

MASTERARBEIT

Nonverbal Cognitive Dysfunction in Children with Specific Language Impairment

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Abstract

Background: Specific Language Impairment (SLI) is currently defined as a significant impairment of the child's linguistic abilities on several levels (phonology, morphology, lexical, syntax, narrative) by the presence of nonverbal IQ scores in the normal range; the diagnosis is based on a set of inclusionary and exclusionary criteria including performance at least one standard deviation below age expectations on a generic language assessment but 'normal' nonverbal intelligence. According to the classical definition (ICD-10-GM version 2009; F80.- '*Umschriebene Entwicklungsstörungen des Sprechens und der Sprache*') a child with SLI performs below age expectations on language measures despite having adequate cognitive and sensory skills for typical development with no obvious identifiable cause such as hearing loss, brain injuries or other neurological disorders.

The aim of this study is to profile a child's performance across linguistic and nonverbal cognitive domains, to determine if the impairments of children affected by SLI embrace also nonverbal areas.

Methods: 25 typically developing children and 13 children with SLI between 6;2-10;0 years were tested on both their verbal and nonverbal abilities with respectively two standardized tests each. The children with SLI were all currently in therapy and classified as 'SLI' by their speech and language pathologists. All participants were from South Tyrol or Vienna and therefore German native speakers with dialectal colouring. To measure the child's nonverbal performance level the *Raven's Coloured Progressive Matrices* (parallel form) and the '*Zahlensymboltest*' (Digit-Symbol-Coding) of the *HAWIK-R* were used.

The verbal abilities were assessed with the German version of the standardized *TROG-D* (original edition by D.V.M. Bishop, 1989; German by Annette V. Fox, 2006) and the '*Digit-Span*' of the *HAWIK-R*.

Results: The results show a slight tendency towards underage-expected performance of the children diagnosed with 'SLI' in the nonverbal tests. So far, this research alludes to a range of nonverbal cognitive mechanisms interacting with language and having its implications in delineating the profile of SLI.

Conclusions: The extent to which the two domains of language and general cognitive abilities are inherently singular or modular remains unresolved and controversial. According to these findings, the definition of SLI as specifically and exclusively linked to language must be revised, since the characteristics of this developmental disorder seem to be wider than first documented.

Keywords: Specific Language Impairment, Cognition, Nonverbal IQ, Developmental Disorder;

1. INTRODUCTION

1.1 Language and Cognition

Language is crucial to all social functioning and codes human interaction within the social environment. Doubtlessly, the centrality of language in human experiences makes the study of language to one of the hottest topics in cognitive science.

Language is a very complex system; it incorporates a variety of conventional components constituting ‘the knowledge of a code for representing ideas about the world through a convention of arbitrary signals for communication.’¹ As commonly known, according to current linguistic theorems this rule-governed system is mainly composed by different components: phonology, morphology, lexicon, syntax, semantics and pragmatics.

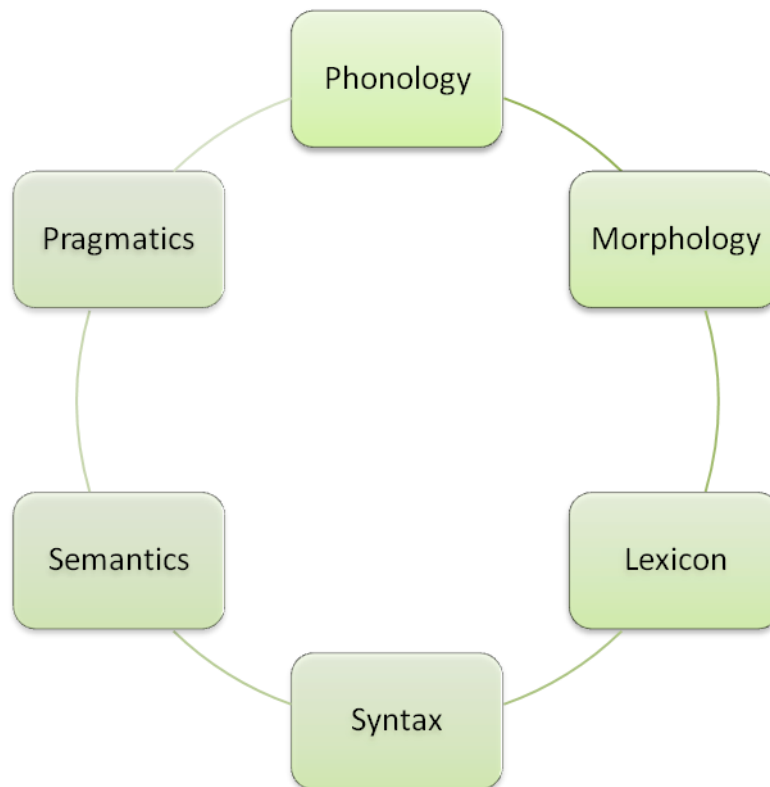


Fig.1.1.: Language components

Phonology studies how sounds are distributed and sequenced in natural languages. Every language is composed of a variety of speech sounds and phonemes (English has for instance approximately 43 phonemes) and their organization and usage is governed

¹ Bloom and Lahey, 1978, quoted in Bernstein & Tiegerman, *Language and Communication Disorders in Children*, A Bell and Howell Company, Ohio, 1985, p. 12.

by phonological rules. Phonology is of course strongly related to other aspects of language, such as morphology. *Morphology* governs the internal structure of words and rules the way they are formed from morphemes. *Syntax* composes the rule system that administrates the formation and structures of a sentence by specifying what kind of word combinations are acceptable and which are not. *Semantics* encompasses the meaning of words and their combination and pragmatics examines the usage, rules and codes of such linguistic structures when used as a mean to communicate.

Clearly, there is much more to say about those different components; the brief remarks annotated here serve the solely purpose to make the terms comprehensible for an interdisciplinary audience, since they are the key to understand normal language development as well as child language disorders. To sum up, the here mentioned and strongly overlapping components constitute language in its form, content and use and can be considered the key elements of any language.

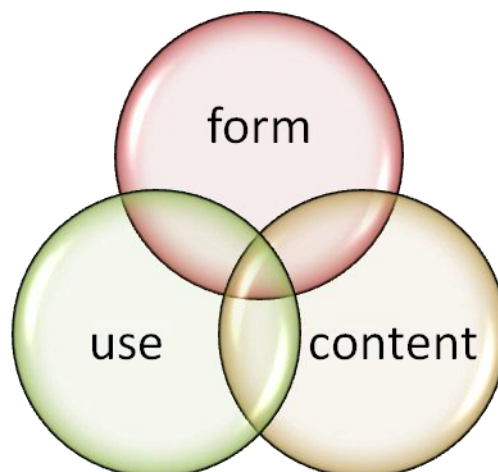


Figure 2.1 Bloom and Lahey's Model of Language

By studying language disorders, it is also fundamental to distinguish between speech and language. While speech is verbal communication involving the accurate coordination of oral neuromuscular actions, language is the system of rules previously mentioned. Naturally, not only speech sounds but also speech rate, rhythm, stress and intensity of sounds contribute for instance to the speech process. Nonlinguistic cues such as facial expressions, eye contact or gestures can also add or detract information from the linguistic message.

Finally, language and communication is a holistic system of codes embracing various components and allowing human beings to interact in their social environment. The impairment of some of these components in young children shall be subject-matter of this work.

The linkage between language development and cognitive development has been for decades a hot debate among specialists (cf. Moore, Timothy E., 1973; K.Nelson, 1996; M.Bowerman, S.C. Lewinson, 2001, D.I. Slobin, 2004; and many more) and is of main interest also for the presented work.

Cognition, here roughly defined as the entirety of mechanisms responsible for sophisticated behaviors such as awareness, perception, reasoning, linguistic performance etc., is often claimed to be both necessary and sufficient for language development. (→ ‘Strong-cognition-hypothesis’ or ‘Cognition-First Hypothesis’). This hypothesis basically states that the child is able to build up language not before cognitive structures in interaction and manipulation with the environment have developed. The assumption is that cognitive abilities serve as ‘underpinnings for language and therefore language a) depends on cognitive development and b) cognitive abilities must precede linguistic abilities.’² It is clear that language is part of a larger developmental model and that the various developmental areas interface with one another, influencing the occurrences of developmental changes in the different areas; however the traditional notion assuming a causal relationship between cognition and language has nowadays been criticized a lot. In fact, for instance Brown (1973) and Bates (1979) demonstrated that object permanence is not a required prerequisite for the early development of words. (A child comes to use a word such as “bed” before it develops object permanence.)

Various developmental models attempt to describe the interdependence of language, cognition and social development, whereas the interaction of the different areas can occur in different ways, such as direct (strong cognition hypothesis) or rather be a developmental continuum. Finally, at this point causality (linguistic development is directly tied to nonlinguistic development) has been difficult to prove and these findings have important implications for a holistic approach to non-/linguistic development.

When talking about typical and atypical cognitive development, the question what is meant by the concept ‘intelligence’ usually arises. Clearly, there is no easy answer to this question, since ‘intelligence’ is a complex construct. In 1927 Spearman proposed the notion of *g*, a concept of general intelligence or hypothetical mental power. Anderson (2001) suggested that the modern equivalent of Spearman’s theory is that differences in processing speed are the basis to differentiate in general intelligence. Hebb (1949) made

² Bernstein & Tiegerman, *Language and Communication Disorders in Children*, A Bell and Howell Company, Ohio, 1985, p. 33.

a distinction between innate intelligence and 'developed' intelligence as a result of the level of brain development as well as innate dispositions. Vygotsky suggested in the 1930's that 'analysis and generalizations form the basis for an intellectual act.'³

Intelligence as a construct is strongly general and integrates different functions.

'Defining human intelligence is further complicated by our inability to divide human behaviour into discrete segments. Ability, cognitive capability, and cognitive processes are not segments of behaviour but abstractions we have applied to an indivisible flow of behaviour. One cannot distinguish between reasoning, retrieval, perception and detection. The behaviour one sees indicates all of these, as well as motivation, emotion, drive, apprehension, feeling and more. Specifying different features of cognition is like slicing smoke – dividing a continuous, homogeneous, irregular mass of gray into...what? Abstractions. (...) Given such unsolvable problems, we can never expect to know the exact nature of intelligence.'⁴

In experimental conditions it is evidently not possible to test the 'whole picture' (for whatever it is) but realistically the 'analysis of the components of a given problem, recognition of the most essential features, and creation of a general plan (scheme) for the performance of the task are (*considered*) essential parts of intelligent thinking (Luria, 1973)'.⁵ Thus, for most researchers intelligence is per definition the ability of an individual to recognize and act successfully (and speedily) upon a given problem. However, the different trials to border and define the construct intelligence have always evoked much debate and shall not be topic of this work.

Intellectual disability is defined as a fundamental deficit in information processing. 'That is, a low IQ represents a pervasive and enduring condition, caused by slow speed of processing that does not improve through cognitive development.'⁶ In severe cases, the processing of certain information might not be possible at all. According to the ICD-10-GM coding for patients with mental retardation people with intellectual disabilities are classified into mild, moderate, severe and profound mentally retarded patients (ICD-10-GM: *leichte* (F70), *mittelgradige* (F71), *schwere* (F72), *schwerste* (F73), *dissoziierte* (F74), *andere* (F78), *nicht näher bezeichnete* (F79) *Intelligenzminderung*.). Thus, intellectual disability refers as a term to a very heterogeneous group of conditions characterized by low or very low intelligence and deficits in adaptive behaviors without reference to etiology. The causes for such an impaired information processing are usually to be found either in organic brain damage or in poor functioning of a 'normal' brain. It is important to note that intellectual disability is not to be confounded with developmental

³ Marja Asikainen *Diagnosing Specific Language Impairment*, University of Tampere, Finland, 2005, p.32.

⁴ J.L.Horn, *Measurement of Intellectual Capabilities: A Review of Theory*, 1991, pp.198-199.

⁵ Marja Asikainen *Diagnosing Specific Language Impairment*, University of Tampere, Finland, 2005, p.32.

⁶ *Ibid*, p.34.

delay since former can only be diagnosed when cognitive abilities and adaptive behaviours are notably below standard and despite some noticeable progress in learning, the individual will always be significantly below average. It is of course especially true that in young children cognitive abilities and behaviours are not easily measurable; also, children with mild developmental delay can catch up with their typically developing peers. Thus, it is to be questioned whether a diagnosis concerning intellectual disabilities is reasonable in very young children.

The development of children with an intellectual disability differs from typically developing children. Regarding language, usually a child with low IQ tends to use and work with less complex language compared to age-matching peers (exception made for children with isolated linguistic capabilities and affected by rare diseases such as the Williams-Beuren syndrome (WBS) and other). According to Spelke (2005) language affects the development of cognitive systems, which is interestingly not the case for SLI within the classical definition: the disability in verbal performance is highly selective and does not affect 'other' cognitive systems.

1.2. Language Development

a.) Typical Language Development

Typically developing children usually acquire language naturally and effortlessly without any formal instructions. Gradually throughout the first years the child learns to integrate and use idiosyncratic forms from within the family to the use of conventional forms within the society. Language is an integrated system of a huge developmental sum the child is going through and serves the main purpose to communicate; effectively, the child learns 'to choose the form and content that will best achieve his intentions within a given communication situation.'⁷

After all, this is clearly a highly complex process, in view of the fact that the child has to figure out what sounds their language uses, it needs to learn how to distinguish and produce the sound patterns of the target language, to understand how the sounds of their language can and cannot combine, it must acquire the ability to mentally represent the structure underlying those patterns, to figure out and learn what the word means, to use the word in combination with other words and finally it has to learn to correctly use the language within different situations. In sum, the child has to acquire the ability to process

⁷ Bernstein & Tiegerman, *Language and Communication Disorders in Children*, A Bell and Howell Company, Ohio, 1985, p.20.

language on all previously mentioned different linguistic levels; this long process starts already within the first months of life with the development of pre-linguistic speech sounds such as cooing, laughter and babbling. The child acquires gradually all the sounds necessary and a typically developing child can be considered 'master of phonology' by the age of five. The child develops progressively a more fluent coordination of the speech production, it becomes more and more expert in using the acquired knowledge of linguistic patterns and of course it develops a grammatical and semantic knowledge of its mother tongue.

This development is accompanied by underlying processes such as the growth of the facial skeleton, the maturation of the sensory receptors and the vocal tract muscles and of course the neurological development in higher brain structures; important for the developing child is undoubtedly also its environment and the experience of hearing adults and hearing the own vocal output (for deaf-mute individuals contact with sign language is important as well).

Finally, the process of acquiring a language requires a great deal of time and work until all pieces necessary to build up such a complex construct as language are developed. The development on the different linguistic levels must be considered as diverse phases of one continuum since all of them are strongly interconnected and overlapping.

The process of acquiring effectively and correctly a language stands at the heart of the child's development since 'effective communication and language skills are fundamental to young people's learning, developing social skills and fulfilling their potential.'⁸

b.) Atypical Language Development

However, there are children who do not develop their linguistic abilities to the same degree their peers do, the process of language acquisition comes in their case unfortunately neither naturally nor effortlessly and is most often linked to a series of developmental impairments. The causes and the symptoms of different language disorder can be as miscellaneous as the prognoses and applied therapy methods are, because language is multidimensional and dynamic and involves different interrelated processes and capabilities.

Generally speaking, children with such deficits do not match the expected linguistic performance level of their age and are either affected by a speech or language disorder.

⁸ L.S. Vygotsky, *Mind in Society*, Harvard University Press, Cambridge MA, 1978.

As previously mentioned, there is a difference to make: in case the child is unable to produce speech sounds correctly or fluently, or it is having difficulties in using his or her voice properly, then the child has a speech disorder. *Speech* disorders include for instance difficulties in pronouncing sounds, articulation disorders and stuttering.

On the one hand, when the child is having trouble in understanding spoken and sometimes written language, the area of '*receptive*' language is impaired, on the other hand the term '*expressive*' language embraces the in-/abilities to being able to produce speech and to communicate.

Traditionally, there are two major approaