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Strahler Rivero, Thiago; Miranda, Monica Carolina; Amodeo Bueno, Orlando Francisco
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Foco, atenção sustentada e vigilância: dimensões atencionais afetadas em adolescentes com TDAH

Thiago Strahler Rivero
Monica Carolina Miranda
Orlando Francisco Amodeo Bueno
Federal University of São Paulo

Abstract

Objectives: This study performed a statistical analysis comparing adolescents with Attention Deficit Hyperactive Disorder (ADHD) and a control group in the Conners' Continuous Performance Test (CCPT) 5 factor model, proposed by Egeland and Kovalick-Gran (2010a). Methods: The clinical group was composed by 28 participants with ADHD (17 male). The adolescents were divided in two groups regarding their ADHD subtype, inattentive or combined. Results: The ADHD group had significantly lower scores on almost all CCPT. The 5 factors model, showed that both ADHD groups exhibited poorer results in three factors: focused attention, sustained attention and vigilance. The ADHD subtypes did not differ in any of the 5 factors. Conclusions: The five factor analysis showed a good sensibility and better comprehension of ADHD symptoms; however it showed no specificity to differentiate the combined and inattentive subtypes.

Keywords: attention; attention deficit disorder with hyperactivity; adolescent.

Resumo

Foco, atenção sustentada e vigilância: dimensões atencionais afetadas em adolescentes com TDAH. O presente estudo realizou uma análise estatística comparativa entre adolescentes com e sem Transtorno de Déficit de Atenção e Hiperatividade (TDAH) no Conners 'Continuous Performance Test (CCPT). Foi utilizado o modelo de cinco fatores proposto por Egeland and Kovalick-Gran (2010a). Método: O grupo clínico foi composto por 28 participantes com TDAH (17 homens), que foram divididos em dois grupos em relação ao subtipo de TDAH (predominantemente desatento ou combinado). Resultados: O grupo TDAH teve escores significativamente mais baixos em quase todas as medidas do CCPT. Na comparação de grupos no modelo de cinco fatores, os resultados indicaram que ambos os grupos TDAH apresentaram resultados inferiores em três fatores: atenção focada, atenção sustentada e vigilância. Os subtipos de TDAH não diferiram em nenhum dos cinco fatores. Conclusões: A análise de cinco fatores mostraram uma boa sensibilidade e propiciou uma melhor compreensão dos sintomas do TDAH, no entanto ela não mostrou especificidade para diferenciar os subtipos combinado e desatento.

Palavras-chave: atenção; transtorno do déficit de atenção e hiperatividade; adolescentes.

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most prevalent and widely studied developmental disorders diagnosed in childhood (Stefanatos & Baron 2007). These authors claims, that "Given the large estimated prevalence, chronicity, and significant impairment of academic performance, social functioning, and overall quality of life, the Center for Disease Control and Prevention identified ADHD as a major public-health problem in 1999" (Stefanatos & Baron 2007).

Generally, individuals with this disorder tend to present both cognitive and behavioral problems. In the last few decades an improvement in the understanding of the core cognitive, behavioral, and emotional consequences of the disorder has occurred (Stefanatos & Baron, 2007). It was suggested that deficiencies in specific neuropsychological processes can potentially elucidate why the disorder develops and how it is expressed. Although the role of heterogeneity in this clinical populations has been discussed (Biederman, 1998), there are efforts to characterize ADHD types on the basis of neuropsychological patterns of performance (Barkley, 2008; Biederman, 1998; Stefanatos & Baron, 2007).

The most popular and widely used test to evaluate the cognitive aspects associated with ADHD is the Conners Continuous Performance Test (CCPT). The importance of the CCPT measures in detecting impaired performance compared to children without ADHD has been extensively demonstrated

(Edwards et al. 2007; Mani, Bedwell, & Miller, 2005; Nichols & Waschbusch, 2004). Although specificity and sensitivity of CCPT remain contradictory in literature, the CCPT measures displayed substantially larger effects (Barkley, 2008; O'Laughlin & Murphy, 2000; Stefanatos & Baron, 2007).

