Behavioral aspects of executive functions of school-age children with a history of specific language impairment

Lisensiaatintutkimus
Tampereen yliopisto
Psykologian laitos
Marika Kuusisto
Kesäkuu 2010

TABLE OF CONTENTS:

UNIVERSITY OF TAMPERE

Department of Psychology

KUUSISTO, MARIKA: Behavioral aspects of executive functions of school-age children with a history of specific language impairment

Licentiate Thesis, 24p.

Special Psychologist's Studies in Neuropsychology

June 2010

Abstract

Purpose Children with specific language impairment (SLI) have deficits in language and often in other cognitive functions. Language has a central role in cognitive self-guidance. Yet there is a lack of studies on the executive functions (EFs) of children with SLI in everyday environment. The aim of this study was to describe behavioral aspects of EFs of school-age children with a history of SLI and compare them to the functioning of typically developing children. Group comparisons in EFs were made also considering the effects of nonverbal IQ.

Methods Participants were 7 to 9 year-old children with a history of SLI (n=22) and age, gender and maternal education matched children (n=22) with typical development. The EFs were assessed by parents and teachers using the Behavior Rating Inventory of Executive Function (BRIEF). Intellectual functioning was assessed with the Wechsler Intelligence Scale for Children. EFs of the groups were compared with paired analysis using conditional logistical regression models, with and without controlling for the Performance Intelligence Quotient (PIQ).

Results Statistically significant differences between the groups were found on four Parent BRIEF scales and on six Teacher BRIEF scales. The group differences partly remained after controlling for PIQ.

Conclusions School-age children with SLI have more deficits in executive functions in daily life than their peers. In clinical practice, it is recommended to pay attention to EFs when assessing and planning interventions for children with SLI.

Keywords: executive functions, specific language impairment, school-age children

TAMPEREEN YLIOPISTO
Psykologian laitos

KUUSISTO, MARIKA: Toiminnanohjaustaidot arkipäivän tilanteissa kouluikäisillä lapsilla, joilla on kielellinen erityisvaikeus

Lisensiaatintutkimus, 24s.

Neuropsykologian erikoispsykologikoulutus

Kesäkuu 2010

Tiivistelmä

Tavoite Lapsilla, joilla on kielellinen erityisvaikeus eli dysfasia, on heikkouksia kielellisten taitojen lisäksi usein myös muissa kognitiivisissa taidoissa. Heidän toiminnanohjaustaitojaan on tutkittu suhteellisen vähän, vaikka kieli on tärkeä toiminnanohjauksen väline. Tutkimuksen tavoitteena oli kuvailla dysfasialasten toiminnanohjaustaitoja arkipäivän tilanteissa ja vertailla niitä ikätoverien taitoihin. Toiminnanohjaustaitoja vertailtiin ryhmien välillä myös huomioiden ei-kielellisen älykkyyden merkitys.

Menetelmät Tutkimusryhmään (n=22) kuului 7-9 –vuotiaita lapsia, joilla oli tai oli ollut dysfasiadiagnoosi. Verrokkiryhmään (n=22) kuului tyypillisesti kehittyneitä lapsia, jotka vastasivat iältään, sukupuoleltaan ja äidin koulutustaustaltaan dysfasialapsia. Vanhemmat ja opettajat arvioivat lapsen toiminnanohjaustaitoja Behavior Rating Inventory of Executive Functions -lomakkeella (BRIEF). Kognitiivinen taso tutkittiin Wechsler Intelligence Scale for Children -testillä. Ryhmien toiminnanohjaustaitoja vertailtiin ehdollisen logistisen regression avulla (pariutettu asetelma), sekä vakioimatta että vakioiden suorituspuolen älykkyysosamäärä.

Tulokset Ryhmät erosivat toisistaan tilastollisesti merkitsevällä tasolla neljässä vanhempien BRIEF-skaalassa ja kuudessa opettajien BRIEF-skaalassa. Ryhmien väliset erot osittain säilyivät suorituspuolen älykkyysosamäärän vakioinnin jälkeen.

Pohdinta Kouluikäisillä lapsilla, joilla on kielellinen erityisvaikeus, on enemmän heikkoutta arkipäivän toiminnanohjaustaidoissa kuin ikätovereillaan. Kliinisessä työssä on suositeltavaa kiinnittää huomiota dysfasialasten toiminnanohjaustaitoihin tehtäessä arvioita ja kuntoutussuunnitelmia.

Avainsanat: toiminnanohjaus, kielellinen erityisvaikeus (dysfasia), kouluikäiset lapset

INTRODUCTION

Language and executive functions

Language has a central role in cognitive self-guidance (Baddeley, Chincotta, & Adlam, 2001; Luria, 1961; Stuss & Benson, 1986; Vygotski, 1962). The claim that the development of executive functions depends on the development of language (Luria, 1961; Vygotski, 1962) has been adopted by contemporary researchers (Denckla, 1996; Gioia, Isquith, & Guy, 2001; Ylvisaker & Feeney, 2008). Still there is a lack of studies concerning the relationship between language impairment and executive functions (Hoffman & Gillam, 2004; Rapin, Allen, & Dunn, 1992; Vance, 2008). Executive functions (EFs) are simultaneous unitary and diverse, as they encompass several separate and interacting self-regulatory functions (Best, Miller, & Jones, 2009), which are responsible for purposeful, goal-directed, problem-solving behavior (Welsh & Pennington, 1988). The subdomains of EFs are initiation of behavior, inhibition of competing actions, selection of relevant goals, organization of behavior, flexible shifting of problem-solving strategies, monitoring of behavior, working memory in support of these behaviors, and emotional control (Gioia, Isquith, Guy, & Kenworthy, 2000). Behavioral aspects of EFs refer to one's behavior in daily life, considering EFs as a whole (Gioia, Isquith, & Kenealy, 2008).

Developmental disorders and risk of executive deficits

Generally children with any kind of developmental disorder are at risk of suffering from executive impairments (Anderson, Anderson, Jacobs, & Smith, 2008). Deficits in EFs have been confirmed in various clinical child groups, like Attention-Deficit/ Hyperactivity Disorder (ADHD), autism (Geurts, Verté, Oosterlaan, Roeyers, & Sergeant, 2004; Hughes, 2002) and traumatic brain injury (TBI) (Levin & Hanten, 2005, Mangeot, Armstrong, Colvin, Yeates, & Taylor, 2002). Children with specific language impairment have shown evidence of weakening nonverbal intelligence over time (Botting, 2005), and of poor social and educational attainment (Clegg, Hollis, Mawhood, & Rutter, 2005; Conti-Ramsden, 2008). However, little is known about the potential predictors of these developmental outcomes (Clegg et al., 2005; Conti-Ramsden & Durkin, 2008). One of them might be executive functioning. Therefore EFs of children with language impairment are worth studying for both clinical and theoretical reasons.

