Sex Differences in Attentional Performance in a Clinical Sample With ADHD of the Combined Subtype

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Thomas Günther[1], Eva Lotte Knospe[1], Beate Herpertz-Dahlmann[1], and Kerstin Konrad[1,2]

Abstract

Objective: The goal of the present study was to assess whether girls with ADHD express similar deficits in various attention tasks to those described in boys. **Method:** A total of 175 children with the combined subtype of ADHD (89 females) and 132 normal controls (60 females) aged 8 to 14 years participated. Five different tests were conducted: alertness, sustained attention, focused attention, divided attention, and a set-shifting task. **Results:** The children with ADHD performed worse on all aspects of attention compared with healthy control participants. Several overall general sex differences could be detected, with boys exhibiting faster reaction times and greater response variability. Controlling for ADHD symptom severity and psychiatric comorbidities, no Sex × Diagnosis interaction was found, suggesting that males and females with ADHD experience comparable attentional deficits. **Conclusion:** These results indicate that deficits in various attentional domains are a robust component of ADHD in males and females. *(J. of Att. Dis. 2012; XX(X) 1-XX)*

Keywords

ADHD, sex, cognitive functioning

Introduction

ADHD is one of the most common neuropsychiatric disorders, with 5% to 10% of children and 4% of the adult population being affected (Biederman, 2005; Faraone, Sergeant, Gillberg, & Biederman, 2003). Sex differences in ADHD are indicated by male-to-female ratios ranging from 3:1 to 10:1, with higher ratios in clinical samples than in population-based samples (American Psychiatric Association [APA], 2000; Biederman et al., 2005). In addition to hyperactive and impulsive symptoms, attentional deficits are core symptoms of the disorder (APA, 2000). Relatively few studies have examined whether sex differences are detectable for symptoms of inattention. Furthermore, the results of these studies are contradictory. Several studies delineate differences between boys and girls with ADHD (Newcorn et al., 2001; Rucklidge & Tannock, 2001). Male participants are described as being more impaired in processing speed with respect to complex aspects of attention (Newcorn et al., 2001; Rucklidge & Tannock, 2001), and they are revealed to be more impulsive in continuous performance tasks (Newcorn et al., 2001; Rucklidge & Tannock, 2001). In a systematic review, Balint et al. (2009) reported that a higher proportion of males than females in the ADHD sample exhibited impaired attentional functioning compared with the control group, suggesting that females with ADHD perform better than males on attention tasks. In contrast, other studies failed to show any sex-specific differences in attentional performance (e.g., Biederman, Faraone, Monuteaux, Bober, & Cadogen, 2004; Seidman, Biederman, & Faraone, 2005; Sharp et al., 1999).

These heterogeneous findings could be explained by three different factors, and none of the previous studies controlled all of them. First, the severity and the subtype of the disorder could explain differences in performance between boys and girls with ADHD. It has been suggested that girls are more often classified as the "inattentive only" subtype described in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association [APA], 1994) criteria (Wodka et al., 2008) and that boys are more impaired due to a higher prevalence of hyperactive/impulsive symptoms (Gershon, 2002; Thorell & Rydell, 2008). Second,

[1]RWTH Aachen University, Germany
[2]Research Centre Juelich, Germany

Corresponding Author:
Thomas Günther, Child Neuropsychology Section, Department of Child and Adolescent Psychiatry, RWTH Aachen University, Neuenhofer Weg 21, Aachen, 52074, Germany
Email: thomas.guenther2@post.rwth-aachen.de

