

Associations Between Language Disorders and ADHD Symptoms in Three-Year-Old Children

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May 2007

Acknowledgements

First of all, I would like to thank my supervisor Anne Inger Helmen Borge for being supportive and encouraging throughout the work on this study. I would also like to thank specialist in clinical psychology, and director of psychiatric assessments at the ABC study, Synnve Schjølberg for invaluable advice and guidance during this process.

I am grateful to the ABC study group, and the National Institute of Public Health, for letting me use data from their projects, providing office space and including me in the research environment at the Division of Psychic Health during this time. The whole assessment group and staff at the ABC study have been a great support and inspiration.

I would especially like to thank my fellow students Mari Vaage Wang and Ima Maria Zambrana for the collaboration on the video transcriptions performed as a part of this study. In addition I would like to thank Cathy Lord for constructive advice and suggestions on the transcript methods.

In the end, warm appreciation goes to family, friends and my most important ally Espen Brandlistuen.

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Abstract

By middle childhood, children with Language Disorders (LDs) are frequently identified with comorbid psychiatric disorders. Attention Deficit Hyperactivity Disorder (ADHD) is one of the disorders most frequently reported to be comorbid with LDs. The ADHD symptoms are reported to be present at early age in children with LDs. Yet, few studies have explored these early patterns of co-occurring symptoms. Accordingly, little is known as to how LDs might be associated with ADHD symptoms at an early age. In a case/control design, ADHD symptoms were studied in a group of 35 children clinically examined and diagnosed with LDs, or suspected of LDs, and compared to a group of 25 children with normal language development at three years of age. Language measures from video transcriptions (SALT) were used in addition to the classification of sub diagnoses of LD to explore the plausible early associations between LDs and ADHD symptoms. The ADHD symptoms were assessed using the Preschool Age Psychiatric Assessment (PAPA) interview. Measure of nonverbal IQ was adopted from the Stanford Binet 5th edition. Significantly more ADHD symptoms were detected in the group of LDs compared to the control group. High means of ADHD symptoms were associated with the expressive/receptive subtype of LD in children with low level of intelligibility. No association was detected between ADHD symptoms and nonverbal IQ. Early associations between LDs and ADHD symptoms can be detected at three years of age and seem to be associated with expressive/receptive subtype of LD and low level of intelligibility in the children with LDs.

Introduction

Children have a facility for learning language that is both astonishing and fascinating. During the preschool years, a typical child learns to produce long, complex sentences, to speak clearly and intelligibly, and to understand a wide range of words. However, language acquisition involves wide individual variation. For some children, language acquisition does not proceed in a straight forward fashion. In fact, disorders of language rank among the most prevalent developmental disabilities in children (Heim and Benasich, 2006). Some children appear to outgrow these problems; others struggle with language and associated difficulties into adolescence and adulthood (Clegg et al., 2005).

Disturbance in language can occur in severe syndromes like Downs-Syndrome, and it is a common problem in children with Autism Spectrum Disorder. At the other end of the scale, language disorders can present in isolation among children with language impairment who have otherwise age-adequate development. Within this range of language difficulties, comorbidity or co-occurrence of other psychiatric and psychological disorders has become an important topic of research (Beitchman et al., 1996). One of the disorders reported most frequently to be comorbid with Language Disorders is Attention Deficit Hyperactivity Disorder (ADHD) (Snowling et al., 2006).

It has been suggested that comorbid patterns of Language Disorders and ADHD symptoms are present at an early age and increase further as the child grows older (Benasich et al., 1993). Even if ADHD symptoms can be detected at an early age, few studies have been able to detect the language features that could be associated with ADHD symptoms. Comorbid diagnostic patterns in childhood are often reported to be associated with more serious outcomes and greater impairment later in life (Egger and Angold, 2006). Early identification of these co-occurring symptoms is important for detecting children possibly at risk of sustained language deficits and ADHD, and for addressing questions about how intervention can be adjusted and made appropriate to suit the additional challenges these children might be facing.

Defining and Diagnosing Language Disorders

The defining and diagnosing of language disorders in childhood is a complicated matter (Bishop, 2004). In the DSM-IV (American Psychiatric Association (APA), 2000) an explicit contrast has been drawn between pervasive developmental disorders and specific developmental disorders (Bishop, 2002). In pervasive disorders, for example autism, multiple areas of functioning are impaired. These may include, but are not limited to, language. In specific developmental disorders, a single domain, such as language, is impaired. A diagnosis of language disorder is therefore only appropriate when: “language lags well behind age level, but development is proceeding normally in other respects, and when there is no obvious explanatory factor for language delay (such as grossly abnormal home environment, global developmental delay, hearing loss or acquired neurological lesion)” (Bishop, 2002: 669).

Historically, significant language delay has been given a variety of labels, all referring to the same condition (Heim and Benasich, 2006). “Specific Language Disorder” is one, commonly adopted term (Leonard, 1998), but terms such as “Developmental Language Disorder” or simply “Language Disorders” (LDs) are preferred by others (Heim and Benasich, 2006). The term “Language Disorders” (LDs) has been adopted by the present author.

Even disregarding disagreement about the name of the condition, the “Language Disorders” diagnosis has been defined very different by different authors and researchers. Some researchers apply very strict inclusion criteria for LDs, for example excluding children with a nonverbal intelligence quotient (Nonverbal IQ) below .85, or with comorbid diagnosis such as ADHD (Bishop, 2004). However, applying such strict inclusion criteria might lead to important information being lost. In contrast, some researchers do not differentiate between global developmental delay, or pervasive disorders, and Language Disorders (LDs) (Heim and Benasich, 2006). Applying too wide inclusion criteria could limit the interpretations of comorbid patterns.

The varying terminology and low consensus in the field on how to diagnose language disorders make the literature on LDs and comorbid patterns difficult to interpret (Bishop, 2004). In addition, LD is a heterogeneous category including subtypes of LDs.

The DSM IV text revision (APA, 2000) distinguishes between language disorders with and without comprehension difficulties:

Expressive and phonological subtype

The Expressive type of LD is usually recognized by 3 years of age and is quite common, occurring in 10 – 15 % of children (APA, 2000). However, many of these children catch up-, and, by school age, prevalence estimates are reduced to ranging from 3 % to 7 % (APA, 2000). Impairment in expressive language development often includes limited amount of speech, limited range of vocabulary, difficulty attaining new words, use of short sentences, and limited varieties of grammatical structure. The linguistic features vary depending on the severity of the disorder and the age of the child. Nonlinguistic functioning and language comprehension skills are usually within normal limits. Expressive LD may be either acquired or developmental. Children with the developmental type often begin speaking late, and progress more slowly than usual through the various stages of expressive language development (APA, 2000).

In young children, Phonological Disorder is the most common, associated feature of expressive impairments and it is difficult to separate phonological disorder from expressive disorder in preschoolers. The essential feature of phonological disorder is a failure to use developmentally expected speech sounds. Articulation errors are typical, ranging in severity from little or no effect on speech intelligibility, to completely unintelligible speech (APA, 2000).

Mixed expressive/receptive subtype

The expressive/receptive type of LD is usually detected before 4 years of age. The prevalence rate varies with age. This subtype may occur in up to 5% of preschoolers, decreasing to 3 % in school age. Expressive/receptive type LD is probably less common than expressive LD (APA, 2000). Children with this disorder have the difficulties associated with Expressive LD mentioned above, but in addition they are impaired in their receptive language development implying that they have difficulty understanding words or sentences. Some children with mixed type LD eventually acquire normal

language, but the prognosis is worse than for those with expressive disorder. Children with more severe forms are likely to develop Learning Disorders (APA, 2000).

Etiology and Mechanism Underlying Language Disorders

The etiology and mechanisms underlying different LDs are not agreed upon. It is unlikely that a single etiology will be found due to the wide range of different language disorders (Heim and Benasich, 2006). Still, two broad competing theoretical perspectives have attempted to explain Language Disorders in the absence of neurological damage, hearing deficits, severe environmental deprivation or mental retardation. One perspective is that children with LDs suffer from a deficit or delay that is specific to the domain of language (e.g. Rice, 2000). The second perspective has been more concerned with the non-linguistic processing deficits prevalent in LDs. This tradition has viewed language as an integral part of the general cognitive system. More recently, more specific parts of the cognitive system have been suggested to be related to language disorders. A recent hypothesis proposed within this tradition is the “Procedural Deficit Hypothesis” developed by Michael T. Ullman and Elisabeth I. Pierpont (2005). This hypothesis suggests that abnormal brain structures involving basal ganglia, especially the striatum in the procedural memory system, might underlie difficulties in language and associated processes. The abnormal brain structures could be a result of numerous etiologies including a genetic predisposition. A genetic basis for at least some aspects of LDs has been repeatedly demonstrated across several studies (reviewed in Heim and Benasich, 2006).

Symptoms of ADHD

ADHD is currently defined as a cognitive/behavioral developmental disorder (Sagvolden et al., 2005). By others it is defined as a complex neurodevelopmental condition (Stefanatos and Baron, 2007). The symptoms of ADHD are, however, behavioral, and thus it is not easy to determine the correct category. Symptoms of ADHD are usually present before the age of 7 years and include inattention, impulsiveness and hyperactivity (APA, 2000). The DSM-IV text revision states that the child’s inattention and/or

hyperactivity-impulsivity must be severe, frequent, persistent, and “inconsistent with developmental level” to be considered a symptom of ADHD (APA, 2000).

In the normal population, ADHD affects around 4% of all children, although estimates vary from 3% to 11% (Daley, 2006). Using the newly developed Preschool Age Psychiatric Assessment Interview (PAPA), 3% of the children in a sample of non-specialty-referred children (N=307) were diagnosed with ADHD (Egger and Angold, 2006). Higher rates have been reported in studies using `yes/no` questionnaires such as the Behavior Check List (Pavuluri et al., 1999). The ADHD diagnosis can be divided into three subtypes: the ADHD predominantly inattentive subtype, the ADHD predominantly impulsive/hyperactive subtype and the combined subtype (APA, 2000). The combined and the impulsive/hyperactive subtypes are reportedly more common than the predominantly inattentive type in the preschool years (Egger and Angold, 2006).

Etiology and Mechanisms Underlying ADHD

The behavioral -and other symptoms of ADHD are theorized to result from the complex interplay between individual predispositions and environment (Sagvolden et al., 2005). Abnormal dopamine functions are assumed to be part of the neurobiological basis of ADHD (Sagvolden et al., 2005). In addition, ADHD has been shown to be a highly heritable disorder (Levy et al., 2006). Genes coding for dopamine have been found to relate to ADHD, but specific genes have not yet been identified (Levy et al., 2006). Neurological findings suggest that areas in the cerebellum and basal ganglia, especially portions of the striatum, are less developed in children with ADHD (Bradshaw, 2001). These central brain structures are likely to be implicated in both LDs and ADHD. Ullman and Pierpont (2006) suggest that this might, thus, be the common neurological basis of the comorbidity between LDs and ADHD.

Comorbidity between Language Disorders and ADHD

Research on the relationship between different language disorders and other psychiatric disorders has been conducted over the last 30 years. These studies have reported a high rate of different types of other disorders in children with LDs. Comorbid patterns have been studied in both clinical- and population-based samples. A third to half of children in

speech and language clinics show some type of behavior problem, a rate that is three times greater than in the community (Goodyer, 2000; Toppelberg and Shapiro, 2000). Several clinical studies have reported ADHD symptoms to be the most frequent behavior observed among the behavior difficulties in LDs. For example, in a study of 600 children referred to a speech/language pathology clinic, the psychiatric prevalence for any diagnosis was 50%. The most common, individual psychiatric diagnosis was Attention Deficit Disorder (19%) (Cantwell and Baker, 1991).

Correspondingly, children in psychiatric clinics show substantially more language problems than controls. This has been especially documented for children with a primary diagnosis of ADHD (Cohen et al., 1998). However, clinical samples may be biased towards the most severe, and possibly most clearly comorbid, cases of LDs and ADHD (Rutter and Mawhood, 1991). Lower rates of comorbidity might be found in normative, population-based samples.

Already in the 1970`s, behavior symptoms like restlessness and hyperactivity were reported in a population-based study of 205, 3-year-old children (Stevenson and Richman, 1978). This study reported behavior symptoms to co-occur in 59% of the children with a language delay. This is an even higher rate than what is typically found in clinic samples (Goodyer, 2000). Later studies have reported lower co-occurrence in population-based studies. In one study of 581 children at 8 years of age, 29% of children with language impairments were reported to show ADHD symptoms (Tomblin et al., 2000). Thus, ADHD symptoms seem to be frequent in LD children both in clinical and community based samples, but the frequencies vary. One of many possible explanations for the difference in comorbidity rates has been variation in the degree of disability among children included in the study (Plomin et al., 2002). A recent study reported high rates of ADHD by the age of 6 years in children initially screened for language problems at 30 months (Miniscalco et al., 2006). However, ADHD in this study often occurred in combination with Autism Spectrum Disorder. Thus, it seems plausible, that some studies reporting high rates of ADHD symptoms in children with LDs neglect the differentiation between pervasive disorders like autism, and Language Disorders (Willinger et al., 2003).

Language Characteristics and ADHD Symptoms

Another important area of discussion has been to what extent different language features or characteristics could be related to ADHD symptoms. Not all children within the wide category of LD have ADHD symptoms. The question is: what differentiates those with co-occurring symptoms of ADHD from those without ADHD? This question has been studied from two angles. Some studies have differentiated categorically between types of LDs, whilst other studies have studied language and behavior as continuous, dimensional constructs.

Subtypes of Language Disorders and ADHD symptoms

Although ADHD symptoms have been reported in both expressive type and mixed expressive/receptive type LD (Willinger et al., 2003), significant behavior problems seem to be more often associated with the mixed expressive and receptive type of language disorder (Goodyer, 2000). One example is the already mentioned early study by Cantwell and Baker (1991) that reported high rates of ADHD in children with LD. These authors reported that attention deficits were more common in children with receptive language disorder. Similar findings have also been reported in population-based studies. In one study, children identified with Language Disorder at 5 years of age were followed up for more than 14 years. Age 5 behavior measures revealed a high prevalence of ADHD (59%) in a group with mixed expressive/receptive disorder (Beitchman et al., 1989). However, this group was also characterized by Beitchman and colleagues (1989) as a high risk group, with low socio economic status, impaired hearing and visual-motor deficits. Thus, the group was categorized as having pervasive problems. At follow up after 14 years, this group was associated with the highest risk of sustained difficulties (Beitchman et al., 1996).

A later study attempted to explore whether the association between the mixed expressive/receptive subgroup of LD and behavior problems would be present at an earlier age (McCabe, 2005). Behavioral problems in this study were found to be more common in the expressive/receptive type of LD, in children between 3 years and 5 years. However, this study did not include items corresponding to ADHD symptoms.

In a study including only children identified with expressive language delay at two years of age no difference in externalizing behaviors including symptoms of hyperactivity/impulsivity and inattention was detected between the LD group and a group of controls (Irwin et al., 2002). Accordingly, not all types of LD seem to be associated with ADHD symptoms early on. However, no comparison group of children with expressive/receptive delay was available in the study, thus it can not be determined if this group would have displayed significant ADHD symptoms at this early age. Thus, whether any subtype of LD is more associated with specific ADHD symptoms in children under the age of 5 warrants further investigation.

Continuous language measures and ADHD symptoms

Most studies, using both clinical- and population-based samples have examined both LD and ADHD categorically. Even where language impairment and ADHD symptoms seem to co-occur few studies have actually reported to what degree language measures are *related* to behavior measures.

In a community study of 518 children at 8 years, correlations between language impairment and behavior problems were reported to be moderate (-.29), and this association was suggested to be mediated by reading disability (Tomblin et al., 2000). In the early study mentioned previously by Stevenson and Richman (1978), low associations between language problems and behavior problems including restless and impulsive behavior, were reported ($r = -.16$). In a more recent, community-based study, 4000 pairs of twins were assessed by their parents at 2, 3 and 4 years of age regarding their language development and behavior problems (Plomin et al., 2002). Behavior problems were only moderately associated with low language scores, with correlations of less than .30. Correlations between language and the hyperactivity and inattention sub-scores were reportedly similar to the correlation for the total behavior scale and were, therefore, not specified.

Thus, even if a strong association might be suggested by the high rate of ADHD symptoms observable in children with certain types of LDs, the few studies that have investigated the relationship have only able to report moderate associations. However,

none of these have considered that certain types of LD might be more related to ADHD symptoms than others. Consequently, possible association between measures of language and ADHD symptoms for different types of LD warrants further investigation.

Nonverbal IQ measures and ADHD symptoms

Another possible explanation for the moderate associations reported between them in the literature is that the co-occurrence of ADHD and LD is mediated by other factors, such as nonverbal IQ (Plomin et al., 2002). A number of studies indicate that behavior outcome is worse if language impairment is associated with low IQ (Benasich et al., 1993, Beitchman et al., 1996). In a study by Benasich and colleagues (1993) an increase in behavior scores falling within the clinical range on the Total Child Behavior Checklist, for children with LDs between the ages of 4 and 8 years, was associated with a decrease in IQ scores. However, because the nonverbal and verbal IQ scores are not reported separately in the Benasich et al. study it has not been possible to determine if this finding indicates that more severe language impairment (measured by low IQ) is associated with behavior outcomes or if it reflects the influence of a general cognitive deficit.

The already mentioned study by Plomin and colleagues (2002) is one of few studies reporting nonverbal cognitive measures in addition to the verbal assessment. Interestingly, in this study the associations were stronger between nonverbal measures and behavior measures than for verbal measures and behavior measures in 2-, 3- and 4-year-olds (Plomin et al., 2002). This implies that the moderate association reported between language measures and behavioral measures could be explained by nonverbal cognitive abilities. However, because this study did not include children diagnosed with LDs, it remains difficult to conclude whether a possible stronger relationship, between LD measures and ADHD measures in children diagnosed with LDs, could be attributed to lower nonverbal IQ.

Summary

The co-occurrence of LD and ADHD appear to be well documented across different studies, but the quality of the association is not clear. Some studies have indicated that

the expressive/receptive type of LD is more related to ADHD symptoms than are other types of LD. However, this association has not been investigated in children under the age of 5. Studies measuring language abilities continuously have not been able to report more than moderate associations between language problems and behavior problems. Accordingly, the plausible association between LDs and ADHD symptoms is not well understood. Further, nonverbal IQ has only been reported in a few studies. More studies are needed to determine whether the plausible associations between LD and ADHD symptoms are mediated by low nonverbal IQ.