Specific language impairment and comorbid deficits

Children with specific language impairment (SLI) have deficits in receptive or expressive language abilities with an unknown etiology, and at the same time normal nonverbal intelligence (Bishop, 1992; Rapin & Allen, 1988). Despite its name, SLI is seldom specific (Rapin et al., 1992; Ullman & Pierpont, 2005; Webster & Shevell, 2004). Therefore domain-specific theories concerning SLI have met criticism based on developmental interaction between various systems over time (Botting, 2005; Karmiloff-Smith, 1998). Children with SLI compose a heterogeneous group (Bishop, 2004). Many of them have comorbid problems in motor (Hill, 2001; Scabar, Devescovi, Blason, Bravar, & Carrozzi, 2006), social (McCabe, 2005; Stanton-Chapman, Justice, Skibbe, & Grant, 2007), emotional (Conti-Ramsden & Botting, 2008) and academic skills (Catts, Fey, Tomblin, & Zhang, 2002; Conti-Ramsden & Durkin, 2007; Pennington & Bishop, 2009), as well as problems of autistic spectrum disorders (Conti-Ramsden, Simkin, & Botting, 2006). Additional cognitive deficits have been reported in spatial cognition (Akshoomoff, Stiles, & Wulfeck, 2006; Hick, Botting, & Conti-Ramsden, 2005; Johnston, 1999), visuospatial memory (Bavin, Wilson, Maruff, & Sleeman, 2005), information processing speed (Schul, Stiles, Wulfeck, & Townsend, 2004), simultaneous processing (Marton, 2008; Marton & Schwartz, 2003) and attention (Finneran, Francis, & Leonard, 2009; McGrath, Hutaff-Lee, Scott, Boada, Shriberg, & Pennington, 2008; Spaulding, Plante, & Vance, 2008). Although SLI as a definition implies normal nonverbal intelligence, the literature shows that SLI is often associated with impaired nonverbal intellectual functioning. (Botting, 2005; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998).

Specific language impairment and executive functions

There are no studies so far concerning behavioral aspects of EFs of school-age children with SLI. Hughes, Turkstra and Wulfeck (2009) had examined executive functioning in the daily lives of adolescents with SLI and found that they had more executive deficits relative to their peers. Individual aspects of EFs, like working memory, have been studied among children with SLI. These studies have been conducted with neurocognitive EF measures, whose ecological validity, however, is questionable (Chaytor, Schmitter-Edgecombe, & Burr, 2006; Gioia & Isquith, 2004). Deficits in verbal working memory (Alloway, Rajendran, & Archibald, 2009; Montgomery & Evans, 2009) and verbal short-term memory (Conti-Ramsden & Hesketh, 2003; Conti-Ramsden, Botting, & Faragher, 2001; Redmond, 2005) are usual among SLI children. Studies on visuospatial working memory abilities report partly mixed results, many of them weakened skills

(Akshoomoff et al., 2006; Hoffman & Gillam, 2004; Marton, 2008). In the area of other executive subdomains planning and shifting have been reported to have declined among children with SLI, as they have had problems in flexible task switching, made perseverative errors and spent less time on planning before problem solving than their peers (Marton, 2008). Sturn & Johnston (1999) showed that children with SLI are poorer in language use in problem-solving tasks than controls. Also, behavioral regulation abilities have been demonstrated to have an influence on language skills, such as literacy and vocabulary, among language impaired children (McClelland, Connor, Jewkes, Cameron, Farris, & Morrison, 2007). Im-Bolter, Johnson and Pascual-Leone (2006) found that children with SLI are deficient in EF subdomains response inhibition and updating of working memory content, indicating problems in general executive processes. In sum, there is a lack of research information in the SLI literature, especially concerning EF components of initiation, monitoring of behavior, emotional control and organization of materials, as well as EFs in daily life.

Aim of the study

The aim of the present study is to describe behavioral aspects of executive functions of school-age children with a history of SLI and study the relationship between executive and intellectual functions in these children. The two research questions are 1) Do 7 to 9 year-old children with a history of SLI differ from typically developing children in terms of the behavioral aspects of EFs?, and 2) Do these groups differ in EFs when nonverbal IQ is controlled for? Intellectual functioning of the groups is also compared. On the basis of earlier studies the EFs (Hughes et al., 2009; Im-Bolter et al. 2006; Marton, 2008) and intellectual functioning (Botting, 2005) of the children with a history of SLI were hypothesized to be weaker than those of typically developing children. Intellectual functioning was assessed to give a picture of the verbal and nonverbal intellectual functioning of the groups and, particularly, to statistically control for nonverbal intelligence when examining EFs, as recommended (Denckla, 1996).

METHODS

Participants

Children with SLI. Two main inclusion criteria were the year of birth (1997, 1998 and 1999) and diagnosis (F80, F80.1, F80.2 and F83) by International Classification of Diseases, 10th revision, ICD-10 (World Health Organization, 1992). The primary data came from the patient register of Tampere University Hospital. It was collected from three units: the Pediatric Neurology Unit, the Department of Child Psychiatry and the Phoniatric Department, where the children were examined and followed-up by multiprofessional hospital teams (neuropsychologist, speech therapist and physician). This original cohort (n=165) consisted of 123 boys (74.5% of the cohort) and 42 girls (25.5% of the cohort), whose medical records were reviewed. The study was approved by the Ethical Committee of Tampere University Hospital.

From the primary data the study group was selected on the basis of the following exclusion criteria: hearing impairment, mental retardation and intelligence below normal, autism spectrum disorder, chromosome abnormality, neurologic disease or syndrome, emotional or behavioral problems and mother's abnormal pregnancy or delivery. Also, children, whose mothers' first language was other than Finnish, who had not yet begun school, who had moved away from the hospital district, and whose nonverbal IQ was lower than 80 standard points (SP) at age 4-5, were excluded. Additional inclusion criteria used were history of SLI, meaning that a child had been diagnosed with SLI and that the condition persisted at five years of age, and, particularly, the three clinically most common SLI subtypes: phonologic-syntactic dysphasia (PS), verbal dyspraxia (VD) and semantic-pragmatic language impairment (SP). Subtypes were defined retrospectively from the children's medical records using Rapin & Allen's (1987) classification.

Following these exclusion and inclusion 47 children with a history of SLI remained the potential study group. They were invited to participate the study with a letter. The final sample (n=22) consisted of those children whose parents gave their written informed consent. As Table 1 shows, the groups of participants and non-participants were quite similar in terms of age, gender, SLI subtype and degree of language impairment. Both expressive and receptive language impairments were classified on a three-level scale as no impairment, mild impairment and moderate to severe impairment according to the speech therapist's and physician's reports in child's medical record around age 5.