boys and girls with ADHD may differ in their profile of comorbidities (Biederman et al., 2002; Gaub & Carlson, 1997; Monuteaux, Mick, Faraone, & Biederman, 2010). Boys often demonstrate more comorbid disruptive behavior disorders, whereas girls exhibit more affective disorders. Moreover, these types of comorbid disorders differentially influence the attentional performance of children with ADHD (Günther, Jolles, Herpertz-Dahlmann, & Konrad, 2009; Günther, Konrad, De Brito, Herpertz-Dahlmann, & Vloet, 2011; Vloet, Konrad, Herpertz-Dahlmann, Polier, & Günther, 2010). Third, the sex differences could be a general phenomenon (also present in typically developing participants) and not specific to ADHD. For example, unaffected boys were found to respond more rapidly, more impulsively, and less variably on a continuous performance task (Burton et al., 2009; Conners, Epstein, Angold, & Klaric, 2003; Miranda, Sinnes, Pompeia, & Francisco Amodeo Bueno, 2008). Females were also found to outperform males on various tasks measuring executive functions (Van der Elst, Van Boxtel, Van Breukelen, & Jolles, 2006a, 2006b).

To summarize, it is still unclear whether sex differences in attentional performance exist in children with ADHD. This question is particularly relevant when inattention is assessed for diagnostic purposes. Accordingly, the aim of the current study was to examine sex differences in a large clinically based sample, controlling for three possible confounding factors: (a) ADHD subtype and symptom severity, (b) distribution of comorbid disorders, and (c) attentional differences in typically developing participants. Therefore, we examined sex differences in attentional performance in participants with and without ADHD, controlling for all of the above-mentioned possible confounding factors. Moreover, the previous studies largely investigated only one aspect of attention (e.g., a continuous performance test). Thus, all of the participants were investigated with a model-oriented test battery that assessed various aspects of attention.

Method

Participants and Selection Procedure

A total of 175 children with ADHD, aged 8 to 14 years (86 males and 89 females), participated in this study. Both sex groups were comparable for symptom severity, comorbidity profiles, and the diagnosed ADHD subtype. To exclude subtype as a confounding factor, only children who met the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; APA, 2000) criteria for the combined subtype of ADHD were included (APA, 2000). No children with an inattentive only or hyperactive only subtype participated. These children were recruited from our inpatient and outpatient departments of child and adolescent psychiatry. All of the new referrals with suspected ADHD symptoms underwent an extensive child psychiatric examination conducted by an experienced child and adolescent psychiatrist. Classification according to the *DSM-IV-TR* criteria was determined using a semistructured interview (Diagnostische Interview bei Psychischen Störungen im Kindes- und Jugendalter [K-DIPS; Unnewehr, Schneider, & Margraf, 1995]) of the parents and the child, conducted in German, which included the developmental history, playroom observation, and pediatric examination of the child.

In addition, the Child Behavior Checklist (CBCL; Dopfner et al., 1998) was administered to all of the parents of the children to measure symptom severity. A total of 92 of the CBCLs given to the parents were returned or filled out completely (46 for each group). Both groups were equally impaired on the inattention subscale (*T*-score > 70; see Table 1), and they did not differ significantly with respect to the other CBCL subscales, $t(90) < 1.83$; $p > .071$. Only children without a prior history of stimulant treatment or other medication for ADHD were included in the study protocol. Further exclusion criteria were as follows: general IQ below 80 (Wechsler Intelligence Scale for Children–Third Edition [WISC-III]; Tewes, Schallberger, & Rossmann, 1999); any potentially confounding diagnoses, such as psychosis, mania, substance abuse, pervasive developmental disorders or receptive language disorders; or any type of additional medication.

To exclude the possible confounding effects of comorbidities on the dependent measures, 86 boys were selected out of a database of 634 boys with ADHD. The disorder profiles of the boys were matched with the comorbidities of the 89 girls (based on the K-DIPS); thus, no differences in the comorbidities were detected, $\chi^2(1) < 0.16$; $p > .2$. See Table 1 for an overview of the measured comorbidities. Informed parental consent was obtained for all of the participants, and the study was approved by the Medical Ethical Committee of the University Hospital of Aachen. In addition, all of the children themselves gave their assent for participation. Table 1 summarizes the major clinical data of the ADHD group.

