OPEN ACCESS

Educational Research Applications

Research Article

Bigozzil L Educ Res Appl: ERCA-142.
DOI: 10.29011/2575-7032/100042

Attentional Processes Predictive of Reading in Second and Third Classes: the Role of Selective/Focused Attention and Planning

Lucia Bigozzi*, **Sara Pezzica, Amanda Grazi**

Department of Education and Psychology, University of Florence, Italy

***Corresponding author:** Lucia Bigozzi, Department of Education and Psychology, University of Florence, Italy. Tel: +390552755010; Fax: +390552756134; Email: lucia.bigozzi@unifi.it

Citation: Bigozzi1 L, Pezzica S, Grazi A (2018) Attentional Processes Predictive of Reading in Second and Third Classes: the Role of Selective/Focused Attention and Planning. Educ Res Appl: ERCA-142. DOI: 10.29011/2575-7032/100042

Received Date: 8 February, 2018; **Accepted Date:** 28 February, 2018; **Published Date:** 8 March, 2018.

Abstract

Background: The attentive functions appear to be involved in learning. In particular, at the beginning of schooling the processes of visual attention are important. In subsequent years, in line with the automation of the processes of learning, the processes of active attention such as inhibition, interference control and management of a double task are more important. On the basis of these findings it is important to consider which are the attentive indices able to predict reading.

Methods: In our study, a group of children aged between 8 and 10 years was evaluated in order to locate the attentive predictors of school performance.

Results: This study can provide information on which attentive processes are predictive of learning.

Conclusions: The results point out that the development of decoding requires the activation of different cognitive components over time. We support the hypothesis that in second grade, reading might depend on proper functioning of the visuospatial selective and active attentional system, confirming the causal relationship between active attention and reading in this age group. Only later, when access to the mental lexicon is automated, will visuospatial basic and active attentional processes no longer be involved. In third, the child uses a type of more active attention because he/she is preparing to automate the process and access mental lexicon.

Keywords: Coding; Focused Attention; Planning; Reading; Selective Attention

The role of attention in literacy

Coltheart's (1980) Dual Route Cascaded model of reading and writing argues that children learn to read through the grapheme-phoneme route system (sub lexical route) and through orthographic representation (lexical route). A correct phonological recoding in the grapheme-phoneme route system is especially important for the development of future reading skills [1,2]. 1,2 In this phase, both linguistic [3,4], and attentive cognitive processes are required with particular reference to visual attention [5,6].

Our focus is decoding. In fact, the decoding of a text is a task which requires attention to be focused visually and spatially [7]. Decoding involves the use of an attentional spotlight, a kind of directional light that illuminates specific areas of interest [8] and allows one to concentrate or distribute attentional resources [9] It is important to emphasize that in the early stages of learning, phonological decoding needs a visual search task [10] Phonological decoding requires visuospatial segmentation of a string of letters into graphemes. Therefore, visuospatial attention is crucial in addition to phonological skills for correct reading [11]. Laberge and Samuels (1974) [12]. had also highlighted the central role of visual attention in decoding. In the beginning readers should pay attention to single letters in sequence to identify the correct word. Stevens & Bavelier (2012) [13] highlighted that reading requires visuospatial selective attention, particularly during the early learning stages.

Some studies have identified the predictive relations of attentive regulation on decoding. In fact, poor self-regulation is associated to negative outcome, including school failure [14] In particular, visual attention is important. At the beginning of reading acquisition, letters must be specifically selected through the rapid orientation of visual attention [10]. In an Italian study [6] visual spatial attention in pre-schoolers predicts the future acquisition of reading in grades 1 and 2. So, attentional orienting has a very important role in reading skills development. This relationship has been confirmed by both studies of transparent orthographies such as French [15] and in opaque orthographies like English [16,17]. This evidence supports the causal role of visuospatial attention in learning to read and demonstrates that this process is fundamental in the early stages of acquisition of reading. With experience, the identification of the letters becomes automatic and readers became gradually able to pay attention to a greater quantity of information. In fact, in later times lower levels of effort are required, with the automatization of reading processes (lexical reading) [18]. This passage occurs when the individual has reached sufficient automatization [19].

