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Phonological Awareness and Executive Functions: associations with schooling and age

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ABSTRACT

Both phonological awareness and executive functions develop gradually and progress with the advance of schooling. Such specificities encourage us to investigate them in children at the beginning of schooling. The aim of this study was to explore the associations between the two skill groups, taking age and schooling as covariant. A total of 152 children of both sexes participated, they are from public nursery and pre-school. The following instruments were applied: Columbia Mental Maturity Scale (CMMS), Predictive Reading Skills Test (THPL), Pre-School Track Test (TT-P) and the Day and Night Stroop Task. The results pointed from weak to moderate correlations between age group and the components of executive functions. Regarding phonological awareness, we found correlations of weak magnitude, but statistically significant. We conclude in favor of the influence of age and schooling upon phonological awareness and executive functions.

Keywords: Phonological awareness; executive functions; child development.

Consciencia fonológica y funciones ejecutivas: asociaciones con escolaridad y edad

RESUMEN

La consciencia fonológica y las funciones ejecutivas se desarrollan gradualmente y progresan con el avance de la escolaridad. Tales especificidades nos incentiva a investigarlas en niños en el inicio de la escolarización. El objetivo de ese estudio fue explorar las asociaciones entre los dos grupos de competencias, volviéndose la edad y la escolaridad como covariantes. Participaron 152 niños de ambos sexos, egresas de escuelas públicas desde la escuela maternal y el jardín de infancia. Se aplicaron los siguientes instrumentos: Escala de madurez Mental Columbia (CMMS), Test de Habilidades Predictoras de la Lectura (THPL), Test de Trillas para Preescolares (TT-P) y la Tarea Stroop Día y Noche. Los resultados apuntaran para correlaciones de débeles a moderadas entre grupo de edad y los componentes de las funciones ejecutivas. Ya en relación a consciencia fonológica, comprobamos correlaciones de magnitud débil, pero estadísticamente significativa. Concluimos a favor de la influencia de la edad y de la escolaridad sobre la consciencia fonológica y las funciones ejecutivas.

Palabras clave: Consciencia fonológica; funciones ejecutivas; desarrollo infantil.

Consciência fonológica e funções executivas: associações com escolaridade e idade

RESUMO

Tanto a consciência fonológica como as funções executivas se desenvolvem gradualmente e progridem com o avanço da escolaridade. Tais especificidades nos incentivam a investigá-las em crianças no início da escolarização. O objetivo deste estudo foi explorar as associações entre os dois grupos de competências, tomando-se a idade e a escolaridade como covariantes. Participaram 152 crianças de ambos os sexos, egressas de escolas públicas do maternal e do pré-escolar. Foram aplicados os seguintes instrumentos: Escala de maturidade Mental Columbia (CMMS), Teste de Habilidades Preditoras da Leitura (THPL), Teste de Trilhas para Pré-escolares (TT-P) e a Tarefa Stroop Dia e Noite. Os resultados apontaram para correlações de fracas a moderadas entre faixa etária e os componentes das funções executivas. Já em relação à consciência fonológica, verificamos correlações de magnitude fraca, mas estatisticamente significativa. Concluímos a favor da influência da idade e da escolaridade sobre a consciência fonológica e as funções executivas.

Palavras-chave: Consciência fonológica; funções executivas; desenvolvimento infantil.

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INTRODUCTION

The so-called learning difficulties encompass a range of disorders and limitations encountered by children at the beginning or during the schooling process (Mazer, Bello, & Bazon, 2009). They can be of several types: psychomotor problems, spatial orientation, cognitive, emotional and motivational problems, behavioral, auditory, problems with neurological basis or specific character (learning to read, write and calculate) (Peixoto, 2008).