Furthermore, we examined a typically developing control group (NC) of the same age range (72 males and 60 females). These children were selected in a broad area around Aachen (Germany), and the selection was based on the voluntary interest of primary and secondary schools. If the school was willing to participate, the participants and their parents received a letter of participation, a document indicating informed consent and an information letter about the importance of the research. Psychiatric disorders in the control group were excluded by a semistructured interview with the mother of each child (K-DIPS; Unnewehr et al., 1995). The four groups were comparable in age and IQ (see Table 2 for details).

Experimental Procedures

Researchers studying attention generally distinguish between the selectivity and the intensity of attention.

Table 1. Clinical and Demographic Features of the Sample of Children With ADHD (combined subtype)

	Females (n = 89)	Males (n = 86)	p
Comorbid DBD	35	36	.733
Comorbid anxiety	14	8	.200
Comorbid OCD	2	2	—
Comorbid affective	17	16	.933
Comorbid tic	4	4	—
Comorbid enuresis	3	4	—
Comorbid dyslexia	14	12	.741
CBCL ($M \pm SD$)	(n = 46)	(n = 46)	
Social withdrawal	63.8 (8.1)	61.7 (11.1)	.286
Somatic complaints	63.0 (8.9)	59.7 (8.5)	.071
Anxiety/depression	67.2 (8.9)	64.0 (10.2)	.110
Social problems	66.5 (11.1)	63.3 (10.8)	.172
Thought problems	66.8 (9.1)	64.2 (10.1)	.205
Attention problems	72.3 (7.8)	70.1 (8.1)	.193
Delinquent behavior	59.7 (21.3)	65.4 (10.4)	.103
Aggressive behavior	70.0 (9.1)	69.0 (12.9)	.670

Note: DBD = disruptive behavior disorder (conduct disorder or oppositional defiant disorder according to *DSM-IV* criteria); OCD = obsessive-compulsive disorder; CBCL = Child Behavior Check List (*T*-scores).

Table 2. Descriptive Data of Age and IQ for Normal Developing Children (NC) and Children With ADHD (combined subtype)

	NC (n = 132)		ADHD (n = 175)		Diagnosis effect	Sex effect	Interaction Sex × Diagnosis
	Male (n = 72)	Female (n = 60)	Male (n = 86)	Female (n = 89)	p	p	p
Age	11.4 (1.9)	11.3 (2.1)	11.5 (1.7)	11.5 (1.6)	.518	.682	.888
IQ	97.8 (12.6)	100.8 (9.9)	97.2 (11.4)	97.1 (9.2)	.081	.253	.224

Note: NC = control group. All F values were below 3.1 (df 1;303).

Whereas selectivity refers to the process that modulates responsiveness to specific constellations of stimuli by giving priority to certain stimuli, intensity describes the ability to activate and maintain attention over time. In addition to the selectivity and intensity components of attention, a supervisory attentional system (SAS) is assumed to act as a control mechanism, modulating both selectivity and intensity (Van Zomeren & Brouwer, 1994). Figure 1 presents this theoretical framework and possible paradigms for assessing these attentional functions.

Alertness and sustained attention both constitute aspects of the intensity dimension. Alertness was assessed using a simple reaction time (RT) task with 80 trials in which the participant was instructed to respond with the dominant hand to the presence of a target stimulus (Zimmermann & Fimm, 2007). To measure sustained attention, 600 different dot patterns were continuously and consecutively presented (de Sonneville, 2000). Equal numbers of three-, four-, and five-dot patterns were shown in a pseudorandom manner. The child was instructed to push the "yes" button with the index finger of the dominant hand whenever a four-dot pattern (target) was presented and to press the "no" button with the index finger of the nondominant hand if the pattern presented contained three or five dots (nontargets).

