Paper IV

Cognition in African school children with symptoms of Attention Deficit Hyperactivity Disorder

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By

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Cognition in African Children With Attention-Deficit Hyperactivity Disorder

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The aims of the study were: (1) to describe the performance of African children with symptoms of attention-deficit hyperactivity disorder on selected neuropsychologic tests and compare it with performance among peers of the same age without symptoms; (2) to explore through a factor analysis if the selected tests cover the same functions as known from studies in Europe and North America. A nested case-control approach was used to select the two groups of children. The tests were selected to measure aspects of executive functions, attention and memory functions as well as motor skills. A total of 185 schoolchildren (28 cases and 157 control subjects) aged 85 to 119 months old were included. The findings indicate only minor difference between children with symptoms of attention-deficit hyperactivity disorder and control subjects in most of the tasks. However, children with symptoms of attention-deficit hyperactivity disorder performed more poorly on tests of motor skills and had more violations of rules on the planning task. The factor analysis indicated a three-factor model, confirming that the selected tests could be used as measures of executive/motor functions, attention, and memory functions. Similar findings have been reported among children in Europe and North America.

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Introduction

Attention-deficit hyperactivity disorder (ADHD) is a common disorder of childhood, occurring in approximately 5-10% of school-age children [1]. Previous studies have often reported males to be more often affected than females, with a male to female ratio ranging from 3:1 to 9:1 [2]. However, in community-based samples, this male-to-female difference is typically not as marked [1]. The prevalence of ADHD in community-based studies may vary according to the diagnostic criteria or the assessment method used (rating scales or interviews) [1]. Less is known about the prevalence among African children, but the few studies conducted reported prevalence of ADHD symptoms to range from 1% to 6% [3,4].

According to the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV), ADHD is a disorder with symptoms of inattention, or hyperactivity and impulsivity that can affect both daily life and school performance in school-aged children. A large number of studies have been performed to assess cognitive function in children with ADHD. Studies including neuropsychologic test measures have documented impairment on various tasks of behavioral inhibition, sustained attention, and executive functions [5,6]. However, Barkley et al. [7] observed that there was an inconsistency of findings across studies owing to different methodological approaches as well as inclusion of different neuropsychologic measures. Furthermore, Nigg et al. [8] emphasized in a recent review paper the heterogeneity in cognitive function among children with ADHD, by demonstrating that the neuropsychologic impairments on single test measures characterize only a portion of children with ADHD. As an illustration, they mentioned that only 35% to 50% of the children with combined subtype (ADHD-C) have deficits in aspects of executive functions.

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Table 1. Methods of assessment of neuropsychologic performance for the African schoolchildren with attention-deficit hyperactivity symptoms at 7 to 9 years of age

Tool Used	Measures	Target Ability/Function
Strengths and Difficulties Questionnaire (SDQ)	Hyperactivity-inattention	Behavior reported by teachers
Disruptive Behavior Disorder Rating scale (DBD)	Hyperactivity/impulsivity-inattention	Behavior reported by teachers
Raven	Executive functions/Intellectual function	General intelligence, deductive thinking
Design Copying	Executive functions/visual cognition	Ability to copy geometric figures
Tower	Executive functions	Problem-solving and planning
Knox cube	Visual attention and memory	Focused attention and immediate memory
Digit Span	Auditory attention and memory	Ability to recall digits
Coding B	Visual attention and memory	Measure of visuomotor coordination
Cats and Faces	Visual attention and memory	Ability to focus and discriminate visual target
Statue	Attention and memory	Ability to inhibit impulses, motor persistence
Fingertip Tapping	Motor skills	Finger dexterity and motor speed
Groove Peg-board	Motor skills	Measure of manipulative skills and motor speed

To the best of our knowledge, the present study is the first to present neuropsychologic test performance among African children with ADHD symptoms. The aims of the study were: (1) to describe and compare test performance among same-age peers with and without ADHD symptoms, (2) to explore the factor structure of the test results among the African children to evaluate whether the selected neuropsychologic tests measure the same functions as known from studies of children in Europe and North America.

Subjects and Methods

Study Area

A detailed description of the study area has been given in a previous study [3]. In brief, the study was conducted in Kinshasa between November 2002 and March 2003. Kinshasa, which is the capital and largest city of the Democratic Republic of Congo, has an estimated population of five million inhabitants and is thus one of the largest cities in Africa. Most of the Congolese ethnic groups are represented in Kinshasa.