Table 1. Characteristics of participants and non-participants

Descriptive variables	Participants N=22	Non-participants N=25
Age (years)	8,2	8,3
Gender (females / males)	4/18	7/18
SLI subtype		
PS	12	14
VD	8	9
SP	2	2
Expressive language at age 5		
No impairment	0	0
Mild impairment	12	12
Moderate or severe impairment	10	13
Receptive language at age 5		
No impairment	9	8
Mild impairment	7	9
Moderate or severe impairment	6	8

SLI=Specific language impairment, PS = phonologic-syntactic dysphasia, VD = verbal dyspraxia, SP = semantic-pragmatic language impairment

Typically developing children were recruited from two mainstream schools in Tampere as a control group. The study was approved in writing by the principals of the schools. The same exclusion criteria were applied as with the study group. Typically developing controls had no language impairment or learning disabilities and they were not attending special education. Teachers were asked to distribute information forms to children with typical development, whose parents gave written consent to their participation. Matching controls were selected according to age (+/- 6 months), gender and maternal education. Mean age difference between the matched pairs was 12 days. Maternal education was used as an indication of socio-economic status (SES) and classified into a three-level scale (1= comprehensive school, 2= vocational or upper secondary school, and 3= college or university). Some problems were encountered when recruiting volunteers with low educational background, mothers of the control group were slightly more educated than mothers of SLI children. Table 2 presents the sociodemographic and intellectual functioning of children with a history of SLI and typically developing children.

Table 2. Sociodemographic and intellectual functioning of the children with SLI and typical development

	Children with SLI	Typically developing children	
	N=22	N=22	Sig
Age in years: Mean (SD), Range	8.2 (0.6), 6.9-9.6	8.3 (0.7), 7.2-9.9	
Gender (females / males)	4/18	4/18	
Maternal education			
Comprehensive school	5	2	
Vocational or upper socondary school	7	5	
College or University	10	15	
School (number of children)			
Special education	8	0	
Mainstream school	14	22	
Intelligence (WISC-scores)			
Verbal IQ: Mean (SD), Range	88.00 (15.41), 59-135	107.09 (11.39), 84-131	.002 **
Performance IQ: Mean (SD), Range	94.59 (20.82), 61-144	106.68 (16.06), 75-135	.042 *
Full Scale IQ: Mean (SD), Range	90.68 (16.49), 70-139	106.59 (11.13), 87-130	.002 **

** = p< .01, * = p< .05

SLI=Specific language impairment, Sig=Significance, SD = Standard Deviation, WISC= Wechsler Intelligence Scale for Children, 3rd ed., IQ= Intelligence Quotient

Measures

Executive functions were measured assessing children's everyday behavior. The Behavior Rating Inventory of Executive Functions (BRIEF) -Parent and Teacher Forms (Gioia et al. 2000), Finnish version[1] was used. BRIEF is reliable, valid and the only rating scale initially intended for children (Gioia et al., 2008). Both Parent and Teacher BRIEF Forms contain 86 items in which child's behavior is rated on a three-point Likert scale (Never, Sometimes, Often) with higher ratings indicating greater perceived impairment. Items are divided into eight clinical scales measuring different aspects of EFs: Inhibit, Shift (Flexibility), Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials and Monitor. The scales form two broader indexes, Behavioral Regulation (BRI) and Metacognition (MI), and an overall score, the Global Executive Composite (GEC). Raw scores on each of the scales and indexes are converted into T scores with a mean of 50 and a standard deviation (SD) of 10. T scores were used for analysis. According to the manual T score 65 was regarded as a threshold for interpretation of a score as abnormally elevated.

Intellectual functioning was assessed using the Finnish standardized version of the Wechsler Intelligence Scale for Children (WISC III; Wechsler, 1992). Scores for Verbal Intelligence

[1] Finnish version of the BRIEF, translated by three clinical neuropsychologists A. Nyman, M. Kuusisto, & J. Torsti, approved by PAR Psychological Assessment Resources, Inc.

Quotient (VIQ), for Performance Intelligence Quotient (PIQ) and for Full Scale Intelligence Quotient (FSIQ) were estimated by the following eight subtests: Information, Similarities, Vocabulary, Digit Span, Picture Completion, Block Design, Object Assembly and Mazes. These subtests were selected, because for verbal subtests best average split-half reliability coefficients are for used subtests Information, Similarities, Vocabulary and Digit Span according to the reliability data for the WISC-III (Kaufman & Lichtenberger, 2000). In addition, the first three of these measure general intelligence (g) well. On the Performance scale, the highest g loadings are found on the selected subtests Block Design, Object Assembly and Picture Completion.

Procedure

To arrive at exclusion criteria to control for the scores of nonverbal IQ at age 4-5 the results of psychological assessments made during earlier routine visits to the Phoniatric Department were reviewed. If such evaluations had already been conducted in the child's home town, parents were asked to provide written permission for the researcher to access them. Nonverbal IQ limit 80 SP was chosen following earlier studies (Jarratt, Riccio, & Siekierski, 2005; Rapin et al., 1992; Durkin & Conti-Ramsden, 2007) for two reasons. First, normal nonverbal IQ (85 standard points) was considered too strict, and second, sample size was prevented from becoming too small.

Teachers completed the BRIEF at school and parents completed the BRIEF at home and posted it to the researcher. Intellectual functioning of the children with SLI was assessed in hospital and typically developing children were assessed at school during the school day. Assessments were made individually in a quiet room by a single clinical neuropsychologist (MK). Tests and order of presentation were the same for all children. One child in the SLI group had recent intelligence test scores from a clinical evaluation conducted less than one year earlier. Two children in the control group had intelligence test scores less than one year old, as they happened to have been controls in scientific research earlier, too. These results were obtained and used. One child with a history of SLI had unusually high VIQ, PIQ, and FSIQ scores, but had still met the inclusion criteria and not the exclusion criteria, and was naturally included in the study group.

Statistical analysis

EFs of the children with a history of SLI and with typical development were compared by paired analysis using conditional logistic regression models, with and without controlling for nonverbal

IQ. PIQ score was used as it represents intellectual functioning independent of language skills. Correlation analysis, Spearman's Rho, was conducted between PIQ and the eight Parent and Teacher BRIEF scales in order to examine the relationship between intelligence and EFs. The differences in VIQ, PIQ and FSIQ scores between the study and the control groups were compared with Wilcoxon test (Table 2). Because of skewed distributions and small sample size non-parametric tests were used. Statistical analyses were made by the SPSS (version 18.0). P-values less than .05 were considered statistically significant. Only six children had one missing response each in the BRIEF forms, four of them in the Parent and two in the Teacher form, which were assigned a score of 1 as recommended in the manual. One child had a missing score on Similarities, which was replaced by his VIQ.