The selectivity dimension of attention was measured using a divided attention and go/nogo paradigm. The first of these aspects combined a visual and acoustic discrimination task (Zimmermann & Fimm, 2007). In the visual task, a series of matrices was presented in the center of the computer screen. The participant was asked to press the response button as quickly as possible whenever the moving crosses formed the corners of a square (the visual target). In the acoustic task, the participant was requested to listen to a continuous sequence of alternating high and low sounds and to press the response button as quickly as possible when irregularities of the sequence occurred (the acoustic target). A total of 100 visual and 200 acoustic stimuli were presented, including 17 visual and 16 acoustic targets. The go/nogo paradigm was used to measure response selection and inhibition (Zimmermann & Fimm, 2007). In this task, a

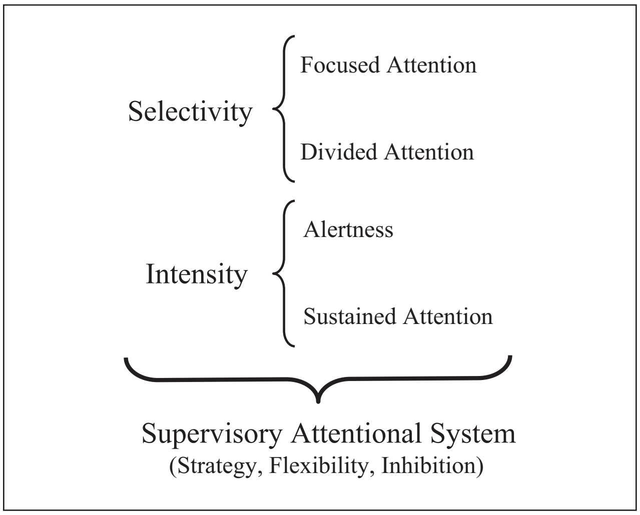

Figure 1. A schedule of the theoretical framework of attentional functions according to Van Zomeren and Brouwer (1994)

motor response with the dominant hand was either initiated (go) or inhibited (nogo), depending on whether an "x" (go) or a "+" (nogo) stimulus appeared on the screen. The visual stimuli appeared in random order for 200 ms each, with a variable intertrial interval of a maximum of 1,600 ms, and 50% of the 40 stimuli were go trials. This task triggers impulsive reactions and constitutes a suitable measurement of impulsive behavior (Van Zomeren & Brouwer, 1994).

The visual set-shifting task is suitable for the investigation of the supervisory attentional control system. This task consists of three different parts, in each of which a bar with a colored square is presented (de Sonneville, 2000). The square moves from the left to the right side of the bar and vice versa. Depending on the color of the square after the movement, the participant is instructed either to imitate the movement by pressing the reaction buttons (Part 1) or to mirror the movement of the square, that is, by pressing the left key in response to a rightward movement or the right key in response to a leftward one (Part 2). In Part 3, the square can change its color at any moment, upon which the child must adjust his or her responding behavior. Parts 1 and 2 consisted of 40 trials each, and Part 3 consisted of 80 trials. The outcomes of Part 3 were used as measurements of attentional control.

Outcome Measures and Statistical Analysis

All of the described tasks give a median RT to the stimuli and a standard deviation (*SD*) of RTs (within-participant *SD*). The sustained attention, divided attention, go/nogo and set-shifting task also detect two different error measurements: the number of false alarms (FA) and the number of misses (MIS). To include the association between the different variables within one task (e.g., accuracy trade-offs), we used adjusted scores for each task (e.g., Capitani, 1997). For each task, we calculated an efficiency score and a variation score. The efficiency score is the quotient of the RT and the proportion of correct reactions. The variation score, defined as the quotient of the *SD* and RT, describes the continuousness and stability of the performance within the task.

$$\text{Efficiency} = \frac{\text{median RT}}{(n\,\text{trials} - (\text{FA} + \text{MIS}))\,/\,n\,\text{trials}};$$

$$Variation = \frac{SD}{\text{median RT}}.$$

The data were analyzed using SPSS 19. The clinical characteristics were assessed by an independent t test (CBCL scores) and χ^2-Pearson (comorbidity). The age, IQ, and group differences of the neuropsychological dependent measure were evaluated using univariate analysis of variance (ANOVA) with a 2 × 2 design, wherein sex (female and male) and diagnosis (control group and ADHD) were factors with two levels each. Only children with no missing data were included in the study. Due to the use of multiple comparisons, we corrected the p values as described by Benjamini and Hochberg (2000).