Study Population

This study is based on data collected as part of a research program on mental health among schoolchildren in Kinshasa, which involves a cohort of 7- to 9-year-old children.

We first performed a cross-sectional survey of 1187 schoolchildren aged 7 to 9 years from randomly selected schools, which is reported elsewhere [3]. Teachers were asked to complete the French version of the Strengths and Difficulties Questionnaire (SDQ) [9]. The 183 children with scores above the 90th percentile cutoff (abnormal scores) on the Strengths and Difficulties Questionnaire hyperactivity-inattention scale (SDQ-HI) and 174 randomly selected children among those with normal scores on the SDQ-HI were selected for further studies. In each group, 39 and 32 children, respectively, were excluded for different reasons. Teachers were asked to complete the 18 items of the Disruptive Behavior Disorder rating scale [10] for all the 286 children. These 18 items of the Disruptive Behavior Disorder rating scale, which are based on the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV) [11], were used to investigate the presence of ADHD symptoms. Among the 286 schoolchildren assessed with the Disruptive Behavior Disorder rating scale, 28 children were identified with ADHD symptoms according to the DSM-IV criteria and 157 were randomly selected as control subjects.

Study Procedure

A sample of 28 children with ADHD symptoms (cases) and 157 children without ADHD symptoms (control subjects) participated in the study. There were 76 males and 109 females, with a mean age of 8 years and 5 months (101 months). None of the children were on medication at the time of the evaluation.

A team of five persons unaware of the child's diagnostic status and background performed the testing. The team comprised one research neuropsychiatrist (E.K.) and four graduate students, who were recruited and trained for the neuropsychologic testing.

In a pilot study, 30 children from the same age group were assessed on the selected neuropsychologic test. It was found that for the Design Copying Test, the Coding B Test, and the Cats and Faces Test, children were more confident when evaluated in groups than alone. The entire sample was thus examined using a group session on these tests. All tests were performed in one uninterrupted test session, in a quiet room at school. A group of five pupils were called upon, and all five children began with the in-group session (Design Copying Test, Coding B Test, Cats and Faces Test). Then the other tests were administered individually according to the test manual. Each member of the team was in charge of administering the same specific tests to ensure a standardized procedure. On a daily basis, the tests were scored and a meeting with the psychometrists was held to discuss any occurring problems and to make a plan for the following day. The child's behavior was assessed by the principal investigator (E.K.), in discussion with the team members in cases of doubt.

The project protocol was approved by the National Medical Council of the Democratic Republic of Congo and the Regional Ethics Committee on Medical Research in Norway. Collaboration and informed consent were obtained from all head masters, teachers, and parents.

Psychometrics Measures

A selection of nonverbal neuropsychologic tests was used to ensure that all children would evenly understand the tests in this multilingual setting. They were primarily selected to measure aspects of attention and memory functions, but also motor speed and coordination, intellectual function, visual cognition, problem solving and planning, to assess aspects of motor skills and executive functions (Table 1). All tests are frequently used in the evaluation of children in European countries and are part of a wide range of neuropsychologic studies of

Table 2. Neuropsychologic performance for children at 7 to 9 years of age with DSM-IV ADHD symptoms (cases) compared with children without attention-deficit hyperactivity symptoms (controls)

Measures	Cases n = 28 Mean (S.D.)	Controls n = 155 Mean (S.D.)	Difference of the mean (95% CI)	*P* Value
Intellectual function				
Raven scores	15 (2.7)	15 (4.8)	0.4 (−1.4 to 2.2)	0.7
Executive functions				
Design Copying	66 (6.7)	66 (6.6)	−0.2 (−2.8 to 2.5)	0.9
Tower total score	15 (3.9)	16 (3.7)	0.8 (−0.7 to 2.3)	0.3
Memory and attention				
Knox mean	7.6 (1.8)	7.3 (2.4)	−0.4 (−1.3 to 0.6)	0.4
Coding B total score	91 (4.8)	90 (7.6)	−0.7 (−3.7 to 2.2)	0.6
Digit total score	8.9 (1.9)	8.7 (2.6)	−0.3 (−1.3 to 0.7)	0.6
Digit Forward	6.6 (1.6)	5.9 (1.8)	−0.5 (−1.2 to 0.2)	0.2
Digit Backward	2.5 (1.1)	2.7 (1.4)	0.2 (−0.3 to 0.8)	0.4
Cats and Faces	1.2 (1.1)	1.2 (1.4)	−0.0 (−0.6 to 0.5)	0.9
Statue total score	28 (1.7)	28 (1.8)	−0.3 (−1 to 0.5)	0.5
Motor skills (speed and coordination)				
Fingertip Tapping	75 (7.9)	72 (4.5)	−2.4 (−4.5 to −0.3)	0.025*
G-Pegboard RS[1]	46 (18)	44 (12)	−3 (−7.9 to 2.5)	0.3
G-Pegboard LS[2]	47 (14)	49 (21)	1.8 (−6.2 to 9.9)	0.7

