

# Performance of Phonological Processing in Children with Attention Deficit Hiperactivity Disorder

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Received 2 December 2013; accepted 17 August 2015; published 20 August 2015

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## Abstract

**Purpose:** The objective of this study was to compare the performance of Phonological Processing (Phonological Awareness, Lexical Acess and Working Memory) between children with ADHD and children with typical development. **Methods:** Participated in this study, 30 school aged children of both genders aged between 9 - 12 years, divided into 2 groups: Experimental Group (EG), 15 children with ADHD combined type and, Control Group (CG), 15 children with typical development, who attended elementary school in public and private education. The instruments utilized were: Phonological Awareness Test—Sequential Assessment Tool (CONFIAS); Rapid automatic Naming Testd); and Proof of repetition of nonsense words (Kessler, 1997). **Results:** The results revealed differences between in the instruments used. **Conclusion:** Regarding the performance of Phonological Processing, the children with ADHD showed lower performance in Phonological Awareness, Access to Lexical and Phonological Memory compared to children with typical development.

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## Keywords

Children, Evaluation, Learning, Reading, Writing

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## 1. Introduction

The Attention Deficit Hyperactivity Disorder (ADHD) is a common neuropsychiatric disorder of childhood (Casella, 2009) and is present among most students (American Academy of Pediatrics, 2000). In samples not referenced, it is estimated that 3% to 6% of school-aged children have ADHD (Benczik & Rodhe, 1999; Faraone,

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2003). ADHD is often manifested early in the life of the individual, but only outset the scholarly that the symptoms become perceptible, suggesting the diagnosis (Diniz Neto & Sena, 2007; Zorzi & Ciasca, 2009; Pinheiro, Lourenceti, & Santos, 2010; Silva, Cunha, & Capellini, 2011), and may present failure in their academic performance, determined by changes in the input information. The attention difficulties and hyperactivity displayed by children with ADHD can affect their academic performance. In addition to the symptoms of the disorder, over 50% of cases there are comorbidities (Mattos et al., 2006; Gomes et al., 2007). Individuals with ADHD often have comorbid language impairment (Boada, Willcutt, & Pennington, 2012). The language deficit displayed may affect learning the alphabetic writing system, considering the skills that underlie this process, such as meta-linguistic skills (ability to reflect on language), that may impair the acquisition. And the inattentive behavior determines basic difficulties in perception and processing of visual and auditory information, which is fundamental in the learning process (Miranda, Garcia, & Jara, 2001; Rabiner & Malone, 2004; Asberg, Dahlgren, & Sandberg, 2008; Ygual-Fernández et al., 2011).

Phonological Processing (PP) skills are essential for the acquisition and development of reading and writing (Pestun, 2005). PP refers to phonological information received through hearing, which is directly related to the development of oral and written language as a system of alphabetic writing (Wagner & Torgesen, 1987). The Phonological Awareness (PA), Lexical Access (LA) and Working Memory (WM) compose the PP.

The PA may be defined as an ability to manipulate the structure of noise words from the replacement of a particular sound to the segmentation of smaller units. The PA is an important factor in the development of reading and writing (Walcott, Scheemaker, & Bielski, 2010; Cunha & Capellini, 2011). It is in the beginning of scholarly that children learn to read and write, developing the ability to pay attention to speech, observing the various segments, phonemes, syllables and words (Maluf & Barreira, 1997). Studies show the relationship between deficits in PA and difficulties in writing, pointing out that children who do not have this ability are subject to fail to learn to read and write (Capellini & Ciasca, 2000; Crenitte, 2002; Santamaria, Leitão, & Assencio-Ferreira, 2004).

The LA is understood as part of the speed of information processing (Wagner & Torgesen, 1987). Studies claim that the AL is associated with reading, especially in decoding skills, fluency and comprehension (Wagner et al., 1997; Wolf & Bowers, 1999; Brizzolara et al., 2006; Vukovic & Siegel, 2006; Miranda-Casas et al., 2010).

The WM is responsible for the temporary storage of information while performing cognitive tasks such as reasoning, comprehension and learning (Alloway, Gathercole, & Elliott, 2010; Carrillo-Mora, 2010; Voorde, Roeyers, & Wiersema, 2010, Ferreira, Valentin, & Ciasca, 2013). According to the model of Baddeley and Hitch (1974) and Barkley (2002), the WM is responsible for maintaining the information recently processed and the establishment of connections with the new information. WM is the basis of learning and when altered, can cause damage and learning disabilities (Martinussen, 2005).

Studies have shown that individuals with ADHD often have a deficit of WM, which may be identified through evaluations, which have underperformed when compared to individuals without ADHD, thus impairing the performance of the learning of reading and writing (Wechsler, 1993; Shue & Douglas, 1992). This suggests that deficiencies in MT are associated with low learning outcomes and are a high risk factor for failure in school for children (Alloway, Gathercole, & Elliott, 2010).

Given the above, the objective of this study was to compare the performance of Phonological Processing (Phonological Awareness, Lexical Acess and Working Memory) between children with ADHD and children with typical development.