The CCPT offers 15 measures that potentially reflect the different dimensions involved in the attention processing. However, as pointed out by the authors of a recent factor analysis (Egeland & Kovalik-Gran, 2010a), there are not 15 distinct dimensions of attention performance, even if there are 15 measures in the test. They performed a factor analysis to evaluate whether the set of 15 CCPT variables could be grouped comprehensively. The analysis contributed to the understanding of two important problems that CCPT shows: first, to know which attention components the 15 measures of the test actually measure; secondly, the use of the 15 CCPT measures to evaluate a specific disorder, such as ADHD, can incur in a fallacy given the high probability that the participant would present a poor performance in at least one of the 15 measures, leading one to assume that he/she has ADHD when in reality he/she does not (Gomes, Palmini, Barbirato, Rohde, & Mattos, 2007).

For that purpose, Egeland and Kovalik-Gran (2010b) have tested the hypothesis that if the CCPT evaluates specific attention constructs. Five different factors emerged from the factor analysis:

1) Focus: the capacity to concentrate attentional resources on a specific event filtering out distracting stimuli, is composed of measures of Variability, Hit Reaction Time Standard Error, Perseveration, and Omissions;

2) Hyperactivity/Impulsivity, composed of Commissions, Hit Reaction Time, Response Style;

3) Sustained Attention, defined as the loss over time of the initial ability to focus attention, composed of Hit RT Block Change, Hit SE Block Change, and the measure of the change in omission as a function of time);

4) Vigilance, composed of Hit RT ISI change; Hit SE ISI change;

5) Change in Control, reflected by a change in Hit RT and a change in Commission as a function of time, interpreted as the subject becoming more impulsive as time.

In a previous study conducted by the same group (Egeland, Nordby, & Ueland, 2009) this proposed factor model provided a good tool in the differentiation between groups of diverse pathologies, such as schizophrenia, language disorders, and, more specifically, Attention Deficit Hyperactivity Disorder (ADHD).

The present study replicate the methodology employed by Egeland and Kovalick-Gran (2010a) however, we focus specifically in the investigation of ADHD adolescents performance. A second aim of our study was to compare the performance between both subtypes groups and the control group, employing the 5 factors model. We hypothesize that if we could find a similar pattern to that one found by Egeland´s study, this will endorse a greater clinical validity of such analysis.

Methods

Sample

The group with ADHD was composed of 28 adolescents, aged 12-18, with an average age of 14.43 years (*SD* = 1.82) for the male subgroup and 15.14 years (*SD* = 1.93) for the female subgroup. All patients were referred by medical teams from two ambulatory services associated with the Universidade Federal de São Paulo that are specialized in the diagnosis of children and adolescents. The information regarding diagnosis and classification according to the DSM-IV was directly obtained from the charts provided by the medical team that evaluated the adolescents.

This study excluded subjects with a diagnosis of pervasive developmental disorders, drug abuse, neurological deficits, such as brain lesions, epilepsy or vascular accident, and intellectual disability (IQ < 70) based on data from the charts and a questionnaire on clinical conditions that was completed by the parents/guardians.

According to the SNAP-IV scale classification, 46% of the adolescents in our sample met the criteria for the inattentive subtype (n = 13), 22% for the hyperactive-impulsive subtype (n = 6), and 32% for the combined subtype (n = 9). We divided the ADHD group in 2 subgroups according to the absence of hyperactive/impulsive symptoms (inattentive subtype n = 13) or its presence (combined subtype n = 15) according to Egeland and Kovalik-Gran (2010b).

We evaluated possible co-morbidities in the ADHD group using the CBCL scale, and 32.1% (n = 9) of participants met criteria for Affective Disorder, 25% (n = 7) for conduct disorder, and 25% (n = 7) for Oppositional Defiant Disorder. The control group was composed of twenty-eight participants aged between 12 and 18 years (17 male), matched with ADHD group according to age, gender, and socio-economic status. The control group was randomly selected from the CCPT-II normative study in the Brazilian population (Miranda, Sinnes, Pompeia, & Bueno, 2008; Miranda, Rivero, & Bueno, 2013 accepted).