The vast majority of learning difficulties are represented by inability to read, write and math (Peixoto, 2008; Stevanato, Loureiro, & Marturano, 2003; Bartholomeu, Sisto, & Rueda, 2006). For this, it is necessary to understand which skills contribute so that these difficulties do not arise. The literature has pointed to the role of executive functions and phonological awareness. Consequently, we need to understand the normal course of development of executive functions and phonological awareness over the years and the influence of formal education on them (Dias, 2009; Pinto, 2008; Dias & Seabra, 22013).

Executive Functions (EF): from unintended behavior to targeted behavior

In the history of science, the intentionality of human behavior has always been a subject of deep interest. Among the countless theoretical approaches, cognitive psychology, together with neuropsychology, abstains from a strictly philosophical discussion and seeks to answer such a question in terms of skill, metacognitive processing and brain functioning. For both, the reason for being able to set a goal, striving to achieve it, while monitoring how effective we are, it can be explained by what is conventionally called executive functions (EF).

We call EF a set of skills responsible for superior processing. They are activated whenever routine behavior and habitual mental response is insufficient or inadequate, that is, whenever new situations require a quick adaptation and cognitive and behavioral adjustment (Seabra, Muniz, Reppold, Dias, & Pedron, 2014; Cosenza & Guerra, 2011; Uehara, Charchat-Fichman, & Landeira-Fernandez, 2013; Malloy-Diniz, Nicolato, Moreira, & Fuentes, 2012).

The executive triad proposed by Miyake, Friedman, Emerson, Witzki, Howerter and Wager (2000) is one of the countless models that try to explain executive functioning. According to this model, there would be three main skills that would make up the so-called EF: inhibitory control, working memory and cognitive flexibility. Diamond (2013) argues that these three competencies are responsible for the emergence of what are considered to be complex executive functions (decision making, planning, problem solving, among others).

Inhibitory control is the ability to dominate attention, thoughts and behavior (Friedman & Miyake, 2004). Working memory is a limited capacity system that archives information for a short time until it is used (Baddeley, 1992). It consists of an executive central, a subsystem of a phonological nature (phonological loop), another of visual and spatial processing (visuospatial sketch) and a subsystem with the ability to integrate information from long-term memory (episodic buffer) (Badelley, 1996, 2000). Finally, cognitive flexibility refers to the ability to change perspectives or consider realizing a new plan.

The skills that make up executive functioning gradually emerge and take different developmental paths. It is important to note that this event is related to the completion of the myelination process of the frontal and striatal circuits, that is, the full development of executive functioning will reach maturity when the neurobiological structures and neural circuits linked to it fully mature. This means that although the development of EF starts from the first year of life, its maturation will only happen at the end of adolescence and early adulthood (Papazian, Alfonso, & Luzondo, 2006)

Malloy-Diniz et al. (2012) argue that between the eighth and ninth months of life, it is possible to see that babies demonstrate a certain ability to inhibit behaviors and store a small amount of information in working memory. At 2 years old children are already able to inhibit boastful responses and postpone gratifications. Likewise, children at this age are able to make more advantageous than disadvantageous choices, which points to the rudiments of affective decision making.

At 12 months the first skill emerges, the inhibitory control. Until the age of 3, its manifestation is still quite incipient, since practically all the child's behavioral response is characterized by spontaneous reactions to the environment. Between 4 and 5 years of age it is possible to see more competence in the child to inhibit the automatic reaction and evaluate his/her behavior. We can say that between 3 and 5 years of age, inhibition reaches a marked development, progressing even in adolescence when at this stage it reaches a level equivalent to that of adults (Dias, 2009; Dias & Seabra, 2013).

After 12 months, there are reports that the ability to develop is working memory. The emergence of this competence marks the ability to create and manipulate mental images without direct access to the physical object. In fact, from the age of 3 the child already demonstrates a certain independence in operating with mental images, however, it is at the age of 5 that this ability becomes manifest. Working memory continues to develop during adolescence until early adulthood (Dias & Seabra, 2013; Baddeley, 1992).