Abbreviations:
ADHD = Attention-deficit hyperactivity disorder
DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, 4th edition
G-Pegboard LS[2] = Grooved Pegboard left hand seconds
G-Pegboard RS[1] = Grooved Pegboard right hand seconds
* *t* test *P* value < 0.05.

children [12,13]. The total estimated assessment time per child was 57 minutes, with a maximum time of 105 minutes.

To measure aspects of executive functions, three tests were used (Table 1): the Raven's Coloured Progressive Matrices [14], which was also included as a measure of intellectual function; the Design Copying Test [15]; and the Tower Test from the Developmental Neuropsychologic Assessment (NEPSY) battery [15].

To measure attention and memory functions, five tests were included (Table 1): (1) The Knox Cube Test from the Arthur Point Scale of Performance Battery [16], which is performed in sequences of increasing length and complexity. It is thus considered as a measure of immediate attention span as well as a sequencing and memory component [17]. (2) The Digit Span Test from the Wechsler Intelligence Scale for Children-Revised [18] consisting of two parts, the Digit Span Forward and the Digit Span Backward. The Digit Span Backward is more complex and is known to be more heavily dependent on a working memory component than the forward version [19]. (3) The Coding B Test from the Wechsler Intelligence Scale for Children-Revised [18]. (4) The Cats and Faces Test. (5) The Statue from the NEPSY battery [15].

Two tests were used as measures of motor skills (Table 1): the Fingertip Tapping Test from the NEPSY battery [15] and the Grooved Pegboard Test [20]. These tests measure fine manipulative skill and motor coordination with both the preferred and nonpreferred hand.

Statistical Analysis

The statistical analyses were performed in three stages. Firstly, mean group differences were compared using *t* tests. Secondly, low test results were defined as the performance allocating the 10% weakest children on each test. The number of children within each group with test results below this performance was calculated, and the numbers were compared using the Pearson chi-square test. The odds ratio was used for the risk estimate, and the Fisher's Exact Test was used when applicable. Thirdly, a principal component factor analysis with varimax rotation including all neuropsychologic outcome variables from both cases and control subjects was performed. All analyses were two-tailed, and the results were considered statistically significant for a *P* value less than or equal to 0.05. The Statistical Package for the Social Sciences (SPSS) version 12.0 was used for data management.

Results

Sample Characteristics

All children completed the neuropsychologic testing, except one control child who did not want to perform the Grooved Pegboard Test. According to the Raven scores, two control children were two standard deviations below the sample mean and thus excluded from further analysis. Therefore, 28 cases were compared with 155 control subjects.

Intellectual Function and Aspects of Executive Functions

Fourteen (8%) of the 183 children were performing more than 1 S.D. below the sample mean on the Raven's Coloured Progressive Matrices. Two children (7%) among the cases compared with 12 (8%) children among the control subjects (odds ratio: 0.9; 95% confidence interval: 0.2 to 4.3; $P = 0.8$). Neither the mean Raven scores (Table 2) nor the numbers of children with the 10% weakest results (Table 3) were significantly different between the cases and the control subjects. No difference was evident within the sex groups (Table 4).

On the measures of visual cognition (the Design Copying Test) and problem-solving ability (the Tower

Table 3. Proportion of children with DSM-IV ADHD symptoms (cases n = 28) at 7 to 9 years of age with the neuropsychologic tests scores in the lowest 10th percentile in comparison to children without symptoms (controls n = 155)