Results

Differences Between ADHD and NC

The attentional performance of children with ADHD was significantly worse compared with controls on 6 of the 10 dependent measures, $F(1, 303) > 5.19$; $p < .038$. Children with ADHD were less efficient on the sustained attention, go/nogo and set-shifting task. Task performance characterized by reduced efficiency means that participants made more errors and/or reacted more slowly. Except for the set-shifting task and the divided attention task, the children with ADHD showed less stable (more variable) task performance during the tasks. See Table 3 for additional details.

Differences Between Males and Females

Some differences between males and females could be detected. The areas that differed included the efficiency measurement for alertness, $F(1, 303) = 10.64$; $p = .005$, in which boys had faster RTs than girls. Furthermore, the boys exhibited greater variability in their responses on the sustained attention task, $F(1, 303) = 7.99$; $p = .016$) and the go/nogo task, $F(1, 303) = 11.09$; $p = .001$.

Interaction Effects Between Sex and ADHD Diagnosis

No interaction between sex and diagnostic group could be detected, $F(1, 303) < 6.53$; $p > .110$. All of the described differences between the two sexes were independent of the

Table 3. Performance in all Attention Tasks Separated by Children With and Without ADHD (Combined Subtype) and by Sex

	NC (*n* = 132)		ADHD (*n* = 175)		Diagnosis effect	Sex effect	Interaction Sex × Diagnosis
	Male (*n* = 72)	Female (*n* = 60)	Male (*n* = 86)	Female (*n* = 89)	*p*	*p*	*p*
Efficiency							
Alertness	3.5 (0.6)	3.8 (1.0)	3.4 (0.8)	3.8 (1.0)	.759	**.005**	.718
Sustained	13.4 (3.3)	12.9 (3.8)	14.7 (4.6)	14.7 (3.7)	**.005**	.653	.782
Go/nogo	510 (197)	525 (137)	545 (111)	588 (183)	**.022**	.203	.790
Divided	1,046 (453)	978 (264)	1,167 (858)	1,165 (564)	.106	.693	.793
Set-shifting	1,385 (487)	1,323 (527)	1,378 (430)	1,595 (465)	**.032**	.225	.110
Variation							
Alertness	0.25 (0.12)	0.21 (0.09)	0.27 (0.14)	0.27 (0.11)	**.010**	.225	.623
Sustained	0.19 (0.06)	0.16 (0.07)	0.21 (0.07)	0.20 (0.06)	**.001**	**.016**	.946
Go/nogo	0.26 (0.09)	0.23 (0.09)	0.30 (0.11)	0.25 (0.09)	**.038**	**.001**	.884
Divided	0.37 (0.10)	0.34 (0.07)	0.38 (0.09)	0.37 (0.09)	.065	.192	.847
Set-shifting	0.26 (0.10)	0.27 (0.09)	0.30 (0.11)	0.27 (0.09)	.313	.443	.525

Note: NC = control group. All *p* values were corrected for multiple comparisons.
Bold values = $p < .05$.

diagnostic group factor. Similarly, all of the differences between the controls and the children with ADHD were independent of the sex factor.

Discussion

Consistent with a large and growing body of literature (Egeland, Johansen, & Ueland, 2009; Marchetta, Hurks, De Sonneville, Krabbendam, & Jolles, 2007; Piek, Dyck, Francis, & Conwell, 2007; Toplak, Bucciarelli, Jain, & Tannock, 2009), we found that both boys and girls with the combined subtype of ADHD showed deficits in attentional functions compared with IQ and age-matched typically developing children and adolescents. Participants with ADHD exhibited deficits on 6 out of 10 dependent measures. The boys and girls with ADHD were impaired on the efficiency measures and exhibited greater variation in their performance.