Over the preschool years, the reach of working memory becomes progressively greater, both from a quantitative and qualitative point of view, as other complex skills and the efficient increase in the integration of cognitive processes begin to emerge.

With regard to cognitive flexibility, Diamond (2013) argues that its development occurs as soon as inhibition and working memory have already emerged, as it would be the result of the operation of these two skills. For example, to consider another perspective in solving a problem, it would be necessary to inhibit the current perspective and activate the new strategy in the working memory.

There is still no consensus regarding the age groups that mark the emergence and reach of flexibility. However, some authors argue that there is a continuous growth throughout childhood and adolescence marked by a peak of development between 5 and 7 years of age. It has also been said that this skill develops until the age of 15, although some studies have pointed out that adolescents do not yet have a level of cognitive flexibility equivalent to that of adults (Dias & Seabra, 2013).

Gradually, in the period from 4 to 5 years old, other cognitive skills develop as concentrated attention, greater ability to remember events, ability to ignore distractors, postpone gratifications, regulate their emotions, adapt their behavioral repertoire according to social requirements and rules, in addition to the appearance of shame and guilt when such rules are violated (Dias & Seabra, 2013).

According to Papazian, Alfonso and Luzondo (2006) there are two significant peaks in the development of EF, namely, 4 years old and 18 years old. The peak of maturation occurs around the age of 20, when there is a stabilization of executive processing and subtle and progressive cognitive declines. Such impoverishment is not configured in psychopathological traits, but illustrates the normal course of EF. Thus, it has been said that the development of EF in the arc of life assumes an inverted U curve.

Since EF has a developmental trajectory initiated at an early age and peaks only in adulthood, this means that changes in these abilities can cause negative consequences for the individual. Thus, it is necessary to think about risk factors and those related to vulnerability that can affect the typical course of executive functions (Dias, 2009; Dias & Seabra, 2013). In the same direction, it is necessary to trace the normal course of EF development during the life cycle.

Metalinguistic ability: from spoken language to reflected language

Regardless of the language, language development is very similar among children, which points to a universal biological basis for this ability. However, the language development is quite variable and is linked to contact with enriching social linguistic experiences and the child's ability to make use of such experiences (Hoff, 2009; Johnston, 2010).

The child has a keen sensitivity to language, which favors its acquisition. In the early years, humans progressed gradually in the production of speech. Initially, the child's language is characterized by cooing, that is, the oral expression of babies who explore the production of vowel sounds. This phenomenon is common even in deaf children and is found in all languages. In this phase, the child has the ability to identify and discriminate all the phones, which includes both the phonemes of his/her language and the others. Over time, they lose this ability, becoming sensitive only to the sounds of their own language (Sternberg, 2015; Pakulak & Neville, 2010).

The later stage is marked by babbling, which is the linguistic peculiarity of the youngest child. The babbling includes the emission of vowels and consonants and appears between 6 and 10 months of life. The main characteristic of this phase is the exploration that children do with their vocal apparatus, which results in babbling. At that moment, deaf children cease to emit vowel sounds while listeners change their expression, starting to intensify *feedbacks*. Children with hearing problems experience delays at this stage. The literature has interpreted this data in favor of *feedback*, that is, it would be one of the factors responsible for language development in children (Hoff, 2009, Sternberg, 2015, Pêssoa & Moura, 2008).

At the age of one the child speaks his first word (holophrase), then the second and so on. They are usually nouns limited to the child's context (car, book, ball). She/he uses these utterances to express wishes and intentions and progressively increases her vocabulary, so that at 18 months of age she has a vocabulary of 3 to 100 words. Overextension errors are common, as she/he uses few words to describe a range of situations, demands and things. Thus, the child can call all four-legged animals "cat" (Sternberg, 2015).