The relationship between attention and reading is also highlighted by the fact that many children have problems in both. Attention is an important predictor of at-risk readers [20]. Children that have attention problems, such as Attention Deficit and Hyperactivity Disorder (ADHD), perform poorly in literacy. In particular, the active component of attention is associated with difficulties in reading [21-23]. So, inattention is highly involved [24] in later school failure in ADHD children. In the school-aged population Learning Disabilities (LD) and ADHD are very frequent. ADHD and LD can co-occur frequently and there is a high mean comorbidity rate (45.1%) [25]. About 40% of children with ADHD also have a specific reading disorder [26-29]. Pennington (2006) [30] demonstrates that reading disabilities and attention deficit have a multifactorial aetiology. To explain the overlap between reading and attention, some common dimensions are investigated [31,30], within the context of the multiple deficit framework for neurodevelopmental disorders. A single deficit does not seem to be sufficient to cause the frequent overlap between reading and attention. Processing speed and working memory difficulties are very important in the development of reading disabilities and attention deficit, and they probably interact with other neurocognitive risk factors and protective factors. These dimensions' area associated with executive/active attention capabilities and reflect a general capability to control attention to maintain a limited amount of information in an active state, particularly in the presence of interference. Interest also remains in alternative accounts, and visual attention has been a particular focus. However, visual attention deficit could be an additional risk factor that interacts with a processing speed and working memory deficit [31].

Aims

In this study, we wanted to identify the predictive links between various components of attention and reading in the second and third classes of primary school, keeping under control the predictive role that learning plays on itself. We expect a predictive role of visual selective attention in the early years of school. Instead in the following years, attention should be less implicated in line with the automation of the process.

We investigated what kind of attention is involved in early years of academic learning of reading. The assumption is that the identification of the letters became automatic with experience and that readers became gradually able to pay attention to a greater quantity of information. With the automatization of decoding processes and access to the lexical route, the decoding no longer requires attention abilities.

Method

Participants

A total of 143 children (66males and 77 females) aged 7.6 years and 9.4years participated in the study. The children all attended the same school on the outskirts of a large city in the centre of Italy. We excluded all students with a disability and/or developmental disorder (as diagnosed by the national health system). The measures were administered at a time agreed upon with the school and with due adherence to the requirements of privacy and informed consent required by the Italian law (Legislative Decree-196/2003). Regarding the ethical standards for research, the study referred to the last version of the Declaration of Helsinki by the World Medical Association. The study was approved by the Departmental Ethics Committee, Department of Psychology, University of Florence, Italy.

Procedures

The parents gave written consent to their children taking part in the project. The children themselves were informed of the purposes of there search before the start of testing.

Materials

Reading task- We used the MT battery to test speed and accuracy of text [32]. This is an Italian battery that measures passage reading speed and accuracy. The child has to read a text entitled "The story of Babbbo Natale "in first grade," The topic ampanari "in second grade and "The empty barrel and the full barrel" in third grade. The MT battery comprises different passages for each grade level with increasing number of syllables and complexity of text. The internal reliability coefficientis =.90.

Tests of attention - Cognitive Assessment System (CAS)

This battery is based on the PASS theory of intelligence [33] and is a multidimensional measure of cognitive processing. A standard score is provided for each cognitive process (Planning, Attention, Simultaneous and Successive). We used only Planning and Attention scores. For the Attention score we used:

- Number detection (functions involved: Selective Attention, Shifting Focus).

- Receptive attention (functions involved: Focused Attention).
- Expressive attention (functions involved: Inhibit automatic responses, Interference control).

For the Planning score we used:

- Matching numbers (functions involved: Planning, Selective Attention).
- Planned codes (functions involved: Planning, Inhibition).

The internal reliability coefficients are for Planning=.88 and for Attention=.88. The progression of scores across ages is measured.

Visuospatial working memory/active attention measures – These tests were used because they permit an assessment of level of attentional control (i.e. low attentional control/passive tasks or high attentional control/active tasks) with greater involvement of the central executive system tasks at lowand high level of control.

The visuospatial working memory abilities were evaluated with the test of the Paths and Corsi's Test. Both tests are taken from the BVS-Corsi Battery for assessing visual spatial working memory/active attention [34].

Test of paths on matrices.

Back Courses Test**,** the Italianversion of the Corsi task [34]. The internal reliability coefficient is =.74.

Intelligence quotient -The following tests were used as control variables. We administered two sub tests of the Wechsler Intelligence Scale (WISC-III): Similarities and Block Design [35,36]. I*nternal reliability* for subtests ranged from .79 to .90.

Data analysis

First of all, the descriptive statistics of the metric variables (mean, standard deviation, skewness and kurtosis coefficients, minimum and maximum values), i.e. attentive, active attentive and accuracy and rapidity in reading, were carried out, distinctively for different scholastic classes. The normality assumption for all variables were verified, and in those cases in which a variable distribution did not seem to be a Gauss curve, the appropriate monotone increasing transformations were applied.

Pearson's correlation coefficients were carried out to check the statistical association between accuracy and rapidity in reading, attention and active attention measures, both in the second and in the third classes.

In order to determine which attention and active attention variables are able to predict the skills of reading for the age groups considered (second and third classes), a series of linear multiple regression analyses were performed. For each analysis implemented, the different measurements of attention and of active attention were inserted as independent variables, and the accuracy and rapidity in reading as dependent variables, measured both in the same year (T_1) and in the next year (T_2) with respect to the acquisition of the attention measures. When the predictive analyses were carried out with measurements of attention and of active attention in the second class and accuracy and rapidity in reading in the third class, rapidity and accuracy in the second class were considered as covariates.

Before the implementation of the linear multiple regression analyses, for all the complex of the independent variables the statistical coefficient VIF (Variance Inflation Factor) was calculated to exclude the possible presence of multi-collinearity (Field, 2005). For each independent variable included in the regression models, the effect-size coefficient partial eta-squared (η^2) was calculated.

Results

The descriptive statistics of all the reading, attention and active attention variables are reported in the two next tables (Table 1,2).

	T_1						T_2					
	Min	Max	M	SD	Skewness	Kurtosis	Min	Max	M	SD	Skewness	Kurtosis
Reading (MT text)												
Accuracy (errors) (*)	0	32.5	5.61	4.88	2.88	13.37	0	16	2.09	2.70	3.11	13.06
Rapidity (sill/sec)	.29	5.11	2.27	.84	.43	.97	.58	5.90	3.28	1.09	.13	.05
Attention (Subtest of Cas)												
Number recognition	2	19	11.97	3.41	-.35	.64	8	15	11.1	1.95	.25	-.99
Receptive attention	3	19	11.13	3.32	.12	-.26	5	16	11.32	2.28	-.54	.01
Expressive attention	1	13	7.65	2.95	.14	-.71	4	16	9.64	3.27	.37	-1.08
Planned codes	3	15	1.01	2.55	-.71	.35	3	15	8.68	2.79	-.41	-.03
Matching numbers	4	19	1.86	2.80	.08	.13	6	15	1.32	2.13	.04	-.48
Active attention (subtest of BVS Corsi Test)												

Paths	0	29	1.16	6.17	.73	.50					
Corsi's Test backward	2	6	3.86	.90	.28	-.47					
Cognitive functions involved in each test; Number detection=Visual Selective Attention, Shifting Focus; Receptive attention= Focused Attention; Expressive attention=Inhibit automatic responses, interference control; Planned codes=Planning, Inhibition; Matching numbers=Planning, Selective Attention; (*) = variable normalized by an increasing monotonic transformation.											

Table 1: Descriptive statistics of all measures of reading, attention and active attention skills for the second classes (T_1) and in the next year (T_2): minimum, maximum, mean, standard deviation, skewness and kurtosis.

	T_1						T_2					
	Min	Max	M	SD	Skewness	Kurtosis	Min	Max	M	SD	Skewness	Kurtosis
Reading (MT text)												
Accuracy (errors) (*)	0	14	3.05	3.34	1.61	2.30	0	11	2.28	2.93	1.77	2.39
Rapidity (sill/sec)	.51	4.63	2.84	.91	-.12	-.37	1.23	5.18	3.32	.92	-.25	-.54
Attention (Subtest of Cas)												
Number recognition (*)	3	16	11.41	2.66	-.81	1.35	8	17	11.78	2.62	.35	-1.03
Receptive attention	4	16	1.4	2.42	-.17	-.13	5	18	1.96	2.81	-.13	.32
Expressive attention	4	18	9.45	3.61	.56	-.51	1	16	9.38	3.43	.21	-.31
Planned codes	1	18	1.1	3.23	.12	-.12	5	19	11.13	3.50	.40	-.52
Matching numbers	5	17	1.57	2.32	.21	.48	6	14	1.31	2.17	-.28	-.93
Active attention (subtest of BVS Corsi Test)												
Paths	2	29	13.28	6.94	.48	.06						
Corsi's Test backward	2	7	4.52	1.33	.11	.15						

Table 2: Descriptive statistics of all measures about reading, attention and active attention skills for the third classes (T_1) and in the next year (T_2): minimum, maximum, mean, standard deviation, skewness and kurtosis.

The skewness and kurtosis values refer to the original scale of measure of the variables, and the asterisks indicate those variables that have been normalized by increasing monotonic transformations.