## 2. Method

### 2.1. Subjects

The study was approved by the Research Ethics Committee with Humans, Faculty of Dentistry of Bauru-USP, process n. 65/2010.

Participating in this study were 30 school aged children of both genders (24% - 80% male children and 6% - 20% female children), aged between 9 - 12 years, divided into 2 groups: Experimental Group (EG), 15 children with ADHD combined type and, Control Group (CG) 15 children with typical development, who attended elementary school in public and private education. The EG was matched to the CG according to chronological age, gender and type of institution (public or private) education.

The inclusion criterion for the CG was: children diagnosed with ADHD combined, based on the diagnostic criteria of the DSM-IV TR (APA, 2002) with complaints of difficulties in reading and writing. During phonoaudiological evaluation the students were without drug action. The inclusion criterion for the CG was: to present typical development and good academic performance, according to school information and evaluation criteria of the researcher. For both groups the inclusion criterion was: intellectual performance within the normal ranges observed for psychological evaluation by psychologists belonging to an interdisciplinary team of both institutions; normal development of hearing and speech; visual acuity.

## 2.2. Instruments

- a) Anamnesis Guide: specifies interview with the responsible, referring to the development and learning of the students participating in this study.
- b) Phonological Awareness Test—Sequential Assessment Tool (CONFIAS) (Moojen et al., 2003). This exam consists of two parts, the first corresponding to the syllabic awareness and the second part representing the phonemes awareness. The application followed the proposal to begin the sequential tasks involving syllable awareness and, subsequently, those relating to the phoneme level, respecting their order. For this study, only the results of the syllable, phoneme and total were used. The scoring of the test was carried out in a specific protocol. The correct answers are worth one point and the wrong cards are worth zero. In the syllable, the maximum score is 40 and in the phoneme part the maximum score is 30, totaling 70 points, which is 100% correct.
- c) Rapid automatic Naming Test: computerized version of the Rapid Serial Naming Test (Denckla & Rudel, 1974; Ferreira et al., 2003) is composed of the subtests of naming colors, digits, letters and objects. The subtests consist of five different stimuli, which alternate with each other, forming ten sequential lines for a total of fifty stimuli. Before beginning the test, the children were instructed to repeat the stimuli presented, with the fastest speed possible and without errors, to measure the reaction time. The scores were expressed in time (seconds).
- d) Proof of repetition of nonsense words (Kessler, 1997): was applied to a list of 30 nonsense words in Portuguese, organized into six sublists, each with five nonsense words that vary according to the number of syllables from one to six, consisting of simple syllable structure, privileging the consonant-vowel and consonant-vowel-consonant. To analyze the results, the number of words repeated correctly was counted.

## 2.3. Procedures

Data collection was realized individually in both groups. To evaluate the GC, the researcher contacted public and private schools, according to the type of school that the participant attended GE, considering the criteria of matching. In order to not interfere in the children's performance in school, the evaluation took place outside of school hours at the school. The selected students were nominated by the teacher, appointed by good academic performance and those responsible for anamnesis. The number of sessions varied depending on the individual characteristics and requirements. Complete reviews lasted two to three sessions, with varying lengths, according to the disposition of each participant.

The data was submitted to descriptive and inferential statistical analysis by the Student Test and nonparametric Mann-Whitney Test. The adopted significance level is 5% (0.05) for the statistical tests, ie, when the calculated significance value ( $p$ ) is less than 5% (0.05), there was a difference "statistically significant". Statistically significant results were marked by an asterisk (\*).

## 3. Results

### **Performance of GE relative to GC in the proof of Phonological Awareness**

In the PA test, it was observed that the students from EG had a lower GC performance, phonemic and syllable subtest, significance was found between groups by means of the t Student test (**Table 1**).

### **Performance of GE relative to GC in the proof of Rapid automatic Naming**

To compare the performance of students in the ability to access the lexicon, we used the t Student Test. Met significance in the test of lexical access of letters and digits (**Table 2**).

### **Performance of GE relative to GC in the proof of Working Memory**

Data analysis of WM used the nonparametric Mann-Whitney Test, in order to compare the performance

**Table 1.** Performance comparison among experimental and control groups in the proof of phonological awareness.

Variables	Group	Mean	Standard Deviation	Significance ( <i>p</i> )
PA Syl.	EG	29.47	5.87	0.00*
	CG	37.53	1.30	
PA Phon.	EG	17.47	6.61	0.00*
	CG	26.87	2.03	
Total	EG	46.93	11.99	0.00*
	CG	64.40	2.85	

Legend: PA Syl: Phonological Awareness Syllable; PA Phon: Phonological Awareness Phonemic; t de Student Test. \*Significant.

**Table 2.** Performance comparison among experimental and control groups in the proof of lexical access.

Variables	Group	Mean	Standard Deviation	Significance ( <i>p</i> )
LA Colors	EG	51.16	16.43	0.09
	CG	42.44	11.01	
LA Letters	EG	41.74	14.30	0.00*
	CG	25.13	4.43	
LA Dígitos	EG	38.38	16.37	0.00*
	CG	25.27	3.96	
LA Objetos	EG	42.37	24.59	0.57
	CG	38.01	16.93	

Legend: LA Colors: Lexical Acess Colors; LA Letters: Lexical Acess Letters; LA Dígitos: Lexical Acess Digits; LA Object: Lexical Acess Object. t de Student Test. \*Significant.

among the groups (**Table 3**). As seen in **Table 3**, it was possible to verify that the students from EG showed a lower performance than CG, with statistically significant difference.