RESULTS

Executive functions

Children with SLI had higher mean scores in all Parent and Teacher BRIEF scales compared to the control group (Table 3). Statistically significant differences between the groups were found on four Parent BRIEF scales: Shift ($p<.013$), Emotional Control ($p<.023$), Working Memory ($p<.014$), and Plan/Organize ($p<.021$). In Teacher BRIEF differences were significant on six scales: Shift ($p<.039$), Emotional Control ($p<.049$), Initiate ($p<.016$), Working Memory ($p<.026$), Plan/Organize ($p<.037$), and Monitor ($p<.025$). Differences between the groups were significant also in all mean scores of BRI, MI, and GEC in Parent and Teacher BRIEF.

None of the mean scores in the SLI or the control groups exceeded the BRIEF score limit of 65 for clinical significance. At individual level 13 children (59%) in the SLI group had a T score 65 or above on at least one Parent or Teacher scale, on average on 6 scales. Seven children with SLI had Parent GEC score 65 or above and 6 children had Teacher GEC score at cut-point or above. In the group of typically developing children there were 6 children (27%), with T score 65 or above on at least one Parent or Teacher BRIEF scale, on average on 2 scales per child. One child in the control group had GEC score 65 in Parent BRIEF and none in Teacher BRIEF.

Table 3. Mean T-scores in Parent and Teacher BRIEF for children with a history of SLI and with typical development, and significance of study and control groups difference by conditional logistical regression before and after controlling for PIQ

	Children with SLI		Typically developing children		Before controlling for PIQ	After controlling for PIQ
Scale/ index	**M (SD)**	**Range**	**M (SD)**	**Range**	**Sig**	**Sig**
Inhibition						
Parent	52.27 (12.17)	36-82	47.86 (7.46)	40-62	.163	.248
Teacher	53.18 (9.82)	42-74	49.05 (6.34)	42-63	.116	.078
Shift						
Parent	56.45 (11.30)	37-77	45.14 (7.56)	36-63	**.013***	**.032***
Teacher	54.91 (10.77)	42-81	46.27 (5.69)	42-68	**.039***	.110
Emotional Control						
Parent	55.09 (12.59)	36-80	46.36 (9.30)	36-66	**.023***	.067
Teacher	53.64 (11.32)	43-77	45.68 (5.30)	43-65	**.049***	.059
Initiate						
Parent	52.95 (10.98)	41-83	45.73 (8.14)	36-65	.052	.167
Teacher	56.36 (13.51)	39-81	44.55 (4.55)	39-52	**.016***	**.030***
Working memory						
Parent	58.73 (12.38)	36-81	47.27 (10.51)	35-75	**.014***	**.046***
Teacher	56.05 (11.50)	38-78	46.77 (7.91)	38-63	**.026***	**.040***
Plan/Organize						
Parent	54.73 (12.68)	33-77	44.18 (6.78)	33-65	**.021***	.056
Teacher	52.77 (12.08)	38-74	43.09 (5.70)	38-61	**.037***	**.034***
Organize of Materials						
Parent	52.73 (10.89)	33-71	50.91 (12.31)	32-72	.619	.848
Teacher	53.95 (10.27)	42-78	47.91 (7.43)	42-76	.051	.089
Monitor						
Parent	51.86 (13.55)	31-76	45.00 (8.88)	31-63	.052	.215
Teacher	54.73 (9.74)	38-68	48.27 (6.17)	38-61	**.025***	**.039***
BRI						
Parent	54.86 (11.52)	37-76	45.91 (8.23)	36-63	**.017***	**.040***
Teacher	54.23 (10.28)	42-74	46.68 (4.60)	41-61	**.026***	**.041***
MI						
Parent	55.14 (12.37)	35-76	45.59 (8.04)	33-65	**.027***	.096
Teacher	55.05 (10.72)	37-74	45.73 (5.47)	37-61	**.018***	**.032***
GEC						
Parent	55.41 (12.29)	35-78	45.55 (8.03)	34-65	**.021***	.065
Teacher	55.14 (10.35)	40-73	46.05 (5.25)	38-62	**.020***	**.043***

* = $p < .05$
SLI=Specific language impairment, M=Mean, SD= Standard Deviation, PIQ= Performance Intelligence Quotient, Sig=Significance, BRI= Behavioral Regulation Index, MI= Metacognition Index, GEC= Global Executive Composite

Executive functions after controlling for nonverbal IQ

Some EF regression estimates for difference between the study and control groups remained significant after taking nonverbal IQ into account (Table 3). The group differences between the SLI and control groups' mean BRIEF scores remained statistically significant on two Parent scales: Shift ($p<.032$) and Working Memory ($p<.046$). In Teacher BRIEF differences between the groups remained significant on four Teacher scales: Initiate ($p<.030$), Working Memory ($p<.040$), Plan/Organize ($p<.034$) and Monitor ($p<.039$) after controlling for PIQ. In the study group a negative correlation was found between PIQ and four Parent scales: Initiate ($r_s=-.44$), Working Memory ($r_s=-.47$), Plan/Organize ($r_s=-.47$) and Monitor ($r_s=-.49$) at a statistically significant level. There was no statistically significant correlation between PIQ and teacher ratings in the SLI group. Among typically developing children there was no statistically significant correlation between PIQ and on any of the Parent or Teacher BRIEF Scales (correlation varied between $r_s=-.31$ and $r_s=.14$).

DISCUSSION

The aim of this study was to describe behavioral aspects of EFs and intellectual functioning of school-age children with a history of SLI and compare them to the functioning of typically developing children. Group comparisons in EFs were made also considering the effects of nonverbal IQ. Research shows that SLI is often associated with nonverbal cognitive deficits (Botting, 2005), and impairments in individual EF subdomains have also been reported in recent research (Im-Bolter et al., 2006; Marton, 2008). Theoretically, the development of EFs is dependent on adequate language skills (Denckla, 1996). Therefore, the EFs of children with a history of SLI were hypothesized to be weaker than EFs of typically developing children. In this study children with SLI had indeed weaker skills in many EF subdomains in everyday behavior relative to matched controls, even after nonverbal IQ was controlled for. Thus, the research hypothesis was supported.