Finally, many studies deal with language disorders in a broad sense and differentiation between children with autism and LD is often neglected (Willinger et al., 2003). It will be important to differentiate between children with LD and children with pervasive disorders like autism when studying ADHD symptoms.

The Current Study

The current study is based on a group of 3-year-old children identified with different Language Disorders (LDs) in the Autism Birth Cohort Study (ABC). This sample provides the opportunity to study ADHD symptoms in children thoroughly assessed for autism, but without a diagnosis- or suspicion of autism. The present study includes video transcriptions of the children's language, providing continuous language measures in addition to the subdivision according to Language Disorder type assigned by the ABC group. Continuous nonverbal IQ scores are available for comparison to the verbal measures. Measures of ADHD symptoms are collected from a diagnostically-based parent interview developed to assess clinically significant ADHD symptoms. The main goal is to explore the associations between LDs and ADHD symptoms considering both subtypes of LD and continuous measures of language abilities.

The research questions guiding the current study are:

1. Are there more ADHD symptoms in 3 ½ year old children diagnosed with or suspected of language disorders compared to a group of children with normal language development?

2. If so, are ADHD symptoms associated with subtype of language disorder and/or with continuous language measures?
3. Are the plausible associations between LD and ADHD related to nonverbal IQ?

Method

Participants

The participants were 60 preschool children recruited from the Norway Autism Birth Cohort study (ABC study) assessed between September 2005 and February 2007 (see flow chart in Appendix). The ABC study is a study recruiting participants from the Norwegian Mother and Child Cohort (MoBa; Magnus et al., 2006) between the age of 39 and 46 months. MoBa recruits the mothers of the children during pregnancy and the mothers receive mailed questionnaires during the child's early development. In the questionnaire received at 36 month questions to tap social and communication development is included to form the basis of screening criteria for participation in the ABC study. Children, who screen positive on one or more of five screening criteria and a random selected control group, are invited for a full clinical assessment at the ABC-study by the Oslo Assessment Group (OAG). The inclusion criteria are: 1) low scores on the Social Communication Scale (SCQ-33 score ≥ 12); 2) Repetitive behavior (SCQ-33 = 9); 3) Parent reports language delay and child has been referred to a specialist; 4) Parent report autism/autistic trait; 5) Parent reports worry that the child shows little interest in playing with other children.

By February 1st OAG had assessed 200 children including screened cases and randomly selected controls. The two day long clinical assessment at the ABC study collected detailed neurobehavioral and developmental information in order to generate a diagnosis of Autism Spectrum Disorder (ASD) or other disorders. The case group in the current study consists of 35 children who received a diagnosis of or were suspected of a Language Disorder after the clinical assessment.

In addition a group of 25 children randomly selected from the control group served as a comparison group in the current study. They represent a group of children with normal language (NL).

The 35 children who were classified with or suspected of LD consisted of originally screened out potential cases in the ABC study, as well as children from the control group who had been assigned or suspected of LD by the OAG group. Out of the 35 children, 18 children (51 %) had been screened out on the criteria of language impairment, 8 children (23 %) had been screened out on one of the other criteria, and 9 children (26 %) had originally been invited as controls.

The young children were all Norwegian speaking and none of the children were bilingual. The mean age, sex distribution, nonverbal IQ and socio economic status (SES) (as measured by mothers and fathers income, and mothers and fathers education) is presented in Table 1.

Table 1

Socio-demographic profiles of the children with Language Disorders (LDs) and the Normal Language (NL) group.

	<i>LDs</i> (n=35)	<i>NL</i> (n=25)
Age in months		
M (SD)	42 (SD 1.6)	42 (SD 1.5)
Sex		
Girls (N)	7	13
Boys (N)	28	12
Nonverbal IQ		
M (SD)	96 (SD 11.8)	107 (SD 12.3)
SES		
M(SD)		
Mothers Income ^a	3.7 (SD 1.0)	3.5 (SD 1.1)
Fathers Income ^a	4.6 (SD 1.5)	4.6 (SD 1.6)
Mothers Education ^b	4.5 (SD 1.3)	4.5 (SD 1.2)
Fathers Education ^b	4.1 (SD 1.3)	3.8 (SD 1.7)

Notes:

a) 1) no income, 2) below 150 000 NOK, 3) 150 000-199 999 NOK, 4) 200 000-299 999 NOK, 5) 300 000-399 999 NOK, 6) 400 000-499 999 NOK, 7) above 500 000 (NOK).

b) 1) 9-years elementary school, 2) 1-2 years junior college [“videregående”], 3) 3-years junior college occupational [“yrkesfaglig”], 4) 3-years junior college, 5) 4-years college education, 6) more than 4-years university degree.

Procedures

Assignment of language diagnoses

The assignment of language diagnoses was made by clinical psychologists and child psychiatrists at the ABC assessment. The diagnosis of Language Disorders (LDs) was based on thorough functional assessment of the individual language ability as suggested by the DSM IV text revision (APA, 2000). The two day long assessment included a wide range of interviews and tests and resulted in a group consisting of 25 young children filling the criteria of Language Disorders (LDs). The 25 children received either: expressive (n=8), phonological (n= 2), expressive and phonological (n= 5) or expressive/receptive (n= 10) LDs. For the purpose of the current study the children assigned with expressive, phonological or both disorders were included in one group of expressive and/or phonological LDs (n = 15). In addition to the 25 children filling the criteria of a language diagnose according to the DSM IV TR (APA, 2000), there were 10 children who had clinically significant expressive language difficulties but who did not fill criteria of language diagnoses. These 10 children were included in the LDs group as suspected of LDs.

Accordingly the current study consisted of four subgroups: 1) Normal Language (NL) (n = 25); 2) Suspected Expressive LD (shortened Suspected LD) (n = 10); 3) Expressive and/or Phonological LD (shortened Expressive LD) (n = 15); and 4) Expressive and Receptive LD (n = 10).

Three of the 35 children with LDs had been assigned a comorbid diagnosis of ADHD. In the control group one child was assigned with a diagnosis of ADHD, one child had been assigned a comorbid diagnose of Other Disorder in Childhood NOS and one child had been assigned a comorbid diagnose of Defiant Disorder NOS.

Video transcriptions

In addition to the subdividing into different groups of LDs, continuous language measures of all the children were collected. The availability of valid and reliable instruments for assessing language development in general is very limited (Verboeven and Balkom, 2004). It was chosen to measure language abilities by transcribing the

child's expressive language from a ten-minute video sequence. The transcriptions were made according to the Systematic Analyses of Language Transcripts (SALT) protocol (Miller and Chapman, 2004). The video sequence selected was a ten minute sequence of the child in interaction with the mother of the child. This situation was selected because it provided the most natural situation for the child's language production available from the two day long ABC assessment, as suggested by the SALT protocol (Miller and Chapman, 2004). In this situation the mother and child was asked to choose between different toys to play with. The mother and child were then asked to play with one toy at a time and switch toys after five minutes. The play activities included play like; discussing books, playing with "Gråtass" or "Playdo" etcetera. The SALT program provides several measures of expressive language ability including; measures of semantics, grammatical abilities and lexical data. For the purpose of this study it was chosen to focus on Mean Length of Utterance in words (MLU) and Intelligibility. Due to the young age of the children comprehensive grammatical measures were not included.

Language Measures

MLU is commonly used to measure expressive language (Loeb et al., 2000, Dethorne et al., 2005). It is considered to be a reliable and valid index of general language development from age 3 to 10 (Rice et al., 2006). MLU was calculated in SALT analyses based on the intelligible and complete utterances produced in the 10 minute sequence.

Intelligibility in this study refers to the proportion of a child's output that a listener can readily understand. It has been used as an index of overall speech adequacy by researchers and clinicians (Gordon-Brennan and Hodson, 2000). By 3-years of age 75% of a child's spontaneous speech should be intelligible to strangers (Flipsen, 2006, Coplan and Gleason, 1988). Thus, 75 % intelligibility was used as a cut-off in some of the analyses in the current study differentiating between high and low intelligibility.

The SALT analyses calculate how many percent of the child's utterances that are intelligible based on the transcribers differentiation between intelligible and unintelligible utterances. An utterance was marked unintelligible if the transcriber could not understand the utterance after at least 3 reruns of the tape (in accordance to SALT procedures).

Calculating words or utterances understood from a continuous-speech sample is considered to be the most valid method to measure intelligibility (Kent et al., 1994).

Inter rater reliability

The transcriptions were performed by the author of this thesis in collaboration with two other master students in psychology, all trained especially for the video transcriptions. In order to estimate the inter-coder reliability the three coders rated 20% of the transcripts independently and calculated the Interclass Correlation Coefficient (ICC) on each of the measures. The ICC was .85 on ratings of intelligibility, and .87 on ratings of MLU.