Around 1 ½ years and 2 ½ years old, the children begin to develop knowledge of syntax, which can be seen in the ability to combine two words to express themselves verbally. However, it is a rudimentary syntax, as they do not use prepositions, morphemes and articles to speak, in addition to having difficulties in flexing words (plural or singular) and with verbal tense, which compromises the conversation. We call this phenomenon telegraphic speech, because although they are configured in very simple combinations from a linguistic point of view, they convey the child's intentions and needs. Examples of telegraphic speech are "want juice" and "mommy come" (Sternberg, 2015).

At 3 years of age the child can speak about 1,000 words. At the age of 4, they speak similarly to an adult with all the requirements of syntax. Around 5 years old, they are skilled in the production and construction of complex sentences and in the learning of new linguistic arrangements. In preschool, the lexicon expands and the sentences become more and more complex, especially because the child starts to include relational terms that express notions of size, location, quantity and time (Johnston, 2010). Consequently, over the years, the vocabulary continues to increase and become more sophisticated, making it impossible to map the amount of words spoken by a child over the age of 6 (Hoff, 2009).

Even in the absence of any kind of instruction, from a very early age the child can be sensitive to the sounds of words. The phenomenon is called self-correction and refers to a very preliminary and very elementary moment in the child's dealings with language. These self-corrections, although said in an assertive manner, are not intentionally reflected, that is, they are not the product of a reflection about the use of language. On the contrary, they are the child's intuitive arrangements about what sounds "most pleasant" to the ears (Roazzi, Asfora, Queiroga, & Dias, 2010).

Behaviors such as those mentioned above are the product of implicit or epilinguistic knowledge since they are not related to a conscious mastery of the language properties. On the contrary, they spontaneously manifest themselves in informal situations of communication and they do not require reflection, intentional control and verbal explanation by individuals (Maluf & Gombert, 2008). Roazzi and Dowker (1988) describe other types of behavior implicit among children, such as the use of rhymes and alliterations in the creation of poems, recreational and funny combinations of the sounds of the words, deliberate distortions of the sounds of the same words and the creation of meaningless words.

In contrast, explicit or metalinguistic knowledge is so called because it involves conscious reflection and attention to aspects of language. Such knowledge emerges late and is associated with situations of formal instruction (Paula, Correia, & Spinillo, 2012; Paula & Leme, 2010).

The child's metacognitive work with language occurs progressively. The automation of language skills requires the use of implicit and explicit knowledge, both related to the development of phonological awareness. Phonological awareness is the ability to identify, reflect and manipulate aspects of oral language (Lima, 2014; Roazzi & Dowker, 1988). It involves intra-syllabic (rhyme and alliteration) and extra-syllabic knowledge (awareness of phonemes, syllables and words).

The 6-year-old children can easily break words into syllabic units, unless the words have more than four syllables. Likewise, syllabic reconstruction (from word to syllable) is easier for her than the segmentation process (from syllable to word). Thus, if the child is exposed to the word "pato"[1], it will be easier to divide it syllabically ("pa-to") than to put the syllables together and form a word ("pato"). However, a complete mastery of segmentation occurs only after the end of the literacy cycle (Lopes, 2004; Lima, 2014).

The ability to identify rhymes, alliterations and segment syllables can develop spontaneously, given the small analytical capacity required. However, the sub-skill called phonemic awareness requires formal instruction and depends as much on the development of reading and writing as it is improved by this process (Santos & Maluf, 2010).

Therefore, at the beginning of the schooling process, phonological awareness seems to be the most required metalinguistic skill. Its domain has as a product the competence in reading and writing, whose skills are essential to the literate world. Considering that deficits in this competence cause learning difficulties, it is necessary to understand its development over the years and the influence that formal education has over PA (Guimarães, 2005; Lima, 2014; Rosal, 2014).

METHOD

We sought to investigate the effect of the variables education and age on children's performance in tasks that assess phonological awareness and executive functions. We hypothesized that both EF and PA skills would correlate with schooling and age.