With regard to the statistical association between accuracy and rapidity in reading and attention and active attention, in the second class "Accuracy" (errors in reading) was not correlated with any attention and active attention measure, while "Rapidity" (sill/sec) resulted significantly positively correlated with "Number recognition" (r = .30, p<.01), "Paths" (r = .32, p<.01) and "Corsi's test backward" (r = .28, p< .05). For the third classes, for the parameter "Accuracy", the errors in reading were correlated with "Expressive attention" by a relation of inverse proportionality (r = -.24, p< .05), while "Rapidity" (sill/sec) was positively correlated with "Receptive attention" (r = .37, p<.01), "Expressive attention" (r = .32, p<.01), and "Paths" (r = .36, p<.01) (Table 3).

Classes	**Measure**	**Number recognition**	**Receptive attention**	**Expressive attention**	**Planned codes**	**Matching numbers**	**Paths**	**Corsi's test backward**
Second	MT Accuracy (errors)	-.20	-.05	-.13	-.06	.05	-.19	-.03
	MT Rapidity (sill/sec)	.30**	.06	.15	.12	.18	.32**	.28*
Third	MT Accuracy (errors)	-.13	-.11	-.24*	.16	.04	-.15	-.11
	MT Rapidity (sill/sec)	.22	.37**	.32**	-.02	.13	.36*	-.05
Note. *p<.05; **p<.01.								

Table 3: Correlation analyses between all measures of reading, attention and active attention skills for the second and third classes: Pearson's linear correlation coefficient.

The predictive relationship between reading variables and attention and active attention variables were assessed by a series of linear regression models, that are reported in the tables below (Table 4-9).

For the parameter "Accuracy" (errors in reading), in the second class, was significantly and negatively predicted by "Number recognition" (t = -2.41, p< .05, η^2 = .084) (Table 4), measured in second class, while "Rapidity" in reading was positively predicted by "Number recognition" (t = 2.61, p< .05, η^2 = .097) and "Paths" (t = 2.94, p< .01, η^2 = .121) (Table 5).

Source	B	SEB	t	p	Partial η^2
Intercept	3.649	.748	4.878	< .001	.274
Number recognition	-.004	.002	-2.408	.019	.084
Matching numbers	.051	.047	1.084	n.s.	.018
Planned codes	-.009	.049	-.191	n.s.	.001
Receptive attention	.071	.046	1.556	n.s.	.037
Expressive attention	-.049	.036	-1.359	n.s.	.028
Corsi's Test backward	-.234	.121	-1.937	n.s.	.056
Paths	-.221	.119	-1.857	n.s.	.052
Note. R^2 - adjusted = .13, p< .05.					

Table 4: Summary of the regression model, with "Accuracy" (errors) in the second class as dependent variable and attention and active attention in the second class as independent variables: regression parameter B, standard error of B (SEB), Student's t test (t), p-value and partial eta-squared (Partial η^2).

Source	B	SEB	t	p	Partial η^2
Intercept	3.649	.748	4.878	< .001	.274
Number recognition	-.004	.002	-2.408	.019	.084
Matching numbers	.051	.047	1.084	n.s.	.018
Planned codes	-.009	.049	-.191	n.s.	.001
Receptive attention	.071	.046	1.556	n.s.	.037
Expressive attention	-.049	.036	-1.359	n.s.	.028
Corsi's Test backward	-.234	.121	-1.937	n.s.	.056
Paths	-.221	.119	-1.857	n.s.	.052
Note. R^2 - adjusted = .13, p< .05.					
Source	**B**	**SEB**	**t**	**p**	**Partial η^2**
Intercept	.50	.63	.79	n.s.	.010
Number recognition	.004	.002	2.605	.011	.097
Matching numbers	.045	.040	1.117	n.s.	.019
Planned codes	.012	.042	.289	n.s.	.001
Receptive attention	-.078	.051	-1.529	n.s.	.061
Expressive attention	.035	.030	1.141	n.s.	.020
Corsi's Test backward	.061	.102	.600	n.s.	.006

Paths	.296	.101	2.944	.005	.121

Table 5: Summary of the regression model for, with "Rapidity" (sill/sec) in the second class as dependent variable and attention and active attention in the second class as independent variables: regression parameter B, standard error of B (SEB), Student's t test (t), p-value and partial eta-squared (Partial η^2).

As regards the predictive capability of attention and active attention variables (and accuracy and rapidity in reading as covariates), measured in the second class, on decoding measured in the third class, "Matching numbers" ($t = -2.73$, $p< .05$, $\eta^2 = .107$) and "Paths" ($t = -2.66$, $p< .05$, $\eta^2 = .103$) resulted statistically significant regressors for "Accuracy", while "Matching numbers" ($t = 3.44$, $p< .001$, $\eta^2 = .160$), "Planned codes" ($t = 2.66$, $p< .05$, $\eta^2 = .076$) and "Receptive attention" ($t = 2.08$, $p< .05$, $\eta^2 = .065$) resulted significant regressors for "Rapidity" in reading (Table 6,7).