Measures	Cases n (%)	Controls n (%)	OR (95% CI)	*P* Value
Intellectual function				
Raven scores	2 (7)	12 (8)	0.9 (0.2 to 4.3)	0.9
Executive functions				
Design Copying	3 (11)	13 (8)	1.3 (0.3 to 4.9)	0.7
Tower total score	3 (11)	14 (9)	1.2 (0.3 to 4.5)	0.8
Memory and attention				
Knox mean	0 (0)	13 (8)	-	0.1
Coding B total score	2 (7)	12 (8)	0.9 (0.2 to 4.3)	0.9
Digit Forward	1 (4)	12 (8)	0.4 (0.1 to 3.5)	0.4
Digit Backward	2 (7)	13 (8)	0.8 (0.2 to 3.9)	0.8
Digit total score	1 (4)	16 (10)	0.3 (0.0 to 2.5)	0.3
Cats and Faces†	2 (7)	7 (5)	1.6 (0.3 to 8.3)	0.6
Statue total score	2 (7)	15 (10)	0.7 (0.2 to 3.3)	0.7
Motor skills (speed and coordination)				
Fingertip Tapping	5 (18)	12 (8)	2.6 (0.8 to 8.0)	0.1
G-Pegboard RS[1]	5 (18)	14 (9)	2.1 (0.7 to 6.6)	0.2
G-Pegboard LS[2]	1 (4)	14 (9)	0.4 (0.1 to 2.9)	0.3

**t* test *P* value < 0.05.

Abbreviations:
ADHD = Attention-deficit hyperactivity disorder
DSM-IV = Diagnostic and Statistical Manual of Mental Disorders 4th edition
G-Pegboard LS[2] = Grooved Pegboard left hand seconds
G-Pegboard RS[1] = Grooved Pegboard right hand seconds
† Scores below the 90th percentile.

Test), no significant group differences were observed (Tables 2 and 3). However, cases manifested significantly more violations of rules than control subjects on the Tower Test (Pearson chi-square *P* value <0.05). There were no statistically significant differences between sex groups (Table 4).

Table 4. Means (standard deviations) and *t* test statistics of neuropsychologic performance at 7 to 9 years of age for cases with DSM-IV ADHD symptoms vs controls without symptoms among males and females

Measures	Males		Females	
	Cases n = 15 Mean (S.D.)	Controls n = 61 Mean (S.D.)	Cases n = 13 Mean (S.D.)	Controls n = 94 Mean (S.D.)
Intellectual function				
Raven scores	15 (3.0)	16 (4.8)	15 (2.5)	15 (4.5)
Executive functions				
Design Copying	66 (7.7)	69 (3.9)	66 (5.5)	64 (7.3)
Tower total score	16 (3.5)	17 (3.5)	14 (4.2)	15 (3.7)
Memory and attention				
Knox mean	7.4 (2.0)	7.9 (2.1)	7.8 (1.5)	6.9 (2.5)
Coding B total score	90 (6.1)	91 (4.3)	91 (2.8)	90 (9.1)
Digit total score	9.0 (2.4)	8.9 (2.1)	8.9 (1.3)	8.4 (2.8)
Digit Forward	6.3 (1.7)	6.1 (1.4)	6.6 (1.4)	5.9 (1.9)
Digit Backward	2.7 (1.2)	2.9 (1.4)	2.2 (1.0)	2.6 (1.4)
Cats and Faces	1.2 (0.9)	1.0 (0.6)	1.2 (1.4)	1.2 (1.8)
Statue total score	28 (1.6)	28 (1.8)	28 (1.8)	28 (1.9)
Motor skills (speed and coordination)				
Fingertip Tapping	75 (9.7)*	72 (4.2)	74 (5.8)	72 (4.7)
G-Pegboard RS[1]	42 (12)	40 (11)	51 (22)	46 (12)
G-Pegboard LS[2]	46 (12)	41 (10)	49 (16)	53 (23)

Abbreviations:
ADHD = Attention-deficit hyperactivity disorder
G-Pegboard LS[2] = Grooved Pegboard left hand seconds
G-Pegboard RS[1] = Grooved Pegboard right hand seconds
* *t* test *P* value < 0.05.

Table 5. Principal components factor analysis of the neuropsychologic variables for the children with DSM-IV ADHD symptoms (cases n = 28) and children without ADHD symptoms (controls n = 155) at 7 to 9 years of age (n = 183), Only factor loadings above 0.40 are reported

Measures	Factor 1 Executive Functions	Factor 2 Memory Functions	Factor 3 Attention
Design Copying	−0.56	0.48	
Raven scores	−0.46		
Tower total score	−0.53		
Knox mean		0.58	
Digit total score		0.72	
Coding B total score		0.74	
Cats and Faces			0.64
Statue total score			0.71
Fingertip Tapping	0.53		
G-Pegboard RS[1]	0.75		
G-Pegboard LS[2]	0.82		

Abbreviations as in Table 4.

