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Children with behavioral problems and motor problems have a worse neurological condition than children with behavioral problems only

Lieke H.J. Peters [a,*], Carel G.B. Maathuis [b], Mijna Hadders-Algra [a]

[a] University of Groningen, Department of Paediatrics — Developmental Neurology, Beatrix Children's Hospital, University Medical Center Groningen, Groningen, The Netherlands
[b] University of Groningen, Department of Rehabilitation Medicine, Center for Rehabilitation, University Medical Center Groningen, Groningen, The Netherlands

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ABSTRACT

Background: Some evidence suggests that children with specific behavioral problems are at risk for motor problems. It is unclear whether neurological condition plays a role in the propensity of children with behavioral problems to develop motor problems.
Aims: To examine the relation between behavioral problems, motor performance and neurological condition in school-aged children.
Study design: Cross-sectional study.
Subjects: 174 children (95 boys) receiving mainstream education and 106 children (82 boys) receiving special education aged 6 to 13 years (mean 9 y 7 m, SD 1 y 10 m).
Outcome measures: Behavior was assessed with questionnaires: the parental Child Behavior Checklist (CBCL) and Teacher's Report Form (TRF). Motor performance was assessed with the Movement Assessment Battery for Children (MABC). MABC-scores ≥5th percentile were considered as age-adequate and scores <5th percentile indicated definite motor problems. Neurological condition was assessed in terms of Minor Neurological Dysfunction (MND).
Results: The majority of specific behavioral problems were associated with definite motor problems, except somatic complaints and rule breaking behavior. Children with externalizing problems, according to the CBCL or TRF, and motor problems had more often MND than children with externalizing problems only. The same holds true for internalizing problems according to the CBCL.
Conclusions: The present study demonstrated that various forms of behavioral problems were associated with motor problems. Especially children with motor and behavioral problems showed MND.

1. Introduction

Developmental behavioral disorders and motor problems frequently co-occur during childhood. Especially the relationship between Attention Deficit and Hyperactivity Disorder (ADHD) and Developmental Coordination Disorder (DCD) has been frequently reported [1,2]. Rates of co-occurrence of ADHD and DCD have been stated to be as high as 50% or more [2–4]. Also, children with Autism Spectrum Disorders often show motor problems [5]. However, less is known about the relationship between internalizing and externalizing problems and poor motor performance. A few studies addressed behavioral problems in children with a poor motor performance. Cairney et al. [6] reported that children with a poor motor performance often show internalizing problems. In addition, the recent study of Lingam et al. [7] showed that children with probable DCD have an increased risk of self-reported and parent-reported depression.

It is suggested that neurobiological differences play a role in the pathophysiology of developmental behavioral disorders. To elucidate the role of structural differences in specific behavioral problems, brain imaging studies have been conducted. For example, the meta-analysis of neuroimaging studies by Valera et al. [8] showed that children with Attention Deficit and Hyperactivity Disorder (ADHD) have a smaller cerebellum, reduced total and right cerebral volume, corpus callosum, and right caudate, compared to controls. An advantage of imaging studies is that differences in brain regions can be precisely located. However, a disadvantage is that imaging is not yet clinically applicable to elucidate the neural mechanisms in each individual child with behavioral problems, even though imaging may rule out a structural lesion as the cause of behavioral problems in specific cases. A neurological examination might offer help, as it provides information on the child's specific neurological impairments, and may provide information on the child's vulnerability for the development of behavioral problems [9].

A standardized and age-specific neurological assessment is 'The neurological examination of the child with Minor Neurological Dysfunction'

* Corresponding author at: University Medical Center Groningen, Beatrix Children's Hospital, Developmental Neurology, Hanzeplein 1, 9713 GZ Groningen, The Netherlands. Tel.: +31 50 3614247; fax: +31 50 3636905.
E-mail address: l.h.j.peters@developmentalneurology.com (L.H.J. Peters).

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[9,10]. The examination pays special attention to the presence of Minor Neurological Dysfunction (MND). MND indicates a coherent cluster of neurological signs in the absence of a serious neurological condition, such as cerebral palsy. Hence, the assessment allows for the detection of subtle neurological deficits, e.g., mild diffuse hypotonia or coordination problems, that can be of significance in children with developmental disorders. The examination provides a profile of the neurological make-up of the child. Therefore it gives insight into the child's neurological strengths and limitations.

Accordingly, the present study had two aims: first, we evaluated what different types of behavioral problems are related to poor motor performance. Second, we examined whether neurological condition, in terms of MND, differs between children with both behavioral and motor problems from that of children with behavioral problems only. To achieve our goals, we studied children who attended either a primary school for regular education or a primary school for special education. We deliberately chose this mixed population as we aimed for a wide range of behavioral problems and motor performance.

2. Methods

All children aged six years and older who attended a primary school for mainstream education and a primary school for special education in Appingedam, a small town in the Netherlands, were asked to participate in the study. Indications for referral to the school for special education were specific learning disorders with or without accompanying behavioral problems. The level of education at this type of school is similar to that in mainstream education, implying that the contents of the information taught do not differ between the two educational systems. The systems differ in the way they deliver the educational contents to the pupils. At the special school children receive more educational support e.g., more individual support by means of small groups. None of the children had a major neurological impairment, such as cerebral palsy. Parents of 209 children receiving mainstream education and parents of 147 children receiving special education were asked whether their child was allowed to participate in the study. In total, 176 (84%) children receiving mainstream education and 122 (83%) children receiving special education participated. Eighteen children (7 boys) had entered puberty and were excluded from the study, as puberty is known to affect the expression of MND substantially [11], leaving 280 children eligible for the study. The onset of puberty was defined by the presence of secondary sexual characteristics according to Tanner [11], assessed during the clinical part of the assessment. A group of five research assistants, i.e., medical students with special training in the assessment of MND and supervised by the senior author (MH-A), see Peters et al. [12], assessed the children at school in a separate, quiet room without knowledge of the children's behavioral scores. All parents gave informed consent and children aged 9 years and older provided assent to participate. The study was approved by the ethics committee of the University Medical Center Groningen.