Source	**B**	**SEB**	**t**	**p**	**Partial η^2**
Intercept	2.19	.77	2.85	.006	.116
Accuracy (errors) in 2nd class	.26	.11	2.33	.023	.081
Number recognition	.01	.02	-2.7	.791	.001
Matching numbers	-.11	.04	-2.73	.008	.107
Planned codes	-.03	.04	-.62	.536	.006
Receptive attention	.07	.04	1.68	.099	.043
Expressive attention	.03	.03	.83	.409	.011
Corsi's Test backward	-.03	.11	-.32	.751	.002
Paths	-.29	.11	-2.66	.010	.103
Note. R^2 - adjusted = .27, p< .001.					

Table 6: Summary of the regression model, with "Accuracy" (errors) in the third class as dependent variable and accuracy in second class, attention and active attention in the second class as independent variables: regression parameter B, Standard Error of B (SEB), Student's t test (t), p-value and partial eta-squared (Partial η^2).

Source	**B**	**SEB**	**t**	**p**	**Partial η^2**
Intercept	.55	.57	.98	.331	.015
Rapidity (sill/sec) in 2nd class	.80	.11	7.15	< .001	.452
Number recognition	.01	.01	-.18	.854	.001
Matching numbers	.12	.04	3.44	< **.001**	.160
Planned codes	.08	.04	2.26	**.027**	.076
Receptive attention	.07	.03	2.08	**.042**	.065
Expressive attention	-.03	.03	-1.10	.277	.019
Corsi's Test backward	-.15	.09	-1.69	.096	.044
Paths	.12	.10	1.24	.219	.024
Note. R^2 - adjusted = .64, p< .001.					

Table 7: Summary of the regression model for, with "Rapidity" (sill/sec) in the third class as dependent variable and rapidity in second class, attention and active attention in the second class as independent variables: regression parameter B, standard error of B (SEB), Student's t test (t), p-value and partial eta-squared (Partial η^2).

Regarding the "Accuracy" in reading measured in third class, the attention variables that resulted as significant predictors were "Planned codes" ($t = -2.15$, $p< .05$, $\eta^2 = .103$) and "Receptive attention" ($t = -2.31$, $p< .05$, $\eta^2 = .117$), while for "Rapidity" in reading, the results pointed out as statistically significant predictors "Receptive attention" ($t = 2.72$, $p<.05$, $\eta^2 = .156$) and "Paths" ($t = 2.27$, $p< .05$, $\eta^2 = .114$) (Table 8,9).

Source	**B**	**SEB**	**t**	**p**	**Partial η^2**
Intercept	2.805	1.075	2.610	.013	.146
Number recognition	-.002	.003	-.729	n.s.	.013
Matching numbers	.109	.058	1.875	n.s.	.081

Planned codes	-.146	.068	-2.148	**.038**	.103
Receptive attention	-.182	.079	-2.306	**.026**	.117
Expressive attention	-.074	.051	-1.462	n.s.	.051
Corsi's Test backward	-.089	.130	-.684	n.s.	.012
Paths	-.122	.267	-.459	n.s.	.005
Note. R^2 - adjusted = .21, p< .05.					

Table 8: Summary of the regression model, with "Accuracy" (errors) in the third class as dependent variable and attention and active attention in the third class as independent variables: regression parameter B, standard error of B (SEB), Student's t test (t), p-value and partial eta-squared (Partial η^2).

Source	B	SEB	t	p	Partial η^2
Intercept	.407	.830	.490	n.s.	.006
Number recognition	-.001	.002	-.297	n.s.	.002
Matching numbers	-.034	.045	-.761	n.s.	.014
Planned codes	-.100	.052	-1.909	n.s.	.084
Receptive attention	.166	.061	2.719	**.010**	.156
Expressive attention	.050	.039	1.264	n.s.	.038
Corsi's Test backward	-.002	.100	-.022	n.s.	.000
Paths	.467	.206	2.270	**.029**	.114
Note. R^2 - adjusted = .28, p< .01.					

Table 9: Summary of the regression model for, with "Rapidity" (sill/sec) in the third class as dependent variable and attention and active attention in the third class as independent variables: regression parameter B, Standard Error of B (SEB), Student's t test (t), p-value and partial eta-squared (Partial η^2).

Finally, regarding the predictive capability of attention and action attention variables, measured in the third class, on the "Accuracy" and "Rapidity" in reading, measured in the fourth class, no significant regressors were pointed out.