Measures of ADHD Symptoms

The aim of this study was to measure behaviour symptoms on a continuous scale reflecting what is defined as ADHD symptoms in by DSM IV text revision (APA, 2000). The goal was not to determine a diagnosis of ADHD or to determine specific subtypes of ADHD. Accordingly, the results are based on the total scale scores reflecting both Hyperactive/Impulsive and Inattentive symptoms as displayed in table 2. ADHD symptoms were used as a continuous measure because it provides more information than dichotomized scores. Separate Correlations were performed using Pearson product-moment correlation coefficient on the subscales of inattention and hyperactivity/impulsivity with the language measures. The correlations were no different from the total ADHD scale, therefore only the results of the analyses with the total scale are reported in the present thesis.

The ADHD-symptoms were collected from the ADHD section of the Preschool Age Psychiatric Assessment (PAPA) interview (Egger et al., 1999). The interviewers were research assistants trained and certified in the use of the PAPA interview at the ABC study (author included). The PAPA is a structured parent interview for assessing psychiatric symptoms, symptom scale scores and diagnoses in preschool children age 2 through 5 years (Egger et al., 2006). The PAPA has been tested to reliably assess ADHD diagnosis and symptom scales scores (Egger et al., 2006). The kappa for the diagnosis of ADHD has been reported to be 0.74 and the Intraclass Correlation Coefficient (ICC) for

an ADHD scale score was 0.80 (Egger et al., 2006). In the current study the total ADHD scale had a good internal consistency with a Cronbach alpha coefficient of .90.

The ADHD scale in PAPA contains several items tapping symptoms of Hyperactivity, Impulsivity and Attention difficulties. It is structured similarly to the DSM IV criteria of ADHD. Table 2 shows the total ADHD symptoms included. Each item was rated 0 or 1, giving a maximum possible score of 20 ADHD symptoms in total. In accordance with the DSM IV (APA, 2000) a symptom of ADHD was only scored by the PAPA interviewer as present if; it occurred in at least two activities and, at least in some situations was uncontrollable by the child or by adult admonition (Egger and Angold, 2006). Three mothers of the participants did not complete the PAPA interview and was therefore missing in the analyses of ADHD symptoms.

Table 2

Items of ADHD symptom included in the total ADHD symptom-scale (PAPA).

<i>ADHD symptoms (PAPA)</i>	
Hyperactive/Impulsive Symptoms	Inattentive Symptoms
1 Often fidgets or squirms	1 Often fails to attend to details
2 Often leaves seat	2 Often difficulty sustaining attention
3 Often runs/climbs excessively	3 Often does not seem to listen
4 Often has difficulty playing quietly	4 Often does not follow instructions
5 Often “on the go”/”driven by a motor	5 Often difficulty organizing tasks
6 Often talks excessively	6 Often avoids sustained mental effort
7 Often blurts answers	7 Often loses things
8 Often difficulty waiting turn	8 Often easily distracted
9 Often interrupts or intrudes	9 Often forgetful
10 Impetuous behavior	
11 Accident-prone	
Total ADHD items = 20	

Nonverbal IQ Measure

Nonverbal IQ scores were obtained from the Stanford Binet 5th edition (SB5) (Roid, 2003). Total composite scores (mean= 100, SD=16) are calculated for both verbal and nonverbal IQ, but for the purpose of the current study the nonverbal IQ standard scores were applied. SB5 has not been standardized on Norwegian samples. Two children did not complete the SB5 and, thus, were missing from the analyses.

Socio Economic Status (SES)

In order to control for the possibility that the LD group would be drawn from families with lower socio-economic strata, information on parental SES factors was collected from MoBa questionnaires. The mothers and fathers reported their level of completed education on a scale ranging from 1-6 and their level of income on a scale ranging from 1-7 (see table 1). Because the SES variables constituted continuous scales from low to high levels, it was chosen to keep the original scales without further subdividing and compare the means in the two groups. The LD and NL group showed similar mean scores on both scales as displayed in table 2. Independent samples t-tests were conducted to detect any difference in SES factors between the groups. No difference was detected on any of the scale measured at a significance level of .05.

Statistical Analyses

All analyses were conducted in SPSS version 14.0. The statistical techniques used were: independent samples t-test, one-way between-groups analyses of variance (one-way between-groups ANOVA), Pearson's Product-Moment Correlations, and two way between-group analyses of variance (two-way between-groups ANOVA). Because of violations of assumptions of normality on all the variables, both parametric and nonparametric tests were performed in preliminary analyses. The nonparametric test used to compare means was; Mann Whitney U Test, and to explore correlations; Spearman's Rank Order Correlation. No differences were detected between the results on the parametric tests and the nonparametric test. Thus, only the results of the parametric tests are reported. Missing cases were excluded pair-wise.

Results

The current study was concerned with whether there would be higher means for ADHD symptoms in children with language disorders (LDs) compared to children with normal language development (NL). If so, the study aimed at exploring possible associations between language characteristics such as, subtype of LD, or levels on expressive language measures and ADHD symptoms. In addition, it was explored whether nonverbal

IQ scores would be related to the plausible associations between language measures and ADHD symptoms.

The presentation of the results will be in five parts. First, the LD group and the NL group were compared on ADHD symptoms. Second, the different subgroups of LD were compared on ADHD symptoms. Third, the group means for expressive language measures were compared in the subgroups. Fourth, associations between continuous language measures, nonverbal IQ and ADHD symptoms were explored. Finally, interaction effects were explored. Additional analyses were conducted to include comparison on nonverbal IQ measures.

Group Comparison on ADHD Symptoms

The first aim was to see whether there would be more ADHD symptoms among children with a diagnosis of or suspected language disorders (LDs) compared to children with normal language (NL). An independent sample t-test was conducted to investigate whether the LDs group would display higher means for ADHD symptoms compared to the NL group. The results showed that children with LDs were reported to display significantly higher means of ADHD symptoms compared to the NL group [$t(57) = 2.54$, $p = .015$]. On average LD children displayed 2.9 more ADHD symptoms compared to the NL group. The magnitude of the difference in means was medium strong ($\eta^2 = .11$) (as interpreted by Cohen 1988 guidelines). The means, standard deviations, minimum-maximum scores of ADHD symptoms in the LD and NL group are displayed in table 3, as well as the result of the t-test and the effect size.

Table 3
Group difference for ADHD symptoms between children with LDs and NL.

	<i>LD</i> <i>(N=32)</i>	<i>NL</i> <i>(N=25)</i>	<i>T-test</i>	<i>Effect size</i>
ADHD symptoms			t	η^2
M	3.9	1.0	2.54*	.11
SD	4.2	1.6		
Min-Max	0-18	0-6		

* $p < .05$.

Different Subtypes of Language Diagnoses and ADHD Symptoms

The next question concerned whether ADHD symptoms would be associated with any subgroups of LD. It was explored whether the mean rate for ADHD symptoms would vary between different subgroups of LD. The four groups were: children with no diagnose (NL), children with suspected LD, children with expressive LD (Exp LD) and children with expressive/receptive LD (Exp/Rec LD). A one-way ANOVA was conducted to explore the impact of groups on ADHD symptoms. Because of violation of the homogeneity of variance assumption, the Brown-Forsythe robust test of equality of means was applied. A significant difference in ADHD scores between the groups was detected [F(3, 15)=3.4, p=.046]. Post-hoc comparisons using the Tukey HSD test indicated that the expressive/receptive group was the only group showing significantly higher means for ADHD symptoms compared to the control group. The suspected LD and expressive LD did not differ significantly from the control group. Accordingly, when exploring the differences between the four groups on ADHD symptoms the expressive/receptive LD was the subtype of language disorders with the highest mean for ADHD symptoms. The expressive/receptive group did also show significantly higher means compared to the expressive LD group. The difference between the expressive/receptive LD and the suspected LD was not significant. The means, standard deviations and the minimum and maximum ADHD symptoms in the four groups are displayed in table 4.

Table 4

Means, Standard Deviations and Minimum-Maximum scores for ADHD symptoms in subgroups of LD.

	<i>NL</i> (N=25)	<i>Suspected LD</i> (N=8)	<i>Exp LD</i> (N=15)	<i>Exp/Rec LD</i> (N=9)
ADHD symptoms				
Mean	1.0	2.6	1.7	5.8
SD	1.6	3.0	2.4	6.2
Min-Max	0-6	0-9	0-9	0-18

Different Subtypes of Language Diagnoses and Expressive Language Measures

So far it was discovered that ADHD symptoms were more associated with the expressive/receptive type of language disorder compared to the other groups. In order to determine if the expressive/receptive type of disorder would be different from the other groups on the measures of expressive language abilities, intelligibility or MLU, the group means were compared. First, a one-way between-groups ANOVA was conducted to explore the impact of groups on intelligibility. Because of violation of the homogeneity of variance assumption the Brown-Forsythe robust test of equality of means was applied on the analyses to see if the differences between the groups were robust.

There was a significant difference in intelligibility between the groups [$F(3, 25)=18.54, p=.0005$]. The Post hoc comparisons using the Tukey HSD test indicated that all the LD groups were significantly different from the control group but that they did not differ from each other for means of intelligibility. Table 5 shows the means on the measure of intelligibility in the four groups.

Table 5

Group means and Standard deviations on Intelligibility (INT) and Mean Length of Utterance (MLU) in the NL group and the LD groups.