Executive functions

Children with a history of SLI had higher mean scores on all BRIEF scales assessed by parents and teachers compared to the control group, indicating they have more executive deficits in daily life. Differences between the groups were statistically significant on four Parent and Teacher BRIEF scales (Shift, Emotional Control, Working Memory, and Plan/Organize) and in addition, two Teacher BRIEF scales (Initiate and Monitor). Instead, no statistically significant differences between the groups were found on the scales of Inhibition and Organize of Materials. At individual level almost two thirds (59%) of the language-impaired children had elevated BRIEF scores. The results further supported the previous findings of executive impairments in SLI assessed both by behavioral (Hughes et al., 2009) and neurocognitive measures (Im-Bolter et al., 2006; Marton, 2008). Deficits in EF subdomains have earlier been found in shifting (Marton, 2008), planning (Akshoomoff et al., 2006; Marton, 2008), working memory (Alloway & Archibald, 2008; Alloway et al., 2009; Montgomery, 2003; Montgomery, Magimairaj, & Finney, 2010; Van Daal, Verhoeven, & Van Balkom, 2009) and inhibition (Im-Bolter et al., 2006; Marton, 2008). However, as mentioned in the literature review, the whole picture of the EFs of school-age children with SLI is still far from fully studied (Hoffman & Gillam, 2004; Hughes et al, 2009).

On the basis of the present study many children with SLI have deficits beyond language domain, in executive functioning. What remains unknown is whether these impairments are parallel phenomena or causally related. The findings were consistent with the theoretical assumption that language impairments may secondarily impair EFs (Denckla, 1996), and with the claim that children with developmental disorders are at risk of impairments in EFs (Anderson et al., 2008). It may be that abnormal neurological development in SLI produces cognitive deficits in both language and other higher cognitive functions. On the other hand, deviant development of language skills probably reflects on the development of EFs, as inner speech has an important role in programming and regulating behavior (Luria, 1961; Miyake, Emerson, Padilla, & Ahn, 2004; Sturn & Johnston, 1999; Stuss & Benson, 1986; Vygotski, 1962). EF subdomains planning, shifting (Kray, Eber, & Lindenberger, 2004) and working memory (Baddeley, 2003), particularly, are dependent on language and they were all impaired among the SLI children in the present study. Correspondingly, inhibition was an intact executive subdomain and it may be less dependent on language. Barkley (1997) considers inhibition to be the primary executive function. Therefore the good inhibition of SLI children could be explained by the assumption that it works automatically, before conscious thinking, not being dependent on language.

Some contradictory results have been published earlier concerning individual aspects of EFs. Children with SLI have poor inhibitory control measured by computer tasks (Spaulding, 2008) and neurocognitive tests (Marton, 2008; Marton, Kelmenson, & Pinkhasova, 2007). Shifting was intact assessed by the Children's Trail Making Test and a computer-based set-shifting task in the study by Im-Bolter et al. (2006) and in a fluency task by Bishop and Norbury (2005). This discrepancy between studies may be due to methodological differences. As Im-Bolter et al. (2006) note that there is wide spectrum of executive tasks. Also, behavioral and neurocognitive measures are concerned with different aspects of EFs (Mahone & Hoffman, 2007; Torsti, 2010).

Executive profiles characteristic of different clinical groups of children with developmental and acquired disorders have previously been explored with BRIEF (Gioia, Isquith, Kenworthy, & Barton, 2002). In the present study executive profile of SLI group consists of six impaired (Shift, Emotional Control, Initiate, Working Memory, Plan/Organize and Monitor) and two intact subdomains (Inhibition and Organize of Materials). Children with ADHD have been shown to have problems on all BRIEF scales, especially in Inhibition and Working Memory (Gioia et al., 2002; Jarratt, Riccio, & Siekierski, 2005; Torsti, 2010). Hence, the ability to inhibit appears to differentiate ADHD and SLI groups. Children with Autistic Spectrum Disorders (ASD) have had deficits on all BRIEF scales, particularly Shift (Gioia et al, 2002). Reading Disability (RD) is associated with deficits in three subdomains (Working Memory, Plan/ Organize and Monitor). As Calhoun (2006) concludes, research is still needed to explore unique patterns of executive dysfunction in specific disorders.

Intellectual functioning and executive functions

In this study children with SLI had significantly weaker verbal and nonverbal intellectual functioning than children with typical development, which was in accordance with earlier research (Botting, 2005; Stothard et al., 1998). After controlling for PIQ scores, differences between the groups remained significant on two Parent BRIEF scales (Shift and Working Memory) and on four Teacher BRIEF scales (Initiate, Working Memory, Plan/Organize, and Monitor). This indicates that weakened intellectual functioning does not explain all executive deficits observed among children with SLI. In earlier studies, too, differences between SLI and control groups have at least partly remained in language (Ellis Weismer, Evans, & Hesketh, 1999), social (Clegg et al., 2005; Durkin & Conti-Ramsden, 2007) and visuospatial skills (Marton, 2008), when nonverbal IQs have been controlled for.

Correlations between PIQ and BRIEF scores in the study and the control groups were inconsistent. In the control group no correlation was found between scores on PIQ and BRIEF scales. This result supports earlier findings (Ardila, Pineda, & Rosselli, 2000; Welsh, Pennington, & Groisser, 1991), showing a weak correlation between IQ and executive function tasks in normal child population. Instead, in the study group negative correlation was found between PIQ and four Parent BRIEF scales (Initiate, Working memory, Plan/Organize, and Monitor). Better nonverbal performance was related to better executive functioning. Thus SLI children with good intellectual functioning might be able to compensate their executive deficits. This assumption is in agreement with Mahone's et al. (2002) finding that ADHD children with higher IQ are able to perform normally on clinical measures of EF. The relationship between nonverbal cognition and executive abilities has been argued to be close (Denckla, 1996; Marton, 2008; Miyake, Friedman, Rettinger, Shah, & Hegarty, 2001). Marton (2008) has proposed that nonverbal IQ is a global score likely also measuring executive functions. In fact, executive deficits may be one reason for low nonverbal IQs among children with SLI. Hoffman and Gillam (2004) have stated that general cognitive capacity, EFs, and other cognitive factors of children with SLI operate in synergy, creating dynamic of information processing.

Limitations and strengths of the study

Using quite strict inclusion and exclusion criteria meant that study group was fairly small. The participation rate was only 47%, which is one source of uncertainty in this study. However, the groups of participants and non-participants were similar in terms of age, gender, SLI subgroups and degrees of impairment in expressive and receptive language in the preschool period. Thus the study group may be considered to be a fairly representative sample of children with SLI in this Hospital District. The measure used, BRIEF, has some weaknesses as do other questionnaires (Denckla, 2002). First, a certain level of linguistic proficiency is demanded for a person who reads and completes a rating scale. Second, emotional involvement between the observer and the child observed may influence the responses. Third, BRIEF has not so far been validated in Finland, but the lack of standardized data was compensated for by the use of a matched control group. Nevertheless, the cut value T score of 65 indicating executive dysfunction depends on original norms. The strength of the BRIEF is that it offers an ecologically valid assessment tool for outlining an overall picture of one's EFs capturing everyday behavior (Calhoun, 2006; Gioia et al., 2008). In the literature it is recommended to use both rating scales and performance-based measures when examining the EFs of children (Bodnar, Prahme, Cutting, Denckla, & Mahone, 2007; Isquith, Crawford, Espy, & Gioia, 2005; Torsti, 2010), as they have different benefits and limitations. The strengths of this study are a relatively homogenous and well-assessed group of SLI children and the use of a matched control group. This study produced new behavioral information on the EFs of school-age children with a history of SLI. Also, controlling for effects of nonverbal IQ on EFs made the results clearer.

