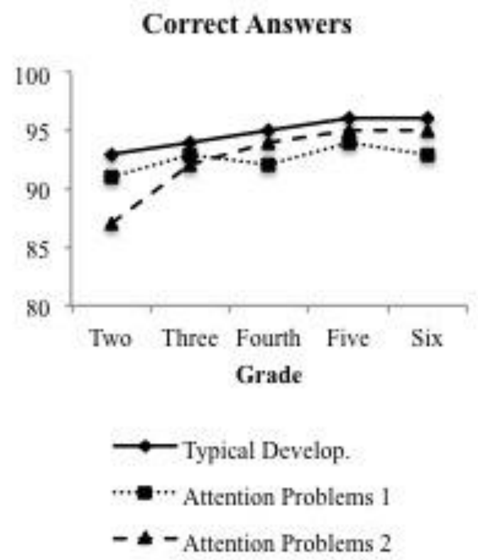


Figure 2
Developmental patterns for DiViSA's scores, for the typical development group (N=1442) and the two groups of children with teacher-reported attentional problems (N=1160 and N=947).




Distraction-Hastiness Index
1.00
0.50
0.00
-0.50
-1.00
Two
Three
Fourth
Five
Six
Grade
Typical Develop.
Attention Problems 1
Attention Problems 2


Performance Time
300
250
200
150
100
50
0
Two
Three
Fourth
Five
Six
Grade
Typical Develop.
Attention Problems 1
Attention Problems 2


Correct Answers
100
95
90
85
80
Two
Three
Fourth
Five
Six
Grade
Typical Develop.
Attention Problems 1
Attention Problems 2