A total of 152 children of both sexes participated (52.6% male and 47.4% female). The children were aged 4 years (32.9%), 5 years (34.2%) and 6 years (32.9%). All of them belonged to the public network of a city in the interior of Paraíba. The instruments used are described below:

1) Columbia Mental Maturity Scale (CMMS) (Alves & Duarte, 2001): It is a non-verbal scale that assesses the capacity for general reasoning, formation and use of concepts and the level of maturity for solving problems in children from 3 years and 6 months to 9 years and 11 months. It consists of 92 cards presented in order of difficulty. It is noteworthy that the child's age will determine the number of items applied.

2) Trail Test for Preschoolers (TT-P) (Trevisan & Seabra, 2012): The test consists of two parts, called A and B, which tells the story of a family of puppies that needs to go to home and feed. The child is instructed to help the puppy family by respecting the test rules. The TT-P assesses cognitive skills such as perception, speed and visual motor tracking, sustained attention and, finally, processing speed. In addition to these, part B requires skill in cognitive flexibility. Only the results of

[1] Duck.

part B of the test were used.

3) Day and Night Stroop Task (Gerstadt, Hong & Diamond, 1994): The task assesses inhibitory control through the sum of inhibited responses. The child is instructed to identify the figure of the sun and the moon as day and night respectively. Subsequently, he/she must give a discrepant response to the visual stimulus. That is, when seeing the figure of the sun he/she must say "night" instead of "day". There is a second part of the test where the figures of the sun and the moon are replaced by two different geometric figures that correspond to day and night. The same procedure follows.

4) Test of Predictive Reading Skills (THPL) (Minervino, Chambel, & Moita, 2013): The instrument assesses children aged between 4 and 7 years in phonological awareness. Therefore, it has alliteration, segmentation, working memory and rhyme tasks. The test has an audiovisual feature and it was given on a *notebook* with touch screen technology.

The research complied with the ethical guidelines of the National Health Council according to Resolution No. 466/2012 (opinion number 2.206.573). The data were analyzed by building a database in the SPSS 21 statistical package and Pearson's correlation test was performed.

RESULTS

We observed in Table 1 that the number of correct answers in the Stroop pointed to a negative correlation with the children of 4 years (r_{pb} = -0,242 and p = 0,003) and 5 years (r_{pb} = -0,58 and p = 0,477), but positive with children 6 years (r_{pb} = 0,303 and p = 0,001). In the same way, it can be said of the successes in the Abstract Stroop.

Regarding the time in the two parts of this task, we found that the 4-year-old children showed a positive correlation with Stroop (r_{pb} = 0,491 and p = 0,001) and with Abstract Stroop (r_{pb} = 0,272 and p = 0,001). The 6-year-olds, on the other hand, showed a positive correlation with the correct answers, both in the Stroop Day and Night task (r_{pb} = 0,303 and p = 0,001) and in the Abstract Stroop (r_{pb} = 0,205 and p = 0,12), and negative with time in both parts of the task. The 5-year-old children did not show significant correlations.

In the TT-P, we see that the average of children aged 4 years in relation to time was positive (r_{pb} = 0,293 and p = 0,001), but this association was negative with children aged 5 (r_{pb} = -0,012 and p = 0,889) and 6 years (r_{pb} = -0,291 and p = 0,001). However, for subjects aged 5 years, this result was not significant. Another important correlation was the average rating of the connection among the 4-year-old children, which was positive (r_{pb} = 0,166 and p = 0,042), but negative for the 5-year-old children (r_{pb} = -0,178 and p = 0,029).

As far as memory is concerned, the average of 4-year-olds showed a negative correlation with skill (r_{pb} = -0,174 and p = 0,033) and percentage of correct answers (r_{pb} = -0.176 and p = 0.031), but positive with time (r_{pb} = 0,245 and p = 0,003). The same pattern was verified with the children of 5 years, except for the time that was also negative. The 6-year-olds children, on the other hand, showed a positive correlation with skill (r_{pb} = 0,351 and p = 0,001) and percentage of correct answers (r_{pb} = 0,321 and p = 0,001), but negative with time (r_{pb} = -0,210 and p = 0,010). Such results are shown in Table 1.