Clinical implications and future research aims

Given that adolescent outcomes of SLI are heterogeneous (Conti-Ramsden, 2008) and associated with elevated risk of psychosocial problems (Durkin & Conti-Ramsden, 2007; Jerome, Fujiki, Brinton, & James, 2002; Snowling, Bishop, Stothard, Chipchase, & Kaplan, 2006) and weak behavioral independence (Conti-Ramsden & Durkin, 2008), the role of executive deficits in these developmental outcomes is still unknown. Gioia et al. (2002) propose that the clinical presentation of the child with developmental disorder consists of interaction between executive deficits, other cognitive domains, and social-emotional strengths and weaknesses. EFs are known to predict academic achievement (McClelland et al., 2007) and social functioning later in life

(Best et al., 2009; Miller & Hinshaw, 2010). Therefore, those children with SLI displaying executive dysfunction, particularly, may be at risk of long-term problems. Without rehabilitation also focused on their executive skills children's linguistic skills may improve and executive deficits persist.

A clinical implication of this study is that it is important to pay attention to the executive functioning of children with SLI when making diagnostic evaluations, as well as when planning interventions, teaching or providing support for daily life. As Rapin et al. (1992) conclude, it is important for the child with SLI to acquire adequate communications skills. Moreover, comorbid deficits need to be identified and the therapeutic services they require ensured. Future research is needed to gain more insight on the nature and extent of executive deficits among children with SLI. Further work is required, especially to learn more about the interaction between executive functions and other cognitive processes during development.

The results of this study add to a growing body of research demonstrating that children with SLI are at higher risk of executive impairments relative to typically developing children. Interaction between language skills and executive functions during development is not well documented. Children with language impairment are obviously heterogeneous in terms of clinical phenotypes, including language, other cognitions and long-term outcomes. Future research will show the significance of EFs on developmental path in this clinical group of children. The findings highlight the importance of assessing and developing interventions that target executive functions among children with SLI.

REFERENCES

Akshoomoff, N., Stiles, J., & Wulfeck, B. (2006). Perceptual organization and visual immediate memory in children with specific language impairment. *Journal of the International Neuropsychological Society, 12*, 465-474.

Alloway, T., P., & Archibald, L. (2008). Working memory and learning in children with developmental coordination disorder and specific language impairment. *Journal of Learning Disablities, 41*, 251-262.

Alloway, T., P., Rajendran, G., & Archibald, L., M., D. (2009). Working memory in children with developmental disorders. *Journal of Learning Disablities, 42*, 372-382.

Anderson, V., Anderson, P. J., Jacobs, R. & Smith, M. S. (2008). Development and assessment of executive function: From preschool to adolescence. In V. Anderson, R. Jacobs & P. J. Anderson (Eds.), *Executive Functions and the Frontal Lobes* (pp.123-154). New York: Psychology Press.

Ardila, A., Pineda, D., & Rosselli, M. (2000). Correlation between intelligence test scores and executive function measures. *Archives of clinical neuropsychology, 15*, 31-36.

Baddeley, A., (2003). Working memory and language: an overview. *Journal of communication disorders, 36,* 189-208.

Baddeley, A., Chincotta, D., Adlam, A. (2001). Working memory and the control of action: Evidence from task switching. *Journal of Experimental Psychology: General, 130*, 641-657.

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

Bavin, E., L., Wilson, P., H., Maruff, P. & Sleeman, F. (2005). Spatio-visual memory of children with specific language impairment: Evidence for generalized processing problems. *International Journal of Language and Communication Disorders, 40*, 319-332.

Best, J., R., Miller, P., H., & Jones, L., L. (2009). Executive functions after age 5: Changes and correlates. *Development review, 29*, 180-200.

Bishop, D., V., M. (1992). The underlying nature of specific language impairment. *Journal of Child Psychology and Psychiatry, 33*, 3-66.

Bishop, D., V., M. (2004) Specific language impairment: diagnostic dilemmas. In L. Verhoeven & H. Balkom (Eds.), *Classification of developmental language disorders* (pp. 309-326). Mahwah: Erlbaum.

Bishop, D., V., M., & Norbury, C., F. (2005). Executive functions in children with communication impairments, in relation to autistic symptomatology. *Autism, 9*, 29-43.

Bodnar, L. E., Prahme, M. C., Cutting, L. E., Denckla, M. B., & Mahone, E. M. (2007). Construct validity of parent ratings of inhibitory control. *Child Neuropsychology, 13*, 345-362.

Botting, N. (2005). Non-verbal cognitive development and language impairment. *Journal of child psychology and psychiatry, 46*, 317-328.

Calhoun, J., A. (2006). Executive functions: a discussion of the issues facing children with autism spectrum disorders and related disorders. *Seminars in speech and language, 27*, 60-71.

Catts, H., W., Fey, M., E., Tomblin, J., B., Zhang, X. (2002). A longitudinal investigation of reading outcomes in children with language impairments. *Journal of Speech, Language and Hearing research, 45*, 1142-1157.

Chaytor, N., Schmitter-Edgecombe, M., & Burr, R. (2006). Improving the ecological validity of executive functioning assessment. *Archives of Clinical Neuropsychology, 21*, 217-227.

Clegg, J., Hollis, C., Mawhood, L., & 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.

Conti-Ramsden, G. (2008). Heterogeneity of specific language impairment in adolescent outcomes. In C. Norbury, J. Tomblin, & D. Bishop, (Eds.), *Understanding Developmental Language Disorders. From theory to practice* (pp.115-129). Glasgow: Psychology Press.

Conti-Ramsden, G., & Botting, N. (2008). Emotional health in adolescents with and without a history of specific language impairment (SLI). *Journal of Child Psychology and Psychiatry, 49*, 516-525.

Conti-Ramsden, G., Botting, N., & Faragher, B. (2001). Psycholinguistic markers for specific language impairment (SLI). *Journal of Child Psychology and Psychiatry, 42*, 741-748.

Conti-Ramsden, G., & Durkin, K. (2007). Phonological short-term memory, language and literacy: developmental relationship in early adolescence in young people with SLI. *Journal of Child Psychology and Psychiatry, 48*, 147-156.