Procedure

The study protocol was approved by the Ethics in Research Committee of the Federal University of São Paulo. Participants who were taking methylphenidate (n = 12) were instructed to discontinue the medication 22 hours prior to the beginning of testing, which is considered appropriate to avoid the effects of the stimulant (Gualtieri et al., 1982).

The participants completed the CCPT version 5.2 for Windows® according to the procedures in the manuals (Conners, 2002). The participants were individually tested using a laptop in a separate study room with adequate sound and lighting.

Statistical analyses

The 15 CCPT measures were analyzed using the value scores of each variable. The performance of the ADHD group and the control group was compared using the Student's t-test. To analyze differences between groups in relation to 5 factors model (Egeland & Kovalik-Gran, 2010a, 2010b), the raw values of the

CCPT measures were transformed into z-scores, we grouped the measures according to the factorial reduction proposed by Egeland and Kovalik-Gran (2010a) and we multiplied each measure value found in our sample by the factorial loads found by these authors. We compared the performance between the ADHD-C, the ADHD-I group and the control group in the 5 factors. Student's t-test was applied. Also we calculated the size effect (Cohen's *d*) between the clinical and control groups to determine the strength of the differences observed between the variables studied. We employed the SPSS Program 13.0 for Windows and the significance level was 5%.

Results

Table 1 shows the performance differences of the ADHD group (grouping the inattentive and combined subtypes into one group) when compared to the control group on the 15 CCPT measures. There were differences in all measures ($p_s <$ 0.001), except for Detectability (d') [$t(54) = 1.09$, $p = 0.27$], and Response Style (β) index [$t(54) = 1.55$, $p = 0.12$]. In all measures where the differences were significant the ADHD group showed poorer performance.

The analyses according to the factorial analysis were performed with the subdivided ADHD group (ADHD-C and ADHD-I. When comparing the 5 factors model between groups, we observed that the ADHD-C and ADHD-I groups differ from control group in the following proposed factors: focused attention ($p_s < 0.05$), sustained attention (idem) and vigilance (idem) (Table 2).

Table 1
Comparison of the 15 CCPT Measures Between the ADHD and Control Groups.

CCPT measures	Mean (SD) ADHD	Mean (SD) Control	t (df)	*p*	(Cohen *d*)
Omissions	17.43 ± 14.16	4.82 ± 3.32	4.58 (54)	0.001	0.93
% Omissions	5.40 ± 4.39	1.50 ± 1.02	4.58(54)	0.001	0.23
Commissions	22.21 ± 7.15	18.32 ± 6.44	2.13(54)	0.036	0.57
% Commissions	61.73 ± 19.81	51.12 ± 18.01	2.09(54)	0.04	0.53
Hit RT	407.70 ± 65.33	334.11 ± 48.38	4.78(54)	0.001	0.27
Hit RT *SE*	13.90 ± 6.98	5.12 ± 1.93	6.40(54)	0.001	0.57
Variability	32.41 ± 22.65	8.41 ± 5.34	5.45(54)	0.001	0.40
Detectability (*d'*)	0.43 ± 0.31	0.51 ± 0.28	1.09(54)	0.278	-0.29
Response style (β)	0.79 ± 0.61	0.56 ± 0.50	1.55(54)	0.126	0.41
Perseverations	12.75 ± 12.57	1 ± 1.96	4.88(54)	0.001	1.62
% Perseverations	3.95 ± 3.89	0.31 ± 0.60	4.88(54)	0.001	1.62
Block Change	0.02 ± 0.04	-0.002 ± 0.01	2.91(54)	0.005	0.67
Block Change SE	0.09 ± 0.14	0.002 ± 0.06	3.03(54)	0.003	1.13
Hit RT ISI	0.10 ± 0.06	0.03 ± 0.03	5.05(54)	0.001	1.56
Hit RT ISI SE	0.17 ± 0.17	-0.01 ± 0.10	5.11(54)	0.001	1.41