Attention and Memory Functions

The results on the Knox Cube Test and the Digit Span Test, assessing immediate memory span as well as the ability for focused attention, were not significantly different among the cases compared with the control subjects (Table 2). On the Digit Span Total score, cases were able to recall more digits than controls, but the difference was not statistically significant, owing to the recall of more digits on the Digit Span Forward subtest whereas the number of digits recalled backwards was similar.

On the more complex Coding B Test as well as on the two measures of sustained attention (the Cats and Faces Test and the Statue Test), the groups were not significantly different (Tables 2 and 4). The number of children with results in the lowest 10% range was not significantly different on any test of attention and memory functions (Table 3).

Motor Skills (Speed and Coordination)

On the Grooved Pegboard Test, patients spent a similar amount of time to complete each trial and did not lose more pegs than the control group. On the Fingertip Tapping task, the cases were significantly less accurate than the control subjects and required more time to complete the task adequately (Table 2). More cases than control subjects were among the 10% slowest in the sample (Table 3). On the Fingertip Tapping Test, male cases were significantly slower than control individuals (Table 4).

The Factor Structure

In the factor analysis, a three-factor model was chosen because eigenvalues leveled off at this number (Table 5). The three factors explained 51% of the total variance. The factors were labeled executive functions, memory functions, and sustained attention. Table 5 indicates that the tests of sustained attention (Cats and Faces Test and Statue Test) loaded on a different factor (factor 3) than the tests of attention with a memory component (Knox Cube Test, Digit Span Test, and Coding B Test). The tests of intellectual function, visual cognition, and problem-solving ability were allocated to a common factor together with the tests of motor skills. The mean scores of the three factors were comparable for both cases and control subjects (Table 6).

Discussion

The present study is the first to report performance of African schoolchildren on the selected neuropsychologic tests and to explore whether the selected tests measure the same functions as known from studies of children in Europe and North America. In general, the studied children with DSM-IV ADHD symptoms were quite similar to their control peers on tests of attention and memory functions as well as executive functions. However, children with ADHD symptoms had poorer motor skills and scored more violations of rules than the control group. A factor analysis of the selected tests confirmed that they could be used as measures of executive functions, memory functions, and attention, as expected from the description in the original test manuals.

Measuring intellectual functioning is valuable in ensuring that the child's symptoms are not a reaction to being overwhelmed by academic demands. In the present study, children with ADHD symptoms and those without symptoms were comparable on measures of intellectual functioning (i.e., Raven Coloured Progressive Matrices). This

Table 6. Differences in mean factor scores for the African schoolchildren with attention-deficit hyperactivity symptoms (cases) and those without (controls) at 7 to 9 years of age*

Factor Scores	Cases (n = 28) Mean (S.D.)	Controls (n = 154) Mean (S.D.)	Difference in Mean Score 95% CI	*P* Value (*t* test)
Executive functions	51.9 (9.1)	49.6 (10.1)	−2 (−6.4 to 1.7)	0.3
Memory functions	51.2 (8.2)	49.8 (10.3)	−1.4 (−5.5 to 2.6)	0.5
Attention measures	51.4 (8.1)	49.8 (10.3)	−1.6 (−5.7 to 2.4)	0.4

* Factor scores were transformed into *t* scores with mean of 50 and S.D. 10 for all children.

finding rules out the possibility of a general intellectual dysfunction as an explanation for the presence of ADHD symptoms. In a previous study [21], it was also demonstrated that none of the children manifested somatic conditions that could explain the presence of ADHD symptoms.

Executive function is a concept that includes several abilities, such as the ability to plan, organize, inhibit impulses, and the ability to monitor information. Several studies and models of ADHD have reported that aspects of executive functions are impaired in children with ADHD. This finding was not confirmed in the present study. A tentative explanation may be attributed to the task interest and the test situation. Children may have considered the tasks as more interesting than European and American children, leading the children with ADHD symptoms to perform as well as those without symptoms. Also the context of testing may have maximized the performance of children with ADHD symptoms. Indeed, Barkley [5] observed that children with ADHD symptoms are excited and perform well on tasks that interest them. In addition, situations with explicit rules, repetition of instructions, task novelty and high rate of reinforcement are likely to maximize the performance of children with ADHD [22].

Another explanation may be related to the selected tasks used to measure executive functions. According to Sergeant et al. [23], it is not possible to differentiate children with ADHD from those without ADHD symptoms when using Tower Tests. Our results are also in line with those reported by Ozonoff and Jensen [24], who did not find any difference between children with ADHD and those without on a Tower task. Our study might thus not exclude that the children with ADHD are impaired on other tests of the planning aspect of the executive functions. The only indication of an executive dysfunction in the present study was that the children with ADHD actually committed more violations of rules on the Tower Test and had a less accurate performance on the motor task, two indications of a response inhibition deficiency.