As suggested by previous research (Bezdjian, Baker, Lozano, & Raine, 2009; Burton et al., 2009; Conners et al., 2003; Miranda et al., 2008; Van der Elst et al., 2006a, 2006b), our findings indicate general sex differences in attentional performance in school-age children. Thus, some of the sex differences that have been described in patients with ADHD might be explained by sex differences in the general population. Consistent with previous studies, the RTs of boys were faster on the alertness task (e.g., Burton et al., 2009). Faster RTs are normally associated with smaller *SD*s, and if boys react faster, they also show less variability in their reactions (e.g., Conners et al., 2003). Due to the correlation between *SD* and RT, we calculated the variation as the quotient of the *SD* and the RT. In this study, the boys had higher variation scores for sustained attention and on the go/nogo paradigm. In addition, faster RTs are often associated with more errors and are interpreted as impulsive behavior (e.g., Bezdjian et al., 2009). However, we could not detect a higher impulsivity for male participants in any task. This inability could be due to the used efficiency quotient, wherein we analyzed commission errors in relation to the mean RT of the task rather than separately and independent of the other variables of the task. Consistent with this possibility, we were not able to detect sex differences in more complex functions, such as the supervisory attentional control system.

Importantly, no Sex × Diagnosis interaction was found, suggesting that males and females with the combined subtype of ADHD experience comparable attention deficits. Thus, our data suggest that when confounding factors, such as comorbidity profiles and symptom severity, are adequately controlled, boys and girls are similarly affected in their neuropsychological performance, even in clinical-based samples. However, it must be noted that our sample of boys and girls was carefully selected from a large database and that this sample is thus not representative of the entire clinical population. In clinical practice, differences in comorbidities (e.g., more disruptive behavior disorders in boys), ADHD subtypes (e.g., inattentive subtype of ADHD more frequent in girls), and severity (e.g., less impulsivity symptoms in girls) are common, and attentional performance could be influenced by these factors. Moreover, it would be interesting to replicate this study in a sample of children with ADHD with predominantly inattentive subtype, which is more frequent in girls with ADHD. Our results are consistent with studies that also controlled for ADHD subtype or comorbidities or included a control group (e.g., Seidmann, Biederman, Monuteaux, et al., 2005; Wodka et al., 2008). To summarize, our data suggest a general difference in attentional functioning between the two sexes. This difference also applies to patients with ADHD but is not specific for the disorder. Of importance for clinical settings, the attentional impairment appears to be identical for boys and girls with a combined subtype of ADHD.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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References

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

Balint, S., Czobor, P., Komlosi, S., Meszaros, A., Simon, V., & Bitter, I. (2009). Attention deficit hyperactivity disorder (ADHD): Gender- and age-related differences in neurocognition. *Psychological Medicine*, *39*, 1337-1345.

Benjamini, Y., & Hochberg, Y. (2000). On the adaptive control of the false discovery rate in multiple testing with independent statistics. *Journal of Educational and Behavioral Statistics*, *25*, 60-83.

Bezdjian, S., Baker, L., Lozano, D., & Raine, A. (2009). Assessing inattention and impulsivity in children during the go/nogo task. *British Journal of Developmental Psychology*, *27*, 365-383.

Biederman, J. (2005). Attention-deficit/hyperactivity disorder: A selective overview. *Biological Psychiatry*, *57*, 1215-1220.

Biederman, J., Faraone, S., Monuteaux, M., Bober, M., & Cadogen, E. (2004). Gender effects on attention-deficit/hyperactivity disorder in adults, revisited. *Biological Psychiatry*, *55*, 692-700.

Biederman, J., Kwon, A., Aleardi, M., Chouinard, V., Marino, T., Cole, H., & Faraone, S. V. (2005). Absence of gender effects on attention deficit hyperactivity disorder: Findings in nonreferred subjects. *American Journal of Psychiatry*, *162*, 1083-1089.

Biederman, J., Mick, E., Faraone, S., Braaten, E., Doyle, A., Spencer, T., & Johnson, M. A. (2002). Influence of gender on attention deficit hyperactivity disorder in children referred to a psychiatric clinic. *American Journal of Psychiatry*, *159*, 36-42.

Burton, L., Pfaff, D., Bolt, N., Hadjikyriacou, D., Silton, N., Kilgallen, C., & Allimant, J. (2009). Effects of gender and personality on the Conners Continuous Performance Test. *Journal of Clinical and Experimental Neuropsychology*, *30*, 1-6.