RT = reaction time, SE = standard error, ISI = inter-stimulus interval
CCPT = Conners´ Continuous Performance Test, ADHD = Attention Deficit Hyperactivity Disorders

There were no significant statistical differences between both subgroups (ADHD-C and ADHD-I) and the control group in the Hyperactivity/Impulsivity and Control Change factors. However, the Cohen's *d* showed moderate magnitude effect in the factors: a) Hyperactivity/Impulsivity factor ADHD-C, $d = 0.63$, and ADHD-I, $d = 0.58$; b) Control Change factor, ADHD-C, $d = 0.50$ ADHD-I, $d = 0.61$.

The comparison between clinical groups (ADHD-I and ADHD-C) revealed no differences in the five factors analyzed, with only the Vigilance measure having a moderate Cohen's *d* [$t(26) = 1.59$, $p = 0.12$, $d = 0.69$]

Discussion

This study investigated the performance pattern of a clinical sample of adolescents with ADHD in the 15 traditional measures from CCPT and the new 5 factor analyses from Egeland and Kovalik-Gran (2010b).

Several studies have established the CCPT measures performance pattern in children, both pre-school (Miranda et al. 2008; Nichols & Waschbusch, 2004) and school-aged children (Edwards et al. 2007; Mani et al. 2005; Miranda et al. 2008; Miranda, Sinnes, Pompeia, & Bueno, 2009; Nichols & Waschbusch, 2004). However, similar data in adolescent groups are still scarce, with few articles studying this topic (for studies in adolescents see Edwards et al. (2007) and Miranda et al. (2009)).

ADHD adolescents and the control group are significantly different in 13 of the 15 CCPT measures. ADHD adolescents showed higher number of omissions and commission, a slower reaction time and an inconsistency in the response rate (reaction time standard error), suggesting a lower intra-test consistency over time. Regarding intra-participant variability, the ADHD group exhibited a greater variability when compared to the control group. These data corroborate the results (Epstein, Costello, Conners, Klaric, & Erkanli, 2003) in which adolescents with ADHD showed higher variation in reaction time as well as more commission and omission errors in the same version of the test.

Table 2
Factorial and Raw Scores for the CCPT Measures that Compose Each of the Five Index from "5 Factor Model" Compared Between the ADHD-C, ADHD-I, and Control Groups.

	ADHD-C	ADHD-I	Control
Focused attention	**0.875 (1.20)**	**0.375 (0.84)**	**-0.643 (0.19)***
Variability	38.02 (25.03)	25.64 (17.95)	8.41 (5.34)
Hit RT *SE*	15.50 (7.89)	12.04 (5.47)	5.12(1.93)
Perseverations	14.20(13.29)	11.07(11.98)	1.00(1.96)
Omissions	19.53 (16.89)	15.00 (10.31)	4.82(3.32)
Hyperactivity/impulsiveness	**0.233 (0.71)**	**0.340 (1.36)**	**-.283 (0.88)**
Response Style (b)	0.10 (0.61)	0.31 (1.47)	-0.20 (0.88)
Hit RT	413.48 (61.30)	401.01 (71.59)	334.11(48.38)
Commissions	23.26 (6.29)	21.00 (8.11)	18.32 (6.44)
Sustained attention	**0.635 (1.14)**	**0.263 (1.16)**	**-0.462 (0.52)***
Block Change *SE*	15.50 (7.89)	12.04 (5.47)	5.12 (1.93)
D Omissions	-6.40 (5.23)	-4.23(6.79)	-0.57(2.00)
Vigilance	**0.881 (1.08)**	**0.269 (0.92)**	**-0.597 (0.46)***
Hit RT ISI	0.11 (0.06)	0.07(0.05)	0.03(0.02)
Hit RT ISI *SE*	0.22 (0.16)	0.12 (0.16)	-0.01(0.10)
Control change	**0.331 (1.27)**	**0.044 (0.81)**	**-0.198 (0.89)**
D Commissions	0.13 (2.44)	0.30 (1.54)	0.53 (2.09)

No difference was found between ADHD-C and ADHD-I groups; CCPT = Conners´ Continuous Performance Test; ADHD – C = Combined subtype; ADHD - I = Innatentive subtype.
*Difference was found between both ADHD-C and ADHD-I groups relative to the control group ($p < 0.05$).