According to Barkley [5], discrepant results may also be explained by the inclusion of different samples. Several studies that have used samples drawn from the community screening of children, as in the present study, have not found differences on neuropsychologic tests, whereas studies of clinic-referred samples almost always report statistically significant impairment in the group of children with ADHD.

Deficits in memory functions [6,7] and difficulties with repetition of digit spans [25] have been reported in earlier studies of children with ADHD. However, in the present study, no significant difference was evident between children with and those without ADHD symptoms on the memory tests. One reason for this discrepancy might be the simplicity of the included tests or the short term in recalling the information. Although some studies have reported the short-term in recalling visual information in ADHD subjects [26], deficits are more often noticed in long-term visual memory tests [27]. Kalff's results [28] were in line with our findings in that he found that children with and without ADHD were comparable on the short-term auditory memory assessment. Nevertheless, on more complex auditory memory task and when comorbid conduct symptoms were present, ADHD subjects performed poorly.

The lack of significant difference between children with and those without ADHD symptoms on the selected tasks of attention is difficult to explain. It might be related to the fact that our sample included few children with the predominantly inattention subtype and therefore may have been less impaired on the attentional tasks than children in other samples. The present findings are thus in line with the results in a study by Chhabildas et al. [29], reporting no difference between control children and ADHD children with the predominantly hyperactivity/impulsivity subtype. Only children with the predominantly inattention subtype performed more poorly than the control subjects on tests of attention. However, the question about specificity of impairments within subgroups of children with ADHD is still not resolved. Klorman et al. [30] found that children with predominantly symptoms of inattention were not significantly different from a comparison sample. Further studies of ADHD subgroups are thus still called for, not only within the ADHD subtypes, but also within subgroups of children with ADHD and comorbid disabilities. It is still a discussion whether the group differences noticed among children with ADHD are due to cardinal symptoms or symptoms related to such comorbidity [31].

Several studies have demonstrated that about half of children with ADHD have impaired motor skills (speed and coordination) [32,33] and particularly a fine motor dysfunction [34,35]. Kadesjo and Gillberg refer to this overlap between impaired attention and motor problems as deficits in attention, motor control, and perception (DAMP) [33,36]. On the assessment of finger dexterity and motor speed, the results of the present study indicated that children with ADHD performed similarly to those without ADHD on the Grooved Pegboard Test. These results are in line with Pitcher's study [35], which found significant differences only for the ADHD predominantly inattention subtype and not for the ADHD predominantly hyperactivity/impulsivity and combined subtypes. On the Fingertip Tapping task, the present study found that children with ADHD were less accurate, displayed motor coordination dysfunctions, and used more time compared with children without ADHD. These findings suggest that children with ADHD may have problems with internal sensory-motor representations, which may lead to deficiency in programming such movements. Our results are in agreement with other studies that have reported motor coordination problems in children with ADHD [37,38]. In addition, our results support previous findings that the time taken to prepare a movement seems to be prolonged in children with ADHD [39,40].

The main strength of the present study is that, to the best of our knowledge, it is the first report on neuropsychologic function among African children with ADHD symptoms. In addition, the use of a community-based sample avoids biases commonly found in clinic-referred samples. Furthermore, none of the studied children were previously referred by teachers for an ADHD evaluation, and therefore all were without any ADHD medication. Additional strengths were that the selected neuropsychologic tests were nonverbal and simple to administer, and that all psychometrists had no knowledge of the child's status regarding ADHD. The main limitation of the study is that the children were considered as having ADHD symptoms based only on teachers' reports, and did not go through an extended psychiatric evaluation. Also the limited power (only 28 cases from Kinshasa) and the lack of variability in the sample—i.e., non–school attendants not included—might have disguised cognitive dysfunctions in a subsample of children with symptoms of ADHD and limited the generalizability of the present findings.

To conclude, the present study revealed that African schoolchildren with ADHD symptoms manifest impairment of motor skills, but overall a cognitive function on the same level as their age-matched peers. However, the findings are restricted to a small number of school attenders. Further studies are called for, in order to obtain a better understanding of cognitive resources and problems among a larger group of children with ADHD in Africa, and through this strive to provide an optimal educational environment for these children.

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