Conti-Ramsden, G., & Durkin, K. (2008). Language and independence in adolescents with and without a history of specific language impairment (SLI). *Journal of Speech, Language and Hearing Research, 51*, 70-83.

Conti-Ramsden, G., & Hesketh, A. (2003). Risk markers for SLI: a study of young language-learning children. *International Journal of Language and Communication Disorders, 38*, 251-263.

Conti-Ramsden, G., Simkin, Z., & Botting, N. (2006). The prevalence of autistic spectrum disorders in adolescents with a history of specific language impairment (SLI). *Journal of Child Psychology and Psychiatry, 47*, 621-628.

Denckla, M., B. (1996). A theory and model of executive function: A neuropsychological perspective. In G., R. Lyon, & N., A., Krasnegor (Eds.), *Attention, Memory and Executive Function* (pp.263-278). Baltimore: Brookes.

Denckla, M., B. (2002). The Behavior Rating Inventory of Executive Function: Commentary. *Child Neuropsychology, 8*, 304-306.

Durkin, K., & Conti-Ramsden, G. (2007). Language, social behavior, and the quality of friendships in adolescents with and without a history of specific language impairment. *Child Development, 78*, 1441-1457.

Ellis Weismer, S., Evans, J., & Hesketh, L., J. (1999). An examination of verbal working memory capacity in children with specific language impairment. *Journal of Speech, Language & Hearing Research, 42*, 1249-1260.

Finneran, D., A., Francis, A., L., Leonard, L., B. (2009). Sustained attention in children with specific language impairment (SLI). *Journal of Speech, Language and Hearing Research, 52*, 915-929.

Geurts, H., Verté, S., Oosterlaan, J., Roeyers, H., & Sergeant, J. A. (2004). How specific are executive functioning deficits in attention deficit hyperactivity disorder and autism? *Journal of child psychology and psychiatry, 45*, 836-854.

Gioia, G., A., & Isquith, P., K. (2004). Ecological assessment of executive function in traumatic brain injury. *Developmental Neuropsychology, 25*, 135-158.

Gioia, G., A., Isquith, P., K., & Guy, S., C. (2001). Assessment of executive functions in children with neurological impairment. In R., J. Simeonsson & S. L. Rosenthal (Eds.), *Psychological and Developmental Assessment* (pp.317-356). New York: Guilford.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). *BRIEF Bahavior Rating Inventory of Executive Functions. Professionnal Manual*. Lutz: Psychological Assessment Resources, Inc.

Gioia, G. A., Isquith, P. K., & Kenealy, L. E. (2008). Assessment of bahavioral aspects of executive function. In V. Anderson, R. Jacobs, & P. J. Anderson (Eds.), *Executive Functions and the Frontal Lobes* (pp.179-202). New York: Psychology Press.

Gioia, G. A., Isquith, P. K., Kenworthy, L., & Barton, R., M. (2002). Profiles of everyday executive function in acquired and developmental disorders. *Child neuropsychology, 8*, 121-137.

Gruber, O., & Goschke, T. (2004). Executive control emerging from dynamic interactions between brain systems mediating language, working memory and attentional processes. *Acta Psychologica, 115*, 105-121.

Hick, R., Botting, N., & Conti-Ramsden, G. (2005). Cognitive abilities in children with specific language impairment: consideration of visuo-spatial skills. *International journal of language and communication disorders, 40*, 137-149.

Hill, E., L. (2001). Non-specific nature of specific language impairment: a review of the literature with regard to concomitant motor impairments. *International Journal of Language and Communication Disorders, 36*, 149-171.

Hoffman, L., M., & Gillam, R., B. (2004). Verbal and spatial information processing constraints in children with specific language impairment. *Journal of Speech, Language & Hearing Research, 47*, 114-125.

Hughes, C. (2002). Executive functions and development: Emerging themes. *Infant and Child Development, 11*, 201-209.

Hughes, D., M., Turkstra, L., S., & Wulfeck, B., B. (2009). Parent and self-ratings of executive function in adolescents with specific language impairment. *International Journal of Language and Communication Disorders, 44*, 901-916.

Im-Bolter, N., Johnson, J., & Pascual-Leone, J. (2006). Processing limitations in children with specific language impairment: The role of executive functions. *Child development, 77*, 1822-1841.

Isquith, P., K., Crawford, J., S., Espy, K., A., & Gioia, G., A (2005). Assessment of executive function in preschool-aged children. *Mental Retardation and Developmental Disabilities Research Reviews, 11*, 209-215.

Jarratt, K., P., Riccio, C., A., & Siekierski, B., M. (2005). Assessment of Attention Deficit Hyperactivity Disorder (ADHD) using the BASC and BRIEF. *Applied Neuropsychology, 12*, 83-93.

Jerome, A., C., Fujiki, M., Brinton, B., & James, S., L. (2002). Self-esteem in children with specific language impairment. *Journal of Speech, Language and Hearing Research, 45*, 700-714.

Johnston, J., R. (1999). Cognitive deficits in specific language impairment: decision in spite of uncertainty. *Revue d'orthophonie et d'audiologie, 23*, 165-172.

Karmiloff-Smith, A. (1998). Development itself is the key to understanding developmental disorders. *Trends in Cognitive Sciences, 2*, 389-398.

Kaufman, A., S., & Lichtenberger, E., O. (2000). *Essentials of WISC-III and WPPSI-R assessment*. New York: Wiley.

Kray, J., Eber, J., & Lindenberger, U. (2004). Age differences in executive functioning across the lifespan: The role of verbalization in task preparation. *Acta Psychologica, 115*, 143-165.

Levin, H. S., & Hanten, G. (2005). Executive functions after traumatic brain injury in children. *Pediatric Neurology, 33*, 79-93.

Luria, A., R. (1961). *The role of speech in the regulation of normal and abnormal behavior*. Tizard J, trans. New York, Liveright.

Mahone, E., M., Hagelthorn, K., M., Cutting, L., E., Schuerholz, L., J., Pelletier, S., F., Rawlins, C., Singer, H., S., Denckla, M., B. (2002). Effects of IQ on executive function measures in children with ADHD. *Child Neuropsychology, 8*, 52-65.

Mahone, E., M., & Hoffman, J. (2007). Behavior ratings of executive function among preschoolers with ADHD. *The Clinical Neuropsychologist, 21*, 569-586.

Mangeot, S., Armstrong, K., Colvin, A., N., Yeates, K., O., & Taylor, H., G. (2002). Long-term executive function deficits in children with traumatic brain injuries: Assessment using the Behavior Rating Inventory of Executive Functions (BRIEF). *Child Neuropsychology, 8*, 271-284.

Marton, K. (2008). Visuo-spatial processing and executive functions in children with specific language impairment. *International Journal of Language and Communication Disorders, 43*, 181-200.