This group showed a higher frequency in perseverative (anticipated) responses than the control group. This indicates that, in spite of having the ability to differentiate between target- and non-target stimuli and presenting a more conservative response style, the ADHD group still shows a higher number of anticipatory responses, a characteristic that is related to a higher level of impulsiveness (Miranda et al. 2009). It is likely that the composition of our ADHD sample, 53% of the predominantly combined and hyperactive subtypes, for which the presence of the impulsivity symptom is a criterion according to the American Psychiatric Association (APA, 2000), contributed heavily for this result.

With regard to the measures of reaction time to inter-stimulus interval change (Hit RT ISI Change and Hit RT SE ISI Change), the ADHD group showed higher diffuse slowing pace than the control group when the interval was long (4 s). These measures are considered a vigilance index. Generally this measure is impaired in ADHD-C participants during childhood, but in adolescence, these results are much less clear (Egeland et al. 2009).

The performance of ADHD participants was similar to that of the control group in the measures of detectability (d' – a measure that reflects the participants' perceptual sensibility to the targets, i.e., differentiation between the letter X and non-X) and response style (index – an evaluation of the response criterion of the participant) (Swets, Tanner, & Birdsall, 1961). Both ADHD and control groups had high values of detectability, indicating good discrimination between the target and non-target stimuli. These data differ from the results described by Miranda et al. (2008) and Huang-Pollock, Nigg, & Halperin (2006), who compared children with ADHD and or other learning disorders, in which the sample with ADHD showed low detectability values when compared to the control group, suggesting that this deficit disappears with growing age. With regard to the response style measure, our data corroborate the findings of Epstein et al. (2003), in which no statistical differences were found between the ADHD and control groups, indicating that the adolescents in both groups tend to take fewer risks when deciding on which stimulus to respond to during the test.

Furthermore when we employed the 5 factors model (Egeland & Kovalick-Gran 2010a) we were aiming to investigate if this new analyses could enhance the CCPT specificity to statistically determine the ADHD subtypes. The factor analyses determined that 3 of 5 dimensions were affected in this ADHD adolescent's subgroup: focused attention, sustained attention and vigilance. Both subtypes showed a deficit in the ability to focus attention compared to the control group (Egeland et al., 2009; Egeland & Kovalick-Gran 2010a); and also found this ability to be impaired in these groups.

With regarding the vigilance factor our results differ from those obtained by Egeland et al. (2009) where no difference was found in this factor. However, Egeland believe that it is necessary to investigate whether either of the two ADHD subtypes present

a diminution in initiative as a consequence of small intrusions, changes in motor activities, or perceptual stimulations (as attention or perceptive artifacts) (Egeland et al., 2009). Thus, they propose to increase the ISIs (to 6 s, 8 s) to achieve sufficient sensitivity to observe difficulties in the maintenance of attention response. Our study, however, was able to demonstrate that there are differences using the current test intervals (1 s to 4 s), suggesting a deficit of vigilance in both ADHD subtypes.

Regarding the Sustained Attention factor both ADHD groups differed from control group. The patient groups showed slowed responses and an increases number of omission errors in the last part of the test. Egeland et al. (2009) study found that only the ADHD-I group had an impaired performance compared to the control group. Predictable Sustained Attention has always been accepted as a difficulty in the inattentive subtype; however, our data show a greater impairment in the combined group. Deficits in predictable sustained attention in participants with combined ADHD subtype may be due to problems related to inhibition, which corroborates the results found in the measure of perseveration, most importantly a difficulty in inhibitory control (Barkley, 1997; Lezak, 1995).