#### 4. Discussion

ADHD affects the way the child adapts in the academic environment, in interpersonal relationships and in school performance which interferes in the learning process. The PP has been the subject of numerous studies (Ygual-Fernández, Miranda-Casas, & Cervera-Mérida, 2000; Mulas et al., 2006; Capovilla, Dias, & Montiel, 2007; Freitas, Cardoso, & Siquara, 2012), being recognized as a component that participates in the development process of reading and writing. As shown in studies (Bedmarek, Saldaña, & García, 2009; Pinheiro, Germano, & Capellini, 2010; Piasta & Wagner, 2010; Villagrán et al., 2010), changes in phonological processing skills, PA, LA and WM, hamper the development of reading and writing. They are important for the development of reading skills and these changes are found in children with learning problems.

According to the results obtained in this study we found that the performance of GE, was statistically inferior to the performance of the GC, the skills of Phonological Processing.

Individuals with ADHD have alterations in reading and writing because of deficits in PA and WM (Lobo & Lima, 2008; Nunes, Frota, & Mousinho, 2009; Germano, Pinheiro, & Capellini, 2009; Voorde et al., 2009; Silva & Capellini, 2010).

The PA has a reciprocal relationship with the development of reading and writing. For the development of PA, it is also necessary the relationship between WM and performance in activities (Gindri, Keske-Soares, & Mota, 2007; Oliveira et al., 2011). According to the results obtained in the PA test, students with ADHD had this ability underperformed when compared to GC, especially when it comes to the concept of phonemes, with no significant difference (**Table 1**). The result of this study corroborates with Capellini and Lanza (2011), which also found lower performance in the ability of CF compared with typically developing individuals, ie, without reading and writing.

Several studies affirm this result, stating that children with ADHD have deficits in the learning of metalinguistic skills and phonological aspects of language, affecting acquisitions, such as reading and writing (Ygual-Fernández, Miranda-Casas, & Cerveramérida, 2000; Gallardo-Paúls & Martinéz, 2010; Campos, 2010; Oliveira et al., 2011).

**Table 3.** Performance comparison among experimental and control groups in the proof of working memory.

Variables	Group	Mean	Standard Deviation	Significance (p)
WM	EG	3.73	0.80	0.00*
	CG	5.13	0.52	

Legenda: WM: Working Memory. Mann Whitney Test; \*Significant.

Attention and concentration is needed to perform CF tasks (Asberg, Dahlgren, & Sandberg, 2008; Chard et al., 2008; Cunha & Capellini, 2009). This data suggests that the performance of this skill can be altered due to the characteristics of the diagnosis itself, in which children with ADHD have hyperactivity and attentional changes, interfering with retention of information (Mulas et al., 2006; Cavadas, Pereira, & Mattos, 2007).

In recent decades, one of the skills studied further was Lexical Access (Capellini et al., 2007). Through research, it was possible to define normal ranges for different types of tasks Rapid automatic Naming (Denckla & Rudel, 1974).

The results presented in this study showing evidence of naming letters and digits, were statistically significant, since the proofs of colors and objects were not significant among the groups (Table 2). Students with ADHD are slow to name them, with lower scores than the CG. Thus, it was revealed that children with ADHD had less than the Control Group in the Rapid automatic Naming performance, as also shown in the study by Van Mourik, Oosterlaan, Sergeant (2005).

In this perspective, the present study confirms the findings from Capellini et al. (2007), in which children with ADHD are impaired in Rapid Automatic Naming, struggling to quickly appoint stimuli such as colors, digits, letters and objects. González (2004), Capellini and Conrad (2009) and Bicalho and Alves (2010) emphasize that individuals with learning disabilities performed worse in activities that require speed of processing visual information. Studies show that individuals who exhibit attentional failures possibly have low performance in naming stimuli, and consequently, changes in reading fluency (Tannock, Banaschewski, & Gold, 2006; Pham, Fine, & Semrud-Clikeman, 2011).

The WM refers to the ability to temporarily retain and manipulate information. Difficulties of Working Memory largely affect information processing, since the memory is a mediating structure of information.

The students of GE in this study had a lower GC performance of MT results, as shown in Table 3. Results affirm Messina and Tiedemann (2009), Sowerby, Seal & Tripp (2011) and Bolden et al. studies (2012), who reported that children with ADHD have greater inattention and this would probably be one of the causes of low capacity in MT. In studies Schweitzer et al. (2000), Andrade (2002), Oliveira (2007) and Rapport et al. (2008), individuals with ADHD also showed lower performance than expected, also affirming the results found in this study.

## 5. Conclusion

Regarding the performance of Phonological Processing, the children with ADHD showed lower performance in Phonological Awareness, Access to Lexical and Phonological Memory compared to children with typical development.

## Financial Support

Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP).

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