The Dutch version of the Child Behavior Checklist (CBCL), a parental questionnaire, and the Teacher's Report Form (TRF) for children in the age of 6 to 18 years were used to assess behavioral problems. [13,14] The CBCL and TRF largely contain the same items, but a few questions are different. For instance, only the CBCL has a question on nightmares, whereas only the TRF addresses the question “sleeps in class”. The CBCL and TRF have good reliability and validity [14]. The questionnaires include 113 items that measure behavioral problems. The items are rated as ‘not at all true’ (0) ‘sometimes true’ (1) or ‘mostly true’ (2). On the basis of the 113 items eight syndrome scales can be distinguished: (1) anxious/depressed, (2) withdrawn/depressed, (3) somatic complaints, (4) social problems, (5) thought problems, (6) attention problems, (7) rule breaking behavior, and (8) aggressive behavior. The sum of the first three subscales together forms the score of internalizing behavior; the sum of the last two subscales results in the score of externalizing behavior. Total scores are calculated by adding all items. In the analyses, we used T-scores converted to scores within the normal range, borderline range and clinical range. Scores within the borderline and clinical ranges were classified as “behavioral problem” [15]. Questionnaires were excluded when more than eight items were missing (CBCL n = 8; TRF n = 7). When eight or less items were missing, ‘0’ was filled out when no explanation of the item was given or when the item was mistakenly interpreted and ‘1’ was filled out when the given explanation fitted the question (CBCL n = 32; TRF n = 39). The parents stated in the questionnaires whether their child had a medical diagnosis. Maternal and paternal profession was recorded on the CBCL.

Motor performance was assessed with the first edition of the Movement Assessment Battery for Children (MABC), which has four age bands (4–6, 7–8, 9–10 and 11–12 years) [16]. Each age band consists of eight items measuring manual dexterity (three items), ball skills (two items) and static and dynamic balance (three items). High scores indicate poor performance. Raw scores were converted to percentile scores. MABC scores at or above the 5th percentile were considered as age-adequate and scores below the 5th percentile (p5) as definite motor problems. We used MABC total scores in the analysis as total scores are mostly used in DCD-diagnostics [17]. The MABC has satisfactory reliability and validity [16].

The neurological assessment was carried out according to ‘The neurological examination of the child with Minor Neurological Dysfunction’ [9,10]. The examination is age-specific and consists of 97 items that are organized in eight functional domains: posture and muscle tone, reflexes, involuntary movements, coordination, fine manipulation,

Table 1
Background characteristics, behavioral outcome, motor performance and neurological condition in children receiving mainstream education and special education.

	Mainstream education N = 174	Special education N = 106	Test statistic, P-value
Age median, (range)	9 y7 m (6 y–12 y9 m)	10 y4 m (6 y–13 y)	U = 7559[b], P = 0.02
Boys *n*, (%)	95(55)	82(77)	χ^2 = 14.7[a], **P < 0.001**
Maternal profession			
Low *n*, (%)	55(32)	88(83)	χ^2 = 77.6[a], **P < 0.001**
Medium and high *n*, (%)	114(65)	12(11)	
Missing *n*, (%)	5(3)	6(6)	
Paternal profession			
Low *n*, (%)	48(28)	77(73)	χ^2 = 76.2[a], **P < 0.001**
Medium and high *n*, (%)	120(69)	13(12)	
Missing *n*, (%)	6(3)	16(15)	
CBCL *n* (%) with behavioral problems	N = 157	N = 78	
Total score	10(6)	37(47)	χ^2 = 54.9[a], **P < 0.001**
Internalizing behavior	22(14)	36(46)	χ^2 = 29.0[a], **P < 0.001**
Externalizing behavior	15(10)	39(50)	χ^2 = 48.2[a], **P < 0.001**
TRF *n* (%) with behavioral problems	N = 155	N = 100	
Total score	4(3)	28(28)	χ^2 = 37.8[a], **P < 0.001**
Internalizing behavior	17(11)	26(26)	χ^2 = 9.8[a], **P = 0.002**
Externalizing behavior	6(4)	30(30)	χ^2 = 34.2[a], **P < 0.001**
MABC	N = 174	N = 106	
≥5th percentile *n*, (%)	168(97)	37(35)	
<5th percentile *n*, (%)	6(4)	69(65)	χ^2 = 127.6[a], **P < 0.001**
Neurological classification	N = 174	N = 106	
Neurologically normal *n*, (%)	132(76)	10(10)	
Simple MND *n*, (%)	33(19)	48(45)	
Complex MND *n*, (%)	9(5)	48(45)	χ^2 = 125.1[a], **P < 0.001**

Maternal/paternal profession: medium and high = requiring junior vocational college, vocational college or university education required; low = no profession obtained or profession requiring only primary education. Bold values indicate statistically significant differences, i.e. P < 0.01.

Abbreviations: CBCL: Child Behavior Checklist; m: months; MABC: Movement Assessment Battery for Children; MND: Minor Neurological Dysfunction; TRF: Teacher's Report Form; y: years.

[b] Mann–Whitney *U* test.

[a] Chi-square test.