	<i>NL</i> <i>(N=25)</i>	<i>Suspected LD</i> <i>(n= 10)</i>	<i>Exp LD</i> <i>(n= 15)</i>	<i>Exp/rec LD</i> <i>(n=10)</i>
	M (SD)	M (SD)	M (SD)	M (SD)
INT	94.6 (4.9)	81.1 (6.9)	72.7 (10.0)	76.7 (13.7)
MLU	2.9 (.66)	2.1 (.58)	1.6 (.32)	1.8 (.28)

Secondly, the groups were compared on MLU scores. The same pattern as reported for intelligibility scores was detected. A significant difference was observed between the groups on MLU scores [$F(3, 56)=22.35, p=.0005$], and the post hoc comparison indicated significantly lower means on MLU for the LD groups compared to the control group. The suspected LD, expressive LD and the expressive/receptive LD did not differ significantly from each other. Thus, the LD groups spoke on average in shorter utterances (as measured by MLU) compared to the control group, but the LD groups showed similar mean scores. The means and standard deviations in the four LD groups on intelligibility and MLU are displayed in table 5.

Association between continuous measures and ADHD symptoms

Next, the associations between continuous language measures and ADHD symptoms were explored. In addition nonverbal IQ scores were included to investigate whether nonverbal IQ would be related to ADHD symptoms. The relationship between the variables was investigated using the Pearson product-moment correlation coefficient.

As displayed in Table 6 there was a medium strong negative correlation (Cohen, 1998) between ADHD symptoms and intelligibility [$p=.001$], with high levels of ADHD symptoms associated with lower levels of intelligibility. MLU was not significantly correlated with ADHD symptoms [$p>.05$]. There was a strong positive correlation between MLU and intelligibility [$p<.001$] with high levels of MLU associated with high levels of intelligibility. No significant relationship was detected between ADHD symptoms and nonverbal IQ [$p>.05$] indicating that the levels of ADHD symptoms varied independently of the levels of nonverbal IQ. Comparing the nonverbal IQ measure to the language measures a significant moderate relation was detected with intelligibility [$p=.008$] and MLU [$p=.002$]. The language measure with the strongest relation to ADHD symptoms was the measure of intelligibility. Table 6 displays the correlations between ADHD symptoms and the language measures; Intelligibility and Mean Length of Utterance (MLU), and nonverbal IQ (NVIQ).

Table 6

Pearson Product-Moment Correlations between ADHD symptoms, Intelligibility (INT), Mean Length of Utterances (MLU) and Nonverbal IQ (NVIQ).

Measures	1	2	3
(1) ADHD symptoms			
(2) INT	-.45**		
(3) MLU	-.24	.62**	
(4) NVIQ	-.13	.35**	.40**

N = 57

** Correlation is significant at the 0.01 level (2-tailed).

Interactions between Intelligibility and Subtypes of LDs

As demonstrated in the previous analyses an association was detected between ADHD symptoms and expressive/receptive LD. Further, ADHD symptoms were also significantly correlated with intelligibility. In order to explore the possible impact of intelligibility and the different groups of LD on ADHD symptoms, a two-way between-groups ANOVA was conducted. The children were divided into the same four LD groups as before. In addition the intelligibility variable was divided into categories of high and low intelligibility (low intelligibility: <75% intelligible; high intelligibility: >75% intelligible). The cutoff at 75% intelligibility was set according to the differentiation described in method.

The analyses showed a significant interaction effect between level of intelligibility and type of language disorder [$F(2, 57)=10.52, p=.0005$]. The effect size was large (partial eta squared .30) (Cohen, 1988). This indicates that the difference between the groups was dependent on the level of intelligibility. Figure 1 displays the mean ADHD symptoms in the different LD groups depending on the level of intelligibility.

When interpreting the figure it is clear that the high mean scores in the expressive/receptive LD group was dependent on level of intelligibility. To detect if any differences between the LD groups would be present in the children with high intelligibility, a one-way between-groups ANOVA was conducted in the children with high intelligibility separately. If the difference between the groups on ADHD scores would be dependent on low levels of intelligibility it was expected no difference between the groups comparing only children with high intelligibility. The results showed no difference in mean scores for ADHD symptoms between the groups in the children with high intelligibility [$F(3, 39)=2.1, p=.12$]. Accordingly the high levels of ADHD symptoms observed in the expressive/receptive LD group were found in the children with low intelligibility. No children in the control group were low on intelligibility and only one child in the suspected LD group was low on intelligibility. The expressive LD and the expressive/receptive LD was equally distributed on low and high levels of intelligibility, with half of the children low on intelligibility and half of the children high on intelligibility. An independent samples t-test was conducted between the means in the

expressive LD compared to the expressive/receptive LD in the children low on intelligibility separately. The expressive LD group showed significantly lower means on ADHD symptoms ($M=2.0$, $SD=2.9$) compared to the expressive receptive LD group [$M=9.8$, $SD=5.5$; $t(11)= -3.39$, $p=.01$]. The magnitude of the difference in the means was large ($\eta^2=.51$) (Cohen, 1988).

Children in the expressive/receptive LD group that were less than 75 % intelligible (low) showed significantly higher means of ADHD symptoms [$M=9.8$, $SD=5.5$] compared to children within the expressive/receptive LD group that were more than 75 % intelligible (high) [$M=.75$, $SD=.96$; $t(9)=-3.24$, $p=.01$]. The effect size was large ($\eta^2=.60$). This indicates that the higher mean scores on ADHD in the expressive/receptive group were dependent on the level of intelligibility.

Interaction between intelligibility and subtypes of LD

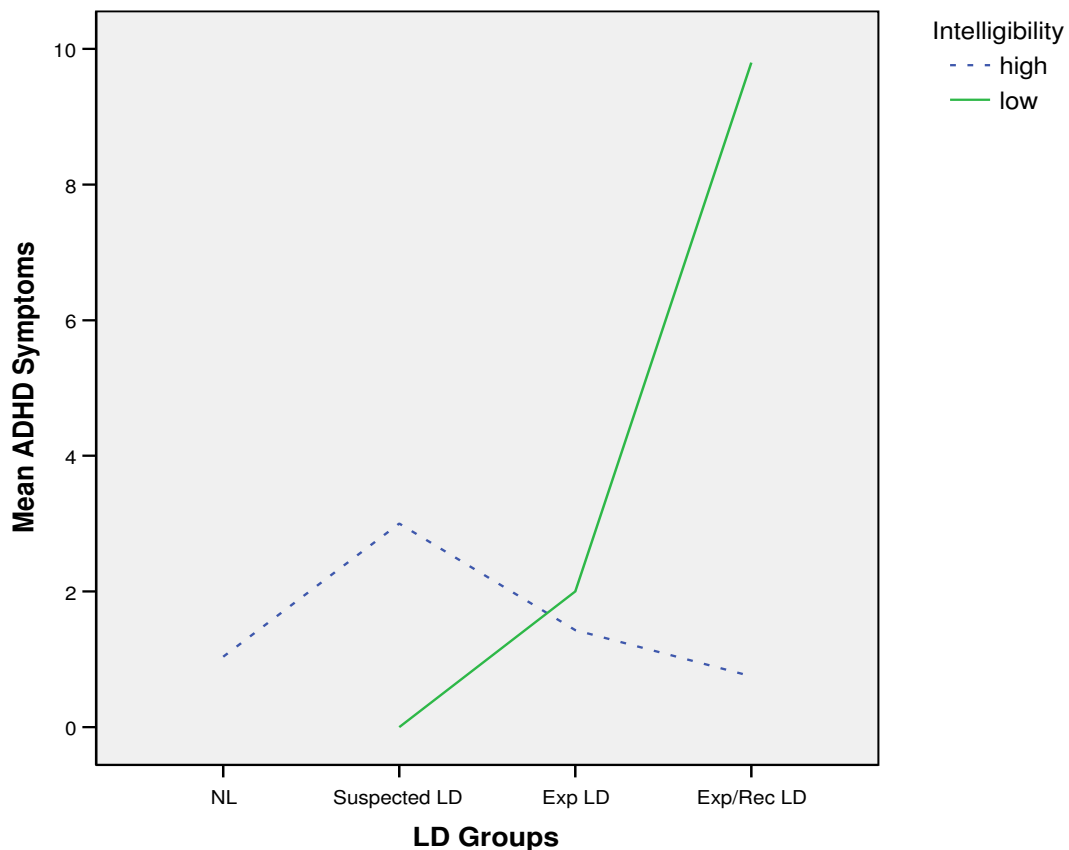


Figure 1

Mean ADHD symptoms in the LD Groups depending on level of intelligibility.

Additional analyses

In order to see whether the difference observed in ADHD symptoms within the expressive/receptive group would be reflected in a similar difference in nonverbal IQ scores, an independent samples t-test was conducted. The means on nonverbal IQ as measured by the SB5 was compared for high and low intelligibility within the expressive/receptive LD group. No significant difference was detected on nonverbal IQ between the low intelligibility [M=89, SD=8.7] and the high intelligibility group [M=81, SD=6.3; $t(9)=-1.6$, $p=.15$] within the expressive/receptive LD group. Accordingly the significant difference on ADHD symptoms between high and low intelligibility in the expressive/receptive LD group could not be explained by differences in nonverbal IQ.

Discussion

Main Findings

There were three main findings of this study:

1. Children with language disorder (LDs) or suspected LD at three years of age had higher means for ADHD symptoms than children with normal language development (NL).
2. High means of ADHD symptoms were associated with expressive/receptive LD *and* low intelligibility.
3. The associations observed between LD and ADHD symptoms were not related to Nonverbal IQ scores.