No differences of hyperactivity/impulsiveness were observed in either of the two ADHD subtypes compared to the control group. Studies by Egeland´s group (Egeland et al. 2009; Egeland & Kovalik-Gran, 2010a) have found an impairment of this factor in the ADHD-C group but not in the ADHD-I group. This factor is composed by 3 measures: reaction time, commissions, and response style. When analyzed individually these measures show statistically significant differences between the clinical and control groups. A possible explanation for not finding statistical significance in the index may be related to the small number of participants (n = 28), as compared to 72 participants only in the ADHD-C group in the validity study (Egeland et al., 2009).

Finally, for the factor Change in Control no statistical significance was observed between the two ADHD subtypes, again differing from results of other studies (Egeland et al., 2009; Egeland & Kovalik-Gran, 2010a), who found differences between the 2 groups for this factor. This factor is composed of the commissions measure, i.e., it evaluates whether the participant produces more or less commission errors (pressing the non-target letter) as the test proceeds, showing if the participant lost, maintained or changed control over his/her own performance as a function of time. First, we found that this factor did not show differences between the ADHD subtypes and the controls, what can be due to the low number of participants in the sample. Measures that only involve errors are decreasingly being used in tests that evaluate continuous performance.

Lately an important change in the manner that the CCPT results are interpreted has occurred (Aaron, Joshi, & Phipps, 2004). The center of attention changed from the errors and reaction time measures to all the variability measures (measures that primarily evaluate the performance of participants throughout the test, for example the block change and ISI change indexes). Aaron et al. (2004) considers more relevant the use of such measures for the full understanding of ADHD impairment spectrum, given that they allow us a greater comprehension of the subliminal patterns of behavior performance (such as difficulty to sustain a task for a long time or difficulty in maintaining the same performance when the stimulus is faster or slower), than the traditional error measures. This is a new manner to come upon the problem of low CCPT specificity, (i.e., the difficulty in separating the ADHD-C and ADHD-I groups through test results, Egeland et al., 2009).

Summarizing, our analyses of the 15 CCPT measures differentiated the clinical group of adolescents with ADHD from the control group in 13 out of the 15 measures, supporting the literature on children and adolescents. The grouping of the 15 measures into 5 indices was useful in the differentiation between ADHD and control groups, given that differences were observed in 3 of the 5 proposed indices, namely focused attention, sustained attention, and vigilance. A possible explanation for not finding statistical differences between the ADHD subtypes may be related to the small number of participants (n = 28), as compared to 72 participants only in the ADHD-C group in the validity study (Egeland et al., 2009).

References

Aaron, P. G., Joshi, R. M., & Phipps, J. (2004). A cognitive tool to diagnose predominantly inattentive ADHD behavior. *Journal of Attentional Disorders*, *7,* 125-135.

APA (American Psychiatry Association) (2000*). Diagnostic and Statistical Manual of Mental Disorders. 4th edition, text revised.* Washington, DC: American Psychiatric Association.

Barkley, R. A (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin, 121*, 65-94.

Barkley, R. A (editor) (2008). *Transtorno de Déficit de Atenção e Hiperatividade: Manual para diagnóstico e Tratamento.* Porto Alegre: Artmed.

Biederman, J. (1998). Attention-deficit/hyperactivity disorder: A life-span perspective. *Journal of Clinical Psychiatry, 59*(7), 4-16.

Conners, C. K. (2002). *Conner´s Continuous Performance Test*. Toronto: Multi-health System.

Edwards, M. C., Gardner, E. S., Chelonis, J. J., Schulz, E. G., Flake, R. A., & Diaz, P. F. (2007). Estimates of the validity and utility of the Conners' Continuous Performance Test in the assessment of inattentive and/or hyperactive-impulsive behaviors in children. *Journal of Abnormal Child Psychology*, *35*, 393-404.

Egeland, J., & Kovalik-Gran, I. (2010a). Measuring several aspects of attention in one test: The factor structure of conners's continuous performance test. *Journal of Attentional Disorders*, *13*, 339-346.

Egeland, J., & Kovalik-Gran, I. (2010b). Validity of the factor structure of Conners' CPT. *Journal of Attentional Disorders*, *13,* 347-357.