Capitani, E. (1997). Normative data and neuropsychological assessment. Common problems in clinical practice and research. *Neuropsychological Rehabilitation*, *7*, 295-309.

Conners, C., Epstein, J., Angold, A., & Klaric, J. (2003). Continuous performance test performance in a normative epidemiological sample. *Journal of Abnormal Child Psychology*, *31*, 555-562.

de Sonneville, L. M. J. (2000). *ANT 2.1-Amsterdam neuropsychological tasks*. Amstelveen, Netherlands: Sonar.

Dopfner, M., Plück, J., Bölte, S., Lenz, K., Melchers, P., & Heim, K. (1998). *Elternfragebogen über das Verhalten von Kindern und Jugendlichen - 2. Auflage mit deutschen Normen [Child Behavior Check List – 2nd edition with German norms]*. Köln, Germany: Arbeitsgruppe Deutsche Child Behavior Checklist.

Egeland, J., Johansen, S., & Ueland, T. (2009). Differentiating between ADHD sub-types on CCPT measures of sustained attention and vigilance. *Scandinavian Journal of Psychology*, *50*, 347-354.

Faraone, S. V., Sergeant, J., Gillberg, C., & Biederman, J. (2003). The worldwide prevalence of ADHD: Is it an American condition? *World Psychiatry*, *2*, 104-113.

Gaub, M., & Carlson, C. (1997). Gender differences in ADHD: A meta-analysis and critical review. *Journal of the American Academy of Child & Adolescent Psychiatry*, *36*, 1036-1045.

Gershon, J. (2002). A meta-analytic review of gender differences in ADHD. *Journal of Attention Disorders*, *5*, 143-154.

Günther, T., Jolles, J., Herpertz-Dahlmann, B., & Konrad, K. (2009). Age-dependent differences in attentional processes in ADHD and disruptive behavior disorder. *Developmental Neuropsychology*, *34*, 422-434.

Günther, T., Konrad, K., De Brito, S. A., Herpertz-Dahlmann, B., & Vloet, T. D. (2011). Attentional functions in children and adolescents with ADHD, depressive disorders, and the comorbid condition. *Journal of Child Psychology and Psychiatry*, *52*, 324-331.

Marchetta, N., Hurks, P., De Sonneville, L., Krabbendam, L., & Jolles, J. (2007). Sustained and focused attention deficits in adult ADHD. *Journal of Attention Disorders*, *11*, 664-676.

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

Monuteaux, M., Mick, E., Faraone, S., & Biederman, J. (2010). The influence of sex on the course and psychiatric correlates of ADHD from childhood to adolescence: A longitudinal study. *Journal of Child Psychology and Psychiatry*, *51*, 233-241.England.

Newcorn, J. H., Halperin, J. M., Jensen, P. S., Abikoff, H. B., Arnold, L. E., Cantwell, D. P., & Vitiello, B. (2001). Symptom profiles in children with ADHD: Effects of comorbidity and gender. *Journal of the American Academy of Child & Adolescent Psychiatry*, *40*, 137-146.

Piek, J., Dyck, M., Francis, M., & Conwell, A. (2007). Working memory, processing speed, and set-shifting in children with developmental coordination disorder and attention-deficit-hyperactivity disorder. *Developmental Medicine & Child Neurology*, *49*, 678-683.

Rucklidge, J., & Tannock, R. (2001). Psychiatric, psychosocial, and cognitive functioning of female adolescents with ADHD. *Journal of the American Academy of Child & Adolescent Psychiatry*, *40*, 530-540.

Seidman, L. J., Biederman, J., & Faraone, S. V. (2005). Impact of gender and age on executive functioning: Do girls and boys with and without attention deficit hyperactivity disorder differ neuropsychologically in preteen and teenage years? *Developmental Neuropsychology*, *27*, 79-105.