The first aim of this study concerned whether children suspected of or diagnosed with LDs at the age of 3 displayed significantly more ADHD symptoms compared to children with normal language abilities at the same age. The finding was that children with LDs displayed significantly more symptoms compared to the controls. The early emergence of ADHD symptoms in children with LDs has also been reported in earlier studies. However, previous research addressing this issue has been criticized for neglecting the differentiation between LDs and autism by using too wide inclusion criteria for LDs (Willinger et al., 2003). In this study the thorough clinical assessment differentiated

children with autism or other pervasive disorders from children with LDs, such that the reported finding can not be attributed to an effect for autism, autism spectrum disorder or other pervasive disorders.

In addition the children with LDs in the current study represent a quite unique group of children; early diagnosed with LDs without having been recruited from a speech and language clinic. The potential bias involved in studying children from speech and language clinics is that this group could possibly represent more severe cases, with higher probability of comorbid patterns (Rutter and Mawhood, 1991). The children in the current study were recruited from a population-based study and were therefore less likely to represent more severe cases. This assumption is in accordance with earlier studies, which have reported that differences in ADHD symptoms between children with LDs and NL are present not only in clinical samples but also in population based samples (Tomblin et al., 2000). However, in the study by Tomblin and colleagues, ADHD symptoms were suggested to be mediated by reading disorders in the 8 year old children. The authors suggested that ADHD symptoms would develop as a consequence of the reading disorder and therefore not be present from early age. If the findings of the current study represent early comorbid patterns of LD and ADHD it suggests that comorbid patterns are not necessarily mediated by reading disorders and can be apparent early on.

The occurrence of ADHD symptoms among LD children was compared to a control group of randomly drawn children within the same age range. Earlier studies reporting ADHD symptoms in children with LDs, but without the employment of a comparison group, might have reported ADHD symptoms commonly occurring among preschoolers in general. Thus, the current finding, that higher rates of ADHD symptoms are observable in young children with LD than in a control group, is an important one.

Few earlier studies have controlled for the possibility that LD and NL children might be drawn from different socio-economic strata. Yet, this has been suggested to be a possible confounding factor in the observation of associations between LDs and ADHD (Stevenson, 1996). In the current study, parents' socio-economic status was compared and was found to be the same in the LD and control groups. Accordingly, the differences observed between the groups are not likely to reflect differences in socio-economic status.

In sum the differences in ADHD symptoms between the two groups supports earlier studies suggesting that children with LDs display more ADHD symptoms than NL children and that these differences can be observed already by the age of 3 years. Even if the mere co-occurrence of early symptoms of LDs and ADHD has been reported in earlier studies and was confirmed in the current study, the association between language and ADHD has not been well understood.

Accordingly, the second aim of this study concerned the exploration of whether ADHD symptoms in children with LDs would be associated with categorical language features, such as type of disorder, or with degree of difficulty or competency as measured using continuous language measures. No previous study has considered both type of LDs and continuous language measures in studying associations between LD and ADHD.

Previous findings suggest that ADHD symptoms are more often associated with expressive/receptive disorders than simple expressive disorders in children by middle childhood (Goodyer, 2000). This was also the case in the current study, suggesting that these findings also apply to younger children. However, not all children within the expressive/receptive type of disorder displayed high means for the ADHD symptoms. Looking more closely at the pattern of symptoms in the expressive/receptive group, an interesting differentiation was detected between children with high versus low intelligibility. Low intelligibility was associated with high means for ADHD symptoms while high intelligibility was associated with low means for ADHD symptoms. This provides new evidence, that children within the expressive/receptive disorder group who have a high ADHD score can be differentiated from those in the group with low ADHD scores, on the basis of intelligibility. The children with high intelligibility had no more ADHD symptoms than the control group or the other children with LDs. Thus, the combination of receptive difficulties and expressive difficulties was of its self not associated with more ADHD symptoms, but having combined receptive and expressive difficulties *and* being difficult to understand (low intelligibility) *was* associated with more ADHD symptoms. It could be argued that these children represent the most severely impaired children, at one end of a continuous scale of language problems, where the combination of problems in several areas of language is associated with the most severe impairment (Snowling et al., 2006).

Earlier studies focusing on continuous measures have reported moderate (Plomin et al., 2002) or low (Stevenson and Richman, 1978) correlations with behavior measures at the preschool age. The present study confirms that some language measures (MLU) are low or insignificantly correlated to ADHD symptoms and others (Intelligibility) are moderately related to ADHD symptoms across the whole sample of three-year-old children. If low scores on expressive measures alone indicate high rates of ADHD symptoms, then one would expect to find high levels of ADHD symptoms in the expressive language group in children with low rates on language measures. This was not the case in the current study. The children within the expressive LD group showed lower means on ADHD symptoms compared to the expressive/receptive group, regardless of whether they were low or high on intelligibility. This suggests that higher associations between language measures and ADHD symptoms will be observed in more severe cases of LDs if the children have both expressive and receptive difficulties. The finding by Irwin and colleagues (2002) that children with expressive LDs without receptive difficulties did not display significantly more externalizing behaviors, including symptoms of hyperactivity/impulsivity and inattention, compared to children with normal language development is in accordance with this assumption.

Because ADHD symptoms in children with a language diagnosis were related to the expressive/receptive type of disorder in the current study, it may be argued that expressive/receptive type of disorder with low intelligibility, identified here as having the highest means for ADHD symptoms, represents a distinct subtype of LDs that is more at risk of ADHD. Alternatively, the fact that ADHD symptoms *are* reported as occurring within the expressive subtype of LDs in some studies (Willinger et al., 2003) excludes the possibility that receptive difficulties are necessary for language disorders to be associated with ADHD symptoms. Accordingly the current results can only be interpreted as tendencies of more ADHD symptoms associated with the expressive/receptive type of LDs in children with low intelligibility. It can not exclude the possibility that ADHD occur in other types of LDs at different ages or in different samples. Further so, the current findings suggest that intelligibility is more associated with ADHD symptoms compared to MLU. This could be explained by short utterances produced in both LD and NL children at this age, and thus small variation in the measure. However, the possibility

that other measures not included in this study might be similar, or more, related to ADHD symptoms compared to intelligibility is plausible.

The third main finding of the current study was concerned with whether the associations between language measures and ADHD symptoms would be related to nonverbal IQ scores. The results showed that the nonverbal IQ scores were not correlated with ADHD symptoms and the differences in ADHD symptoms within the expressive/receptive LD group was not associated with lower nonverbal IQ measures but rather with language measures (intelligibility). Few other studies have compared the relationship between verbal measures and ADHD symptoms to the relation between nonverbal measures and ADHD symptoms. In the study by Plomin and colleagues (2002), nonverbal measures were reported to be moderately correlated with behavior measures and to account for the moderate association between language measures and behavior measures in children at the same age as in the current study. There are several possible explanations for the difference between the results of the current study and those of Plomin and colleagues. First, the study by Plomin and colleagues used a parent-administered subtest to measure nonverbal abilities. Therefore, it is possible that parents who rated children low on language ability also rated them low on nonverbal cognitive abilities. Another option is that the Stanford Binet test used in the current study measures different aspects of nonverbal abilities than the Parent Report of Children's Abilities (PARCA) used by Plomin and colleagues (2002).

Causal and Directional Interpretations

The main findings of the current study support an association between LD and ADHD symptoms for some children with LDs. Because experimental accounts that could shed light on the causal mechanisms for the association between LDs and ADHD symptoms are unavailable and considered difficult to establish (Caron and Rutter, 1991), the causes of the observed association can only be speculated. Given the variables included in the current study, it seems that the children with the most ADHD symptoms represent the most language impaired children in the sample, without representing the most generally cognitively impaired.

First the possibility that the Language Disorder caused the ADHD symptoms needs to be considered. Because ADHD symptoms are thought to be neurologically based (Bradshaw, 2001) this would suggest that the ADHD symptoms reported do not reflect ADHD. A variant of this hypothesis is that the co-occurrence of ADHD symptoms in some children with LDs might reflect a behavioral “phenocopy” of ADHD, without its core or primary characteristics (Pennington et al., 1993). The difficulty of expressing thought and needs in combination with difficulties in understanding others wants and needs might have resulted in behavior similar to ADHD, for example running around, having difficulty staying on task, difficulty concentrating etc.

On the contrary, it is also possible that the ADHD symptoms were precursors of the Language Disorder (Camarata and Gibson, 1999). According to the transactional model of language acquisition, children learn language through interaction with their parents or caregivers. It is possible that the child’s inattentive or hyperactive-impulsive behavior interfered with joint attention activities and the parent’s expansion and extension of the child’s language may have been ineffective (Dreyer, 2006). Children with symptoms of impulsive behavior, hyperactivity and inattention might have experienced a difficult language learning situation resulting in the more serious language impairment observed in the children with co-occurring ADHD symptoms. This explanation is often used to explain why children with ADHD have language development deficits. However, based on the assumptions that LDs are neurologically based and on the early age of the children with LDs, it seems unlikely that this explains the co-occurring symptoms in the present study. It is also important to consider the effect each behavior might have on the other, creating interaction. No matter which difficulty came first, language impairment is likely to influence behavior and behavior is likely to affect the language learning in these preschool years.