Discussion

Correlational and predictive data in second grade and in third grade

The results point out that the development of decoding requires the activation of different cognitive components over time. We support the hypothesis that in second grade, reading might depend on proper functioning of the visuospatial selective and active attentional system (prediction of number recognition for accuracy and rapidity and Paths for Rapidity). Given the regression nature of our study, we assert a causal role of active visual attention on acquisition of reading skills. This type of attention contributes to speed in reading in second grade and to speed and correctness in third grade, confirming the causal relationship between active attention and reading in this age group [37].

Our results extend previous studies on the relationship between attention and reading in the first years of school [6,29] At first the child mainly uses the way of phonological reading, so it is very important to use a basic selective focus on the decoding of syllables. This is an extremely complex task for the child, therefore, he/she should focus his/her attentional resources on the task. This type of process appears to be involved in reading speed. The efficiency of the selective attentional processes influences the development of future reading ability from childhood. Preschool children with difficulties in the identification and selection of information among distractors are at risk of subsequent difficulties in reading [13]. In fact, reading requires visuospatial selective attention [38]. This ability is necessary in order to acquire the mappings between graphemes and speech sounds. In our research, we highlighted that in second grade reading speed is associated with the ability of visual selective attention and active visual selective attention. This datum indicates that the decoding process is not yet fully automated at this stage [19], given that selective attention and active processes are still involved in decoding. However, the type of process involved is not passive (selective attention) but active (active elaboration). At this stage, in fact, the child appears less focused on the decoding of syllables and is trying to recognize the full form of the word. The child makes an active effort to decode the word. This decoding process engages cognitive system and absorbs part of the cognitive resources. At this stage, the decoding of a text is still a very complex task that requires the maintenance and management of attention over time. In this phase, access to mental lexicon is not immediate and the child employs the sub lexical way of reading. Only later, when access to the mental lexicon is automated, will visuospatial basic and active attentional processes no longer be involved.

Active visuospatial elaboration and planning detected in the second grade also appears important in predicting decoding skills in the following year, in third grade. Firstly, the results show a predictive role of active visuospatial attention and planning detected in second grade on reading accuracy detected in third. Secondly, the results show a predictive role of planning and focused attention detected in second grade on reading accuracy detected in third. In this phase, the child uses a type of more active attention because he/she is preparing to automate the process and access mental lexicon. In fact, at the end of second grade, many Italian children can use the lexical route [39] and this may lead to a better fluency in reading. When the child recognizes the whole form of the word, it leads to the mental lexicon. This process allows him/her to quickly recover both meaning and sound. Therefore, active visual spatial attention and planning are skills that contribute to the development of reading, both in speed and in accuracy, because they allow the child to access a more automated type of reading. Moreover, in third classes selective visuospatial attention is no longer involved in the decoding process and focused attention appears more involved in Rapidity. This change in the functions involved is very important. Indeed, selective attention measured in second class predicts the decoding skills in the second class; the decoding skills measured in the second class predicts the decoding skills measured in the third class; finally, focused attention measured in second class predicts the decoding skills measured in the third class. Our results emphasize that the cognitive skills that the child has at the beginning of the literacy process are very important. In the beginning, selective attention is important: it is the ability to select only one stimulus among those present in the environment: it can be regarded as a "filter" which selects the input information, deciding which should be further developed and which, conversely, should be ignored. Later focused attention is important: this is the ability to make calculations more effectively to selected stimuli, through faster detection, better discriminative ability and a higher predisposition to response [40]. The involvement of focused attention is because at this stage the child uses his/her attention to focus on the task rather than to distinguish the letters, as in second grade. So at this stage the reading is most evolved and involves concentration and reflection on the content.

In third grade, the attentional processes that are predictive of accuracy in decoding are planning and focused attention. All these processes involved in decoding are united by the need to play an active control of interference to ignore irrelevant information. In third grade the dimension of interference control becomes particularly important. At the base of fluent decoding there is the ability to switch between automatic and controlled processes in order to use the strategy that best fits the reading of the word. It is possible that children with better interference control skills have better accuracy and reading speed [41]. In fact, at this point, the reading is text interpretation. For automated reading it is very important to select the right information by avoiding the interference of irrelevant information [42]. Interference control at this stage allows the activation of top-down cognitive processes that help in reading comprehension**.** We have also evaluated which attentional processes can predict academic performance the following year. The attentional skills detected in third grade do not predict more decoding in fourth grade. This means that the decoder is fully automated and no longer requires any kind of attention. Probably, the attention process is likely to support the comprehension of the text. The third to fourth grade transition has been shown to be critical for reading achievement because the attention changes from learning to read to reading to learn and reading assignments become more complex [43]. The results of our study support the idea that during the first four years of schooling attentional abilities affect their involvement in learning to read. From an operational point of view this datum suggests that in case of persistent difficulties in reading, it is no longer useful to insist on the strengthening of attention but it is more indicated to enhance learning that is deficient [44].