Regarding phonological awareness measures, we observed some correlations. The 4-year-old children had a negative correlation in the alliteration task (r_{pb} = -0,244 and p = 0,003) and percentage of correct answers (r_{pb} = -0,190 and p = 0,020) but positive with time (r_{pb} = 0,049 and p = 0,549). This pattern was also verified in the rhyme task, however, in the latter, all results are statistically significant. The 5-year-old children showed a statistically significant correlation only for the time spent on the alliteration task (r_{pb} = 0,219 and p = 0,007). Finally, the average of 6-year-old children was positively correlated with skill (r_{pb} = 0,210 and p = 0.010) and alliteration correctness (r_{pb} = 0,322 and p = 0.001) as well as skill (r_{pb} = 0,178 and p = 0.029) and percentage of correctness in rhyme (r_{pb} = 0,190 and p = 0,20). However, the association with time spent performing both tasks was negative (r_{pb} = -0,172 and p = 0,036).

Regarding segmentation, we observed a positive correlation between 4-year-old children with the time variable (r_{pb} = 0,201 and p = 0,013). The percentage of correct answers in children aged 6 years was also positive (r_{pb} = 0.115 and p = 0.057). It is also noted that in this last age group, the association with time was negative (r_{pb} = -0.328 and p = 0.001). Children aged 5 years did not show significant correlations, however, the pattern of association was similar to children aged 4 years.

The total mean of phonological awareness, that is, the mean of all FC sub-skills, pointed to a negative correlation between 4-year-old children (r_{pb} = -0,228 and p = 0,005) and a positive correlation between 6-year-olds (r_{pb} = 0,192 and p = 0,018). The results are described in the table below.

When comparing the children's performance in the EF tasks with school progression, we found that the children's performance of the nursery school in Stroop, TT-P and in the memory task was negative. However, the correlation with time was positive in all tasks. We did not find any significant correlation among Pre-I[2] children. Pre-II children had a higher average than those with less education. We found a positive and significant correlation between the percentage of correct answers

[2] Pre-school.

Table 1. *Point-biserial correlation among EF measurements (Stroop, Thpl and TT-P) and age group.*

EF		4 years	5 years	6 years
Stroop Hits	r_{pb}	-,242	-,058	,303
	p	,003	,477	,000
Stroop Abstract Hits	r_{pb}	-,133	-,070	,205
	p	,103	,393	,012
Stroop Time	r_{pb}	,491	-,091	-,401
	p	,000	,266	,000
Stroop Abstract Time	r_{pb}	,272	,079	-,354
	p	,001	,336	,001
Time Trails	r_{pb}	,293	-,012	-,291
	p	,000	,889	,000
Sequential Trails	r_{pb}	-,091	-,046	,138
	p	,268	,576	,092
Sequential Trails Classification	r_{pb}	-,053	-,048	,102
	p	,520	,560	,215
Conection Trails	r_{pb}	,055	-,115	,062
	p	,505	,160	,451
Conection Trails Classification	r_{pb}	,166	-,178	,013
	p	,042	,029	,870
Memory Skill	r_{pb}	-,174	-,174	,351
	p	,033	,033	,000
Memory % Hit	r_{pb}	-,176	-,143	,321
	p	,031	,081	,000
Memory Time	r_{pb}	,245	-,036	-,210
	p	,003	,665	,010

in the Stroop (r_{pb} = 0,156 and p = 0,057), the percentage of correct answers in memory (r_{pb} = 0,172 and p = 0,036), and ability in memory (r_{pb} = 0,222 and p = 0,007). In relation to time, the correlation was negative for the three instruments. See Table 3:

In the PA measurements, we observed that in the Nursery the associations were negative in direction for ability and percentage of correctness and positive with time. This pattern was found in all PA tasks (alliteration, rhyme and segmentation). However, only the correlations of alliteration skill (r_{pb} = -0,229 and p = 0,005) and percentage of correct rhyme (r_{pb} = -0,172 and p = 0,037) and alliteration (rpb = -0,197 and p = 0,016) were significant. Pre-II children obtained a positive correlation with all measures, with the exception of time. Note that the associations with segmentation were not significant. Finally, the total PA mean was correlated with the children of the Nursery School and of the Pre-II. As in the previous analysis, we also found no significant correlation among children in Pre-I. See table 4:

DISCUSSION AND CONCLUSION

The results pointed at weak to moderate correlations among the age groups (4, 5 and 6 years) and the EF components (inhibitory control, cognitive flexibility and working memory). It is possible to verify the presence of inhibitory control in children aged 4 years. At this age, the control of interference by the child is still very elementary, becoming better at 5 years old and significantly improving at 6 years old (Dias, 2009; Dias & Seabra, 2013). Such a result was found in this research.

At the age of 5, working memory emerges and after the age of 6, the so-called complex executive skills (Diamond, 2013). In general, the data showed that the performance of 6-year-old children is much more expressive than younger children, which may point to the presence and help of these skills, in addition to the fact that the reach of working memory becomes progressively greater and better with age (Badelley, 2000). Thus, we conclude that with advancing age, children improve their performance in executive

Table 2. *Point-biserial correlation between phonological awareness measures (THPL) and age group.*

Phonological Awareness		4 years	5 years	6 years
Aliteration	r_{pb}	-,244	,034	,210
Skill	p	,003	,677	,010
Alliteration	r_{pb}	-,190	-,129	,322
% Hit	p	,020	,114	,000
Alliteration Time	r_{pb}	,049	,219	-,272
	p	,549	,007	,001
Rhyme Skill	r_{pb}	-,229	,052	,178
	p	,005	,529	,029
Rhyme % Hit	r_{pb}	-,227	,037	,190
	p	,005	,650	,020
Rhyme Time	r_{pb}	,286	-,115	-,172
	p	,000	,163	,036
Segmentation	r_{pb}	-,020	-,007	,027
Skill	p	,805	,935	,740
Segmentation	r_{pb}	-,104	-,051	,155
% Hit	p	,205	,538	,057
Segmentation	r_{pb}	,201	,124	-,328
Time	p	,013	,129	,000
Phonological Awareness	r_{pb}	-,228	,036	,192
Total Average	p	,005	,656	,018

functions. In contrast, the younger the age group, the longer the reaction time. These data are corroborated by the literature (Pinto, 2008; Natale, 2007; Pureza, 2011).

Regarding phonological awareness and age, we found correlations of weak but statistically significant magnitude. In this study, we observed the presence of epilanguage in children aged 4 and 5 years. The performance of 6-year-old children is significantly higher, which suggests the emergence of the metacognitive domain of language. Freitas, Cardoso and Siquara (2012) in order to verify the effect of age on tasks involving judgment and identification of rhymes realized that children aged 6 to 8 years had a performance very similar and superior to that presented by children aged 4 to 5 years. This finding is corroborated by other studies that suggest the sophistication of phonological awareness with age progression (Tenório & Avila, 2012; Capovilla, Capovilla, & Soares, 2004; Barrera & Maluf, 2003; Freitas, Cardoso, & Siquara, 2012). In addition, the results show that children aged 4 and 5 years are more skilled in rhyme and alliteration, to the detriment of segmentation (Roazzi & Carvalho, 1995).

When the education variable was taken, we observed weak to moderate correlations, but statistically significant among EF measures. We can observe that the performance in tasks that impose the use of EF improves gradually over the school years. In the nursery, the performance is much lower, causing a significant increase in Pre-I and Pre-II. From the data presented, we can say that inhibitory control and working memory improve with school progression, just as there is an increase in processing speed (Léon, 2015; Pazeto, 2012).