Seidman, L. J., Biederman, J., Monuteaux, M., Valera, E., Doyle, A., & Faraone, S. (2005). Impact of gender and age on executive functioning: Do girls and boys with and without attention deficit hyperactivity disorder differ neuropsychologically in preteen and teenage years? *Developmental Neuropsychology*, *27*, 79-105.

Sharp, W. S., Walter, J. M., Marsh, W. L., Ritchie, G. F., Hamburger, S. D., & Castellanos, F. X. (1999). ADHD in girls: Clinical comparability of a research sample. *Journal of the American Academy of Child & Adolescent Psychiatry*, *38*, 40-47.

Tewes, U., Schallberger, U., & Rossmann, K. (1999). *Hamburg Wechsler Intelligenztest für Kinder III [Hamburg Wechsler Intelligence Test for Children III]*. Göttingen, Germany: Hogrefe.

Thorell, L., & Rydell, A. (2008). Behaviour problems and social competence deficits associated with symptoms of attention-deficit/hyperactivity disorder: Effects of age and gender. *Child: Care, Health and Development*, *34*, 584-595.

Toplak, M., Bucciarelli, S., Jain, U., & Tannock, R. (2009). Executive functions: Performance-based measures and the behavior rating inventory of executive function (BRIEF) in adolescents with attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology*, *15*, 53-72.

Unnewehr, S., Schneider, S., & Margraf, J. (1995). *Kinder DIPS - Diagnostisches Interview bei psychischen Störungen im Kindes und Jugendalter [Diagnostic Interview for Mental Disorders for Children and Adolescents]*. Heidelberg, Germany: Springer.

Van der Elst, W., Van Boxtel, M., Van Breukelen, G., & Jolles, J. (2006a). The concept shifting test: Adult normative data. *Psychological Assessment*, *18*, 424-432.

Van der Elst, W., Van Boxtel, M., Van Breukelen, G., & Jolles, J. (2006b). The Letter Digit Substitution Test: Normative data for 1,858 healthy participants aged 24-81 from the Maastricht Aging Study (MAAS): Influence of age, education, and sex. *Journal of Clinical and Experimental Neuropsychology*, *28*, 998-1009.

Van Zomeren, A. H., & Brouwer, W. J. (1994). Theories and concepts of attention. In A. H. Van Zomeren & W. J. Brouwer (Eds.), *Clinical neuropsychology of attention(2)* (pp. 7-38). New York, NY: Oxford University Press.

Vloet, T. D., Konrad, K., Herpertz-Dahlmann, B., Polier, G. G., & Günther, T. (2010). Impact of anxiety disorders on attentional functions in children with ADHD. *Journal of Affective Disorders*, *124*, 283-290.

Wodka, E., Mostofsky, S., Prahme, C., Gidley Larson, J., Loftis, C., Denckla, M., & Mark Mahone, E.. (2008). Process examination of executive function in ADHD: Sex and subtype effects. *Clinical Neuropsychologist*, *22*, 826-841.

Zimmermann, P., & Fimm, B. (2007). Testbatterie zur Aufmerksamkeitsprüfung–Version 2.1 [Tests of Attentional Performance - Version 2.1]. Herzogenrath, Germany: Psytest.

Bios

Thomas Günther is psychologist & speech and language therapist, Associate Professor at the Child Neuropsychology Section at the Department of Child and Adolecent Psychiatry, University Hospital Aachen and head of the department of Speech and Language Therapy of the Zuyd University in the Netherlands.

Eva Lotte Knospe is psychologist and Ph.D. student at the Child Neuropsychology Section at the Department of Child and Adolecent Psychiatry, University Hospital Aachen.

Beate Herpertz-Dahlmann is a pediatrician and child and adolescent psychiatrist. She is holding the chair of Child and Adolescent Psychiatry in Aachen since 1997.

Kerstin Konrad is head of the Child Neuropsychology Section at the Department of Child and Adolecent Psychiatry, University Hospital Aachen as well as head of the cognitive development group at the Institute of Neuroscience and Medicine (INM-III) at the Research Center Juelich, Germany.