A limitation of this study might be not assessing the comprehension of a written text. In future studies, it would be interesting to consider whether in fourth grade attentional skills go to support the understanding of the content rather than on decoding which is now automated.

Key points

1	Reading is a complex process. A initial correct phonological recoding in the grapheme-phoneme route system is especially important for the development of future reading skills.
2	The development of decoding requires the activation of different cognitive components over time. We support the hypothesis that in second grade, reading might depend on proper functioning of the visuospatial selective and active attentional system.
3	Active visuospatial elaboration and planning detected in the second grade also appears important in predicting decoding skills in the following year, in third grade. In this phase, the child uses a type of more active attention because he/she is preparing to automate the process and access mental lexicon.
4	The results of our study support the idea that during the first four years of schooling attentional abilities affect their involvement in learning to read. Attention plays a significant role in the early stages of learning when it is involved in automating the decoding process. Subsequently attention no longer plays a causal role in the improvement of reading.

References

1. Ziegler JC, Goswami U (2005) Reading acquisition, developmental dyslexia, and skilled reading across languages: a psycholinguistic grain size theory. Psychol Bull 131: 3-29.
2. Share DL (1995) Phonological recoding and self-teaching: sine qua non of reading acquisition. Cognition 55: 151-218.
3. Snowling M, Hulme C, Goulandris N (1994) Word recognition in developmental dyslexia: A connectionist interpretation. Q J Exp Psychol A 47: 895-916.

4. Stanovich KE, Siegel LS (1994) Phenotypic performance profile of children with reading disabilities: A regression-based test of the phonological-core variable-difference model. Journal of educational psychology 86: 24-53.

5. Hari R, Renvall H (2001) Impaired processing of rapid stimulus sequences in dyslexia. Trends Cogn Sci 5: 525-532.

6. Franceschini S, Gori S, Ruffino M, Pedrolli K, Facoetti A (2012) A causal link between visual spatial attention and reading acquisition. Current Neurology 22: 814-819.

7. Kennedy A, Radach R, Heller D (2000) Reading as a perceptual process. Amsterdam: Elsevier Science.

8. Gori S, Facoetti A (2015) How the visual aspects can be crucial in reading acquisition: The intriguing case of crowding and developmental dyslexia. Journal of vision 15: 8.

9. Ronconi L, Basso D, Gori S, Facoetti A (2014) Tms on right frontal eye fields induces an inflexible focus of attention. Cortex 24: 396-402.

10. Casco C, Tressoldi PE, Dell'Antonio A (1998) Visual selective attention and reading efficiency are related in children. Cortex 34: 531-546.

11. Perry C, Ziegler JC, Zorzi M (2007) Nested incremental modeling in the development of computational theories: The CDP+ model of reading aloud. Psychological Review 114: 273-315.

12. Laberge D, Samuels SJ (1974) Toward a theory of automatic information processing in reading. Cognitive Psychology 6: 293-323.

13. Stevens C, Fanning J, Koch D, Sanders L, Neville H (2008) Neural mechanisms for selective auditory attention are enhanced by computerized training: electrophysiological evidence from language-impaired and typically developing children. Brain Research 1205: 55-69.

14. Reppa GP (2017) The Effects of a Yoga and Mindfulness Techniques Program on the Prosocial Behavior and the Emotional Regulation of Preschool Children: A Pilot Study.. Educ Res Appl. ERCA-138.

15. Boss ML, Valdois S (2009) Influence of the visual attention span on child reading performance: A cross-sectional study. Journal of Research in Reading 32: 230-253.

16. Vidyasagar TR (2005) Attentional gating in primary visual cortex: A physiological basis for dyslexia. Perception 34: 903-911.

17. Vidyasagar TR, Pammer K (2009) Dyslexia: A deficit in visual-spatial attention, not in phonological processing. Trends in Cognitive Science 14: 57-63.

18. Samuels SJ (1999) Developing reading fluency in learning disabled students. In Sternberg RJ Spear Swerling, L. *(Eyds.),* Perspectives on learning disabilities: Biological, cognitive, contextual (176-189). Boulder, CO: Westview Press.

19. Karmiloff-Smith A (1992) Beyond a modularity. A developmental perspective on cognitive science. Cambridge, MASS.: MIT Press/Bradford Books.

20. Miller AC, Fuchs D, Fuchs LS, Compton DL, Kearns D, et al. (2014) Behavioral Attention: A Longitudinal Study of Whether and How It Influences the Development of Word Reading and Reading Comprehension among At-Risk Readers. Journal of Research on Educational Effectiveness 7: 232-249.