Marton, K., Kelmenson, L., & Pinkhasova, M. (2007). Inhibition control and working memory capacity in children with SLI. *Psychologia, 50*, 110-121.

Marton, K., & Schwartz, R., G. (2003). Working memory capacity and language processes in children with specific language impairment. *Journal of Speech, Language & Hearing Research, 46,* 1138-1153.

McCabe, P., C., (2005). Social and behavioral correlates of preschoolers with specific language impairment. *Psychology in the Schools, 42*, 373-387.

McClelland, M., M., Connor, C., M., Jewkes, A., M., Cameron, C., E., Farris, C., L., & Morrison, F., J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology, 43*, 947-959.

McGrath, L., M., Hutaff-Lee, C., Scott, A., Boada, R., Shriberg, L., D., Pennington, B., F., (2008). Children with comorbid speech sound disorder and specific language impairment are at increased risk for Attention-Deficit/Hyperactivity Disorder. *Journal of Abnormal Child Psychology, 36,* 151-163.

Miller, M., & Hinshaw, S., P. (2010). Does childhood executive function predict adolescent functional outcomes in girls with ADHD? *Journal of Abnormal Child Psychology, 38*, 315-326.

Miyake, A., Emerson, M., J., Padilla, F., & Ahn, J. (2004). Inner speech as a retrieval aid for task goals: the effects of cue type and articulatory suppression in the random task cuing paradigm. *Acta Psychologica, 115*, 123-142.

Montgomery, J., W. (2003). Working memory and comprehension in children with specific language impairment: what we know so far? *Journal of Communication Disorders, 36*, 221-231.

Montgomery, J., W., Magimairaj, B., M., & Finney, M., C. (2010). Working memory and specific language impairment: An update on the relation and perspectives on assessment and treatment. *American Journal of Speech-Language Pathology, 19*, 78-94.

Pennington, B., F., & Bishop, D., V., M. (2009). Relations among speech, language, and reading disorders. *The Annual Review of Psychology, 60*, 283-306.

Rapin, I., & Allen, D., A. (1987). Developmental dysphasia and autism in preschool children: Characteristics and subtypes. In J. Martin, P. Fletcher, P. Grunwell, & D. Hall (Eds.), *Proceedings of the First International Symposium on Specific Speech and Language Disorders in Children* (pp.20-35). London: Afasic.

Rapin, I., & Allen, D., A. (1988). Syndromes in developmental dysphasia and adult aphasia. In F. Plum (Eds.), *Language, Communication, and the Brain* (pp.57-75). New York, Raven.

Rapin, I., Allen, D., A., & Dunn, M., A. (1988). Developmental language disorders. In S. Segalowitz, & I. Rapin, (Eds.), *Handbook of Neuropsychology* (111-137). New York: Elsevier.

Redmond, S., M. (2005). Differentiating SLI from ADHD using children’s sentence recall and production of past tense morphology. *Clinical Linguistics and Phonetics, 19*, 109-127.

Scabar, A., Devescovi, R., Blason, L., Bravar, L., & Carrozzi, M. (2006). Comorbidity of DCD and SLI: significance of epileptiform activity during sleep. *Child, Health and Development, 32*, 733-739.

Schul, R., Stiles, J., Wulfeck, B., & Townsend, J. (2004). How ‘generalized’ is the ‘slowed processing’ in SLI? The case of visuospatial attentional orienting. *Neuropsychologia, 42*, 661-671.

Snowling, M., J., Bishop, D., V., M., Stothard, S., E., Chipchase, B., & 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.

Spaulding, T., J., Plante, E., & Vance, R. (2008). Sustained selective attention skills of preschool children with specific language impairment: Evidence for separate attentional capacities. *Journal of Speech, Language and Hearing Research, 51*, 16-34.

Stanton-Chapman, T., L., Justice, L., M., Skibbe, L., E., & Grant, S., L. (2007). Social and behavioral characteristics of preschoolers with specific language impairment. *Topics in Early Childhood Special Education, 27*, 98-109.

Stothard, S., E., Snowling, M., J., Bishop, D., V., M., Chipchase, B., B., & Kaplan, C., A. (1998). Language-impaired preschoolers: A follow-up into adolescence. *Journal of Speech, Language and Hearing Research, 41*, 407-418.

Sturn, A., & Johnston, J. (1999). Thinking out loud: an exploration of problem-solving language in preschoolers with and without language impairment. *International Journal of Language and Communication Disorders, 34*, 1-15.

Stuss, D. T., & Benson, D. F. (1986). *The frontal lobes*. New York: Raven.

Torsti, J. (2010). The relationship between Behavior Rating Inventory of Executive Function (BRIEF) and neurocognitive measures – a study of children with and without attention deficit disorder. Licentiate Thesis (unpublished), University of Turku.

Ullman, M., T., & Pierpont, E., I. (2005). Specific language impairment is not specific to language: the procedural deficit hypothesis. *Cortex, 41*, 399-433.

van Daal, J., Verhoeven, L., & van Balkom, H. (2009). Cognitive predictors of language development in children with specific language impairment (SLI). *International Journal of Language and Communication Disorders*, 44, 639-655.

Vance, M. (2008). Short-term memory in children with developmental language disorder. In C. Norbury, J. Tomblin, & D. Bishop, (Eds.), *Understanding Developmental Language Disorders. From theory to practice* (pp. 23-38). Glasgow: Psychology Press.

Vygotsky, L., S. (1962). *Thought and Language*. Cambridge, MIT Press.

Webster, R., I., & Shevell, M., I. (2004). Neurobiology of specific language impairment. *Journal of Child Neurology, 19*, 471-481.

Wechsler, D. (1999). *WISC-III Käsikirja. Wechslerin lasten älykkyysasteikko* (Wechsler Intelligence Scale for Children, 3rd ed., Finnish version). Helsinki: Psykologien Kustannus Oy.

Welsh, M., C., & Pennington, B., F. (1988). Assessing frontal lobe functioning in children: Views from developmental psychology. *Developmental Neuropsychology, 4*, 199-230.

Welsh, M., C., Pennington, B., F., & Groisser, D., B. (1991). A normative-developmental study of executive function: A window on prefrontal function in children. *Developmental Neuropsychology, 7*, 131-149.

World Health Organization. (1992). *ICD-10 Classification for Mental and Behavioral Disorders: Clinical Descriptions and Diagnostic Guidelines*. Geneva: World Health Organization.

Ylvisaker, M., & Feeney, T. (2008). Helping children without making them helpless: Facilitating development of executive self-regulation in children and adolescents. In V. Anderson, R. Jacobs, & P. J. Anderson (Eds.), *Executive Functions and the Frontal Lobes* (pp.409-438). New York: Psychology Press.