We also noticed that the schooling factor helps to increase phonological awareness as well as performing tasks that require the performance of this competence. This data has also been documented in the literature (Araujo, 2011; Reis, Faísca, Castro, & Petersson, 2010). Furthermore, it corroborates with findings that point to the presence of epilinguistic skills in very young children, that is, the development of these skills does not depend on systematic teaching and / or the acquisition of reading (Roazzi & Dowker, 1988; Maluf & Gombert, 2008). Note that the correlations with segmentation were not significant. This may have been due to the fact that segmentation is a difficult task for preschoolers and schoolchildren, since performance in this task is positively affected by the level of reading fluency of children who already read (Roazzi & Carvalho, 1995).

Finally, we verify that the hypotheses raised were confirmed. In summary, we can say that children's

Table 3. *Point-biserial correlation between EF measurements (Stroop, Thpl and TT-P) and school grade.*

EF		Nursery	Pre I	Pre II
Stroop Hits	r_{pb}	-,275	,017	,156
	p	,001	,836	,057
Stroop Abstract Hits	r_{pb}	-,153	-,002	,122
	p	,063	,980	,140
Stroop Time	r_{pb}	,539	,004	-,400
	p	,000	,961	,000
Stroop Abstract Time	r_{pb}	,309	,069	-,289
	p	,000	,403	,000
Time Trails	r_{pb}	,224	,078	-,282
	p	,007	,354	,001
Sequential Trails	r_{pb}	-,251	,110	,095
	p	,002	,182	,249
Sequential Trails	r_{pb}	-,231	,076	,114
Classification	p	,005	,359	,166
Conection Trails	r_{pb}	-,044	-,060	,093
	p	,593	,469	,258
Trails Conection	r_{pb}	,044	-,021	-,020
Classification	p	,591	,797	,811
Memory Skill	r_{pb}	-,245	-,033	,222
	p	,003	,694	,007
Memory % Hit	r_{pb}	-,228	-,021	,172
	p	,005	,802	,036
Memory Time	r_{pb}	,236	,032	-,188
	p	,004	,698	,022

competence in EF improves with advancing age and that the younger the age group, the longer the reaction time. Regarding PA, we concluded in favor of the influence of age and education on this competence, being able to observe the presence of epilinguistic skills in very young children.

For more solid conclusions, further studies are needed. It is suggested that this research be replicated in children of other ages and, consequently, with other levels of education. Another possibility would be to study in clinical groups and illiterate adults. The latter is configured in an interesting sample, since they certainly present a different metalanguage pattern than literate adults or even children who have already mastered reading and writing.

Table 4. *Point-biserial correlation between phonological awareness measures (THPL) and school grade.*

Phonological Awareness		Nursery	Pre I	Pre II
Alliteration	r_{pb}	-,229	,059	,191
Skill	p	,005	,474	,020
Alliteration	r_{pb}	-,197	-,039	,251
% Hit	p	,016	,640	,002
Aliteration	r_{pb}	,116	,117	-,173
Time	p	,160	,154	,034
Rhyme Time	r_{pb}	-,154	-,015	,184
	p	,062	,857	,025
Rhyme % Hit	r_{pb}	-,172	-,029	,214
	p	,037	,728	,009
Rhyme Time	r_{pb}	,242	-,087	-,084
	p	,003	,296	,309
Segmentation	r_{pb}	-,071	,096	,033
Skill	p	,388	,246	,691
Segmentation	r_{pb}	-,070	,063	,084
% Hit	p	,393	,445	,307
Segmentation	r_{pb}	,118	,112	-,228
Time	p	,153	,176	,005
Phonological Awareness	r_{pb}	-,227	,095	,195
Total Average	p	,005	,248	,017

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