21. Martinussen R, Hayden J, Hogg-Johnson S, Tannock R (2005) A meta-analysis of working memory impairments in children with attention-deficit/hyperactivitydisorder. J Am Acad Child Adolesc Psychiatry, 44: 377-384.

22. Marzocchi GM, Osterlaan J, Zuddas A, Cavolina P, Geurts H, et al. (2008) Contrasting deficits on executive functions between ADHD and reading disabled children. J Child Psychol Psychiatry 49: 543-552.

23. DeJong PF, Van derLeij A (1999) Specific contributions of phonological abilities to early reading acquisition: results from a Dutch latent variable longitudinal study. J of Edu Psych 91: 450-476

24. Pingault JB, Tremblay RE, Vitaro F, Carbonneau R, Genolini C, Falissard B, Côté SM (2011) Childhood trajectories of inattention and hyperactivity and prediction of educational attainment in early adulthood: a 16-year longitudinal population-based study. Am J Psychiatry 168(11):1164–1170

25. Du Paul GJ, Gormley MJ, Laracy SD (2013) Comorbidity of LD and ADHD: implications of DSM-5 for assessment and treatment. J Learn Disabil 6: 43-51.

26. Willcutt EG, Betjemann RS, McGrath LM, et al. (2010) Etiology and neuropsychology of comorbidity between RD and ADHD: the case for multiple- deficit models. Cortex 46: 1345-1361.

27. Fletcher M, Shaywitz SE, Shaywitz BA (1999) Comorbidity of learning and attention disorders. Separate but equal. Pediatric Clinics of North Amrica 46: 885-97.

28. Capano L, Minden D, Chen SX, Schacher RJ, Ickowicz A (2008) Mathematical learning disorder in school-age children with attention-deficit hyperactivity disorder. Canadian Journal of Psychiatry 53: 392-399.

29. Bigozzi L, Grazi A, Pezzica S (2016) Attentional Factors Involved in Learning in the First Grade. Journal of Intellectual Disability - Diagnosis and Treatment 4: 94-109.

30. Pennington BF (2006) From single to multiple deficit models of developmental disorders. Cognition 101: 385-413.

31. Peterson RL, Boada R, McGrath LM, Willcutt EG, Olson RK, Pennington BF (2017) Cognitive Prediction of Reading, Math, and Attention: Shared and Unique Influences. Journal of Learning Disabilities, 49: 76-96.

32. Cornoldi C, Colpo G, Gruppo MT (1998) MT test di lettura per la scuola elementare. Firenze: Organizzazioni Speciali.

33. Naglieri JA, Das JP (1997) Cognitive Assessment System Interpretive Handbook. Chicago: Riverside Publishing Company.

34. Mammarella IC, Toso C, Pazzaglia F, Cornoldi C (2008) BVS-Corsi. Batteria per la valutazione della memoria visuo-spaziale. Trento, Erickson.

35. Wechsler D (2003) Wechsler Intelligence Scale for Children-4th Edition (WISC-IV®). San Antonio, TX: Harcourt Assessment.

36. Orsini A, Picone L (2006) WISC-III Contributo alla taratura italiana. Firenze: Organizzazioni Speciali.

37. Gathercole S, Pickering SJ, Knight C, Stegmann Z (2004) Working memory skills and educational attainment: evidence from national curriculum assessments at 7 and 14 years of age, Applied Cognitive Psychology, 18: 1-16.

38. Stevens C, Bavelier D (2012) The role of selective attention on academic foundations: A cognitive neuroscience perspective. Developmental Cognitive Neuroscience 2: S30-S48.

39. Orsolini M, Fanari R, Tosi V, De Nigris B, Carrieri R (2006) From phonological recoding to lexical reading: A longitudinal study on reading development in Italian. Language and Cognitive Processes 21: 5.

40. Faglioni P (1995) Lobo frontale. In: Denes G, Pizzamiglio L. Manuale di Neuropsicologia. Zanichelli, Bologna.

41. Protopapas A, Archonti A, Skaloumbakas C (2007) Reading ability is negatively related to Stroop interference. Cognitive Psychology 54: 251-282.

42. Pinto G, Bigozzi L, Gammanossi BA, Vezzani C (2012) Emergent literacy and early writing skills. J Genet Psychol Psychology 173: 330-354.

43. Troia G, (Ed.) (2009) Instruction and assessment for struggling writers. Evidence-based practices. New York: Guilford.

44. Stipek D, Valentino RA, (2015) Early childhood memory and attention as predictors of academic growth trajectories. Journal of Educational Psychology, 107: 771-788.