Based on the assumptions that both LDs and ADHD are neurologically based, it has also been suggested that both behaviors are a result of a common underlying neurological deficit (Tannock and Schachar, 1996). This has been suggested by some to reflect a general immaturity (Benasich et al., 1993). Others have maintained that it reflects a more specific cognitive deficit. The hypothesis of Ullman and Pierpont (2005) previously mentioned represents the latter viewpoint. They suggest that Language

Disorders and ADHD may both be considered disorders affecting the brain structures of the procedural system, in particular the frontal/basal ganglia circuits. They assume that LD and ADHD involve overlapping but partially distinct, neural structures and therefore overlapping, but partially distinct, cognitive functions. The impaired cognitive functions are therefore suggested to be more specific. For example, they predict that children with this deficit will have difficulties in procedural memory learning tasks but not in declarative memory tasks. Such difficulties might not be reflected on the nonverbal IQ measure used in the current study. Accordingly, the current finding stands in contrast to the view that children with LD and ADHD symptoms at an early age are generally neurologically impaired, but it does not contradict the possibility that specific cognitive impairments underlie the co-occurring symptoms as proposed by Ullman and Pierpont (2005).

Limitations

The number of children with LDs in the current study was not small compared to other studies of children with language disorders. However, when splitting the LD group into different subgroups it resulted in uneven groups with small N. Applying statistical analyses on small group and groups with uneven N could be problematic and the results need to be interpreted with care. Yet, small samples reduce the chance of statistically significant result and thus increase the risk of rejecting a significant group difference when it is actually there (Pedhazur and Schmelkin, 1991). Consequently, the significant difference obtained with the small sample size in the current study indicates that this is a robust difference that could likely occur in larger samples. Still, the results have to be replicated in larger samples to determine whether the results could be generalized to other samples of children with LDs.

A second limitation of the current study is that the ADHD symptoms reported rely solely on interviews with the children's mothers. It is recommended that symptoms of ADHD are collected from several sources, for example by teacher reports, or in this case kindergarten teachers. However, several studies have reported that if any difference in rates is observed between information sources, it is most often the teacher who rates the child more highly on measures of ADHD symptoms and other behavioral problems

(Redmond and Rice, 2002). The ADHD symptoms reported in the current study are therefore unlikely to reflect an overestimation.

Third, the control group in the current study was not matched on sex distribution. The proportion of boys was 80 % in the LD group compared to 52 % in the NL group. Because ADHD symptoms are more common in boys compared to girls in preschool age, more ADHD symptoms could be expected in the LDs group for this reason alone. Future studies should consider matching the NL group to the LD group on gender.

Another limitation of the current study is the cross sectional assessment of the children. The problems observed could be transcending, that is, the child is “growing out” of the problems. Longitudinal designs are necessary to determine whether the problems will sustain over time. However, because the most serious language impaired children are often the children reported to have sustained difficulties later on (Goodyer, 2000), it is most probable that the association between severe LD and ADHD symptoms will be maintained.

Because language abilities change rapidly in the early preschool years, measures appropriate to differentiate between the children also change. The identification of rate of intelligibility as an effective measure for differentiating between the children could possibly, therefore, be limited to this particular age group. For this reason, the results of the current study can so far only be generalized to children within the same age range. Other language measures might be more effective in differentiating between children at other points of time in the child’s development.

Future Studies

Future studies will need to continue the exploration of different mechanisms linking language abilities to ADHD symptoms. Many questions remain unanswered. Several different language measures will have to be explored in addition to more specific cognitive measures. When detecting early patterns of associations between problems, it is also necessary to do longitudinal follow-up studies to determine whether the association reflects early comorbid patterns of LD and ADHD in some children, or whether some early symptoms co-occur as a precursor of later, more serious developmental problems not yet apparent at this early age. A follow-up study can determine whether the

differentiation between language disorders and other pervasive disorders, such as Asperger's Syndrome was successful at this early age. A follow-up will also determine whether the children identified with expressive/receptive LD, low intelligibility and co-occurring ADHD symptoms will be the children with sustained language problems later in life. In addition, it could also reveal whether the children without receptive problems, or those with receptive problems but high levels of intelligibility, will be the children found to outgrow the language disorder. All of this will contribute to our understanding of how language disorders possibly relate to ADHD symptoms, and how early patterns of language and behavior symptoms relate to later outcomes for children.

Future research will also require more attention to specific details of the observed association between LD and ADHD. It will be necessary to differentiate between different subtypes of ADHD symptoms to study whether the type and severity of language disorders are related to specific symptoms of ADHD. In larger samples it will also be possible to study whether there are gender differences.

The cause of LD-ADHD co-occurrence will need to be addressed from several perspectives, including analysis of neurological and genetic factors in addition to environmental factors. An interesting future design will be the comparison of children with LDs to children with LDs and ADHD symptoms, and children with only ADHD symptoms. Such comparison could explore whether the children with co-occurring symptoms represents just a more severely impaired group with the same symptoms, as observed in other children with only LD and only ADHD, or if they represent a distinct subtype of LD or ADHD, characterized by special cognitive features, neurological features or genetic features. Exciting new research is evolving in this field related to older children, but no clear conclusions can yet be drawn.

Implications

Previous research has reported co-occurring symptoms of LDs and ADHD at an early age but they have not been able to identify the language characteristics of the children with co-occurring symptoms. The present study suggests that children with co-occurring symptoms can be differentiated from children with language disorders without co-occurring symptoms from an early age. This has methodological implications, suggesting

that research in this area could start from early in development. More specific predictions can be made based on the current findings, guiding future research on the associations between LDs and ADHD.

The early identification of co-occurring symptoms also has important implications for the treatment of language disorders. The current study show that ADHD symptoms are not common in all 3-year-old children with LDs, and that the children with both LDs and ADHD symptoms can be separated from those without ADHD symptoms by looking more closely at the type of language disorder they are present with and how intelligible they are. This implies that interventions can be adjusted already at this early age by focusing on both language development and ADHD behavioral symptoms in children with co-occurring symptoms. Such a focus might contribute to a better outcome than what is usually predicted for these children (as in Clegg et al., 2005).

Concluding remarks

The current study provided new interesting indications that associations between Language Disorders and ADHD symptoms can be observed already in 3-year-olds taking both type of disorder and level of intelligibility into account. In addition, the current study suggests that this can-not simply be accounted for by low, general cognitive functioning as measured by nonverbal IQ.

If early identification of these associations leads to appropriate developmental diagnosis regarding language and behavior problems, early intervention programs might prevent or reduce the possibly negative consequences of having both language difficulties and ADHD symptoms at an early age.

References

- American Psychiatric Association (APA): *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition, Text Revision, Washington, DC, American Psychiatric Association, 2000.
- Bishop, D.V.M. (2002). Speech and Language Difficulties. In M. Rutter and E. Taylor (Eds.), *Child and adolescent psychiatry: Modern approaches*. Oxford, England: Blackwell.
- Bishop, D.V.M. (2004). Specific Language Impairment: Diagnostic Dilemmas. In L. Verhoeven, and H. von Balkom, (Eds.). *Classification of Developmental Language Disorders, Theoretical Issues and Clinical Implications*. Lawrence Erlbaum Associates, Inc. Publishers, Mahwah, New Jersey.
- Beitchman, J.H., Hood, J., Rochon, J., and Peterson, M. (1989). Empirical classification of speech/language impairment in children: II. Behavioral characteristics. *Journal of the American Academy of Child and Adolescent Psychiatry*, 28, 118-123.
- Beitchman, J.H., Wilson, B., Brownlie, E.B., Walters, H., Inglis, A., and William, L. (1996). Long-Term Consistency in Speech/Language Profiles: II. Behavioral, Emotional, and Social Outcomes. *Journal of the American Academy of Child and Adolescent Psychiatry*, 35, 815-825.
- Benasich, A.A., Curtiss, S., and Tallal, P. (1993). Language, learning and behavioral disturbances in childhood: A Longitudinal Perspective. *Journal of the American Academy of Child and Adolescent Psychiatry*, 35, 585-594.
- Bradshaw, J.L. (2001). *Developmental Disorders of the Frontostriatal System: Neuropsychological, Neuropsychiatric and Evolutionary Perspectives*. Hove, East Sussex, Great Britain, Psychology Press.
- Camarata, S.M., and Gibson, T. (1999). Pragmatic language deficits in attention-deficit hyperactivity disorder (ADHD). *Mental Retardation and Developmental Disabilities Research Reviews*, 5, 207-214.
- Cantwell, D.P., and Baker L. (1991). *Psychiatric and Developmental Disorders in Children with Communication Disorders*. Washington DC: American Psychiatric Press.

- Clegg, J., Hollis, C., Mawhood, L., and Rutter, M. (2005). Developmental language disorders – a follow up in later adult life. Cognitive, language and psychosocial outcomes. *Journal of Child Psychology and Psychiatry* 46, 128-149.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Erlbaum.
- Cohen, N.J., Barwick, M.A., Horodezky, M., Vallance, D.D., and Im, N. (1998). Language, achievement, and cognitive processing in psychiatrically disturbed children with previously identified and unsuspected language impairments. *Journal of Child Psychology and Psychiatry*, 39, 865-877.
- Coplan, J., and Gleason, J.R. (1988). Unclear speech: recognition and significance of unintelligible speech in preschool children. *Pediatrics*, 82, 447-452.
- Daley, D. (2006). Attention deficit hyperactivity disorder: a review of the essential facts. *Child: Care, Health and Development*, 32, 193-204.
- Dethorne, L.S., Johnson, B.W. and Loeb, J.W. (2005). A closer look at MLU: What does it really measure? *Clinical Linguistics and Phonetics*, 19, 635-648.
- Dreyer, B.P. (2006). The Diagnosis and Management of Attention-Deficit/Hyperactivity Disorder in Preschool Children: The State of Our Knowledge and Practice. *Current Problems in Pediatric and Adolescent Health Care*, 36, 6-30.
- Egger, H.L. and Angold, A. (2006). Common emotional and behavioral disorders in preschool children: presentation, nosology, and epidemiology. *Journal of Child Psychology and Psychiatry*, 47, 313-337.
- Egger, H.L., Ascher, B.H., and Angold, A. (1999). *The Preschool Age Psychiatric Assessment: Version 1.1. Unpublished Interview Schedule*. Durham, NC: Center for Developmental Epidemiology, Department of Psychiatry and Behavioral Sciences, Duke University Medical Center.
- Egger, H.L., Erkanli, A., Keeler, G., Potts, E., Keith Walter, B., and Angold, A. (2006). Test-Retest Reliability of the Preschool Age Psychiatric Assessment (PAPA). *Journal of American Academy of Child and Adolescent Psychiatry*, 45, 538-549.
- Flipsen, P., Jr. (2006). Measuring the intelligibility of conversational speech in children. *Clinical Linguistics and Phonetics*, 20, 303-312.
- Goodyer, I.M. (2000). Language difficulties and psychopathology. In D.V.M. Bishop,

- and L.B. Leonard, (Eds.). *Speech and language impairment in children: causes, characteristics, intervention and outcome*. Psychology Press, Taylor and Francis Group, Hove, New York.
- Gordon-Brannan, M., and Hodson, W.B. (2000). Intelligibility/Severity Measurements of Prekindergarten Children's Speech. *American Journal of Speech – Language Pathology*, 9, 141-150.
- Heim, S., and Benasich, A.A. (2006). Developmental Disorders of Language. In D. Cicchetti, and D.J. Cohen, (Eds.). *Handbook of Developmental Psychopathology Second Edition Volume Three: Risk, Disorder and Adaption* (268-316). John Wiley and Sons Inc., Hoboken, New Jersey.
- Irwin, J.R., Carter, A.S., and Briggs-Gowan, M. (2002). The Social-Emotional Development of “Late-Talking” Toddlers. *Journal of the American Academy of Child and Adolescent Psychiatry*, 41, 1324-1332.
- Kent, R. D., Miolo, G., and Bloedel, S. (1994). The intelligibility of children's speech: A review of evaluation procedures. *American Journal of Speech-Language Pathology*, 3, 81-95.
- Leonard, L.B. (1998). *Children with Specific Language Impairment*. A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England.
- Levy, F., Hay, D.A., and Bennett, K.S. (2006). Genetics of Attention Deficit Hyperactivity Disorder: A current review and future prospects. *International Journal of Disability, Development and Education*, 53, 5-20.
- Loeb, D.F., Kinsler, K., and Bookbinder, L. (2000). *Current language sampling practices in preschools*. Poster presented in the Annual Convention of the American Speech-Language-Hearing Association, Washington, D.C.
- Magnus, P., Irgens, L.M., Haug, K., Nystad, W., Skjærven, R., Stoltenberg, C. and The Moba Study Group. (2006). Cohort profile: The Norwegian Mother and Child Cohort Study (MoBa). *International Journal of Epidemiology*, 35, 1146-1150.
- McCabe, P.C. (2005). Social and behavioral correlates of preschoolers with specific language impairment. *Psychology in the schools*, 42, 373-387.
- Miller, J.F. and Chapman, R. (2004). Systematic Analysis of Language Transcripts

- (Version 7.0) [Computer software]. Madison, WI: Language Analyses Lab, University of Wisconsin.
- Miniscalco, C., Nygren, G., Hagberg, B., Kadesjø, B., Gillberg, C. (2006). Neuropsychiatric and neurodevelopmental outcome of children at age 6 and 7 years who screened positive for language problems at 30 months. *Developmental Medicine and Child Neurology*, 48, 361-366.
- Pavuluri, M.N. and Luk, S.L. (1996). Patterns of preschool behaviour problems in New Zealand, using the Behaviour Check List. *Journal of Paediatric Child Health*, 32, 132-137.
- Pedhazur, E.J. and Schmelkin, L.P. (1991). *Measurement, Design and Analysis: An Integrated Approach*. Lawrence Erlbaum Associates, Publishers, Hillsdale, New Jersey.
- Pennington, B.F., Groisser, D., and Welsh, M.C. (1993). Contrasting cognitive deficits in attention deficit hyperactivity disorder versus reading disability. *Developmental Psychology*, 29, 511-523.
- Plomin, R., Price, T.S., Eley T.C., Dale P.S., Stevenson J. (2002). Associations between behaviour problems and verbal and nonverbal cognitive abilities and disabilities in early childhood. *Journal of Child Psychology and Psychiatry*, 43, 619-633.
- Redmond, S.M. and Rice, M.L. (2002). Stability of Behavioral Ratings of Children with SLI. *Journal of Speech, Language, and Hearing Research*, 45, 190-201.
- Rice, M. L. (2000). Grammatical symptoms of specific language impairment. In D.V.M Bishop, L.B. Leonard, (Eds.). *Speech and language impairment in children: causes, characteristics, intervention and outcome*. Psychology Press, Taylor and Francis Group, Hove, New York.
- Rice, M.L., Redmond S.M. and Hoffman L. (2006). Mean Length of Utterance in Children With Specific Language Impairment and in Younger Control Children Shows Concurrent Validity and Stable and Parallel Growth Trajectories. *Journal of Speech, Language, and Hearing Research*, 49, 793-808.
- Roid, G.H. (2003). *Stanford-Binet Intelligence Scales, Fifth Edition*. Itasca, IL; Riverside Publishing.
- Rutter, M. and Mawhood L. (1991). The long term sequelae of specific development

- disorders of speech and language. In M. Rutter, and P. Casaer, (Eds). *Biological Risk Factors in Childhood and Psychopathology*. Cambridge University Press.
- Sagvolden, T., Aase, H., Borgå Johansen E. and Russel, V.A. (2005). A dynamic developmental theory of attention-deficit/hyperactivity disorder (ADHD) predominantly hyperactive/impulsive and combined subtypes. *Behavioral and Brain Sciences*, 28, 397-468.
- Snowling, M.J., Bishop, D.V.M. Bishop, Stothard, S.E., Chipchase, B. and Kaplan, C. (2006). Psychosocial outcomes at 15 years of children with a preschool history of speech-language impairment. *Journal of Child Psychology and Psychiatry*, 47, 759-765.
- Stefanatos, G.A., and Baron, I.S. (2007). Attention-Deficit/Hyperactivity Disorder: A Neuropsychological Perspective Towards DSM-V. *Neuropsychological Review*, 17, 5-38.
- Stevenson, J. (1996). Developmental changes in the mechanisms linking language disabilities and behavior disorders. In J.H. Beitchman, N.J. Cohen, M.M. Konstantareas, and R. Tannock, (Eds.). *Language, learning, and behavior disorders Developmental, biological, and clinical perspectives*. Cambridge University Press.
- Stevenson, J. and Richman, N. (1978). Behaviour, language and development in three-year-old children. *Journal of Autism and Childhood Schizophrenia*, 8, 299-313.
- Tannock, R. and Schachar, R. (1996). Executive dysfunctions as an underlying mechanism of behavior and language problems in attention deficit hyperactivity disorder. In J.H. Beitchman, N.J. Cohen, M.M. Konstantareas, and R. Tannock, (Eds.). *Language, learning, and behavior disorders Developmental, biological, and clinical perspectives*. Cambridge University Press.
- Tomblin, J.B., Xuyang Z., Buckwalter P. (2000). The Association of Reading Disability, Behavioural Disorders, and Language Impairment among Second-grade Children. *Journal of Child Psychology and Psychiatry*, 41, 473-482.
- Toppelberg, C.O. and Shapiro, T. (2000). Language Disorders: A 10-Year Research Update Review. *Journal of the American Academy of Child and Adolescent Psychiatry*, 39, 143-152.

Ullman, M.T. and Pierpont E.I. (2005). Specific Language Impairment is not specific to language: The Procedural Deficit Hypothesis. *Cortex*, 41, 399-433.

Verhoeven, L. and Balkom, H. van (2004). Classification of Developmental Language Disorders, Theoretical Issues and Clinical Implications. Lawrence Erlbaum Associates, Publishers New Jersey.

Willinger, U., Brunner, E., Diendorfer-Radner, G., Sams, J., Sirsch, U., Eisenworth, B. (2003). Behaviour in Children With Language Development Disorders. *The Canadian Journal of Psychiatry-Original Research*, 48, 607-614.

APPENDIX

Flow chart of participants in the MoBa study, ABC study and current study (S. Schjølborg, personal communication, April 2007).