Egeland, J., Nordby., & S. J., Ueland, T. (2009). Differentiating between ADHD sub-types on CCPT measures of sustained attention and vigilance. *Scandinave Journal of Psychology*, *50*, 247-354.

Epstein, J. N., Erkanli, A., Conners, C. K., Klaric, J., & Costello, J. E. (2003). Relations beetween Continuous Performance Test and ADHD Behaviors. *Journal of Abnormal Child Psychology*, *31*, 543-554.

Gomes, M., Palmini, A., Barbirato, F., Rohde, L. A., & Mattos, P. (2007) Conhecimento sobre o transtorno do déficit de atenção/hiperatividade no Brasil. *Jornal Brasileiro de Psiquiatria*, *56,* 94-101.

Gualtieri, C. T., Wargin, W., Kanoy, R., Patrick, K., Shen, C. D., Youngblood, W., … Breese, G. R (1982). Clinical studies of methylphenidate serum levels in children and adults. *Journal of the American Academy of Child*

Psychiatry, *21,* 19-26.

Huang-Pollock, C. L., Nigg, J. T., & Halperin, J. M. (2006). Single dissociation findings of ADHD deficits in vigilance but not anterior or posterior attention systems. *Neuropsychology, 20*, 420-429.

Lezak, M. D (1995). *Neuropsychological assessment*. New York: Oxford University Press

Mani. T. M., Bedwell, J. S., & Miller, L. S. (2005). Age-related decrements in performance on a brief continuous performance test. *Archives of Clinical Neuropsychology*, *20*, 575-586.

Miranda, M. C., Rivero, T. S., & Bueno, O. F. A. (2013). Brazilian adolescents score similar to other age groups on Conners' Continuous Performance Test (CPT-II). *Psychology and Neuroscience* (in press).

Miranda, M. C., Sinnes, E. G, Pompeia, S., & Bueno, O. F. A. (2008). A comparative study of performance in the Conners' Continuous Performance Test between Brazilian and North American children. *Journal of Attentional Disorders*, *11,* 588-598.

Miranda, M. C., Sinnes, E. G., Pompéia, S., & Bueno, O. F. A. (2009). O K-CPT em uma amostra brasileira: Descrição do desempenho e comparação com as normas norte-americanas. *Revista de Psiquiatria do Rio Grande do Sul, 31*(1), 60-66.

Nichols, S. L., & Waschbusch, D . A. (2004). A review of the validity of laboratory cognitive tasks used to assess symptoms of ADHD. *Child Psychiatry and Human Development, 34*, 297-315.

O'Laughlin, E. M., & Murphy, M. J. (2000). Use of computerized continuous performance tasks for assessment of ADHD: A guide for practitioners. *Independent Practitioner*, *20,* 282-287.

Stefanatos, G. A., & Baron, I. S. (2007). Attention-deficit/hyperactivity disorder: A neuropsychological perspective towards DSM-V. *Neuropsychology Review*, *17*, 5-38.

Swets, J. A., Tanner, W. P., & Birdsall, T. G. (1961). Decision processes in perception. *Psychological Review*, *68*(5), 301–340.

Thiago Strahler Rivero, attending the Master's Degree in Science of Post-Graduation Program in Psychobiology at the Universidade Federal de São Paulo (UNIFESP), Doctor's student of Psychobiology at the Universidade Federal de São Paulo. E-mail: thiagorivero@gmail.com

Monica Carolina Miranda, attending the Doctor's Degree in Science of Post-Graduation Program in Psychobiology at the Universidade Federal de São Paulo (UNIFESP), researcher at the AFIP - Associação do Fundo de Incentivo a Pesquisa. E-mail: mcarol@psicobio.epm.br

Orlando Francisco Amodeo Bueno, Doctor in Psychobiology at the Escola Paulista de Medicina, Associate Professor of Psychobiology at the Universidade Federal de São Paulo (UNIFESP). E-mail: ofabueno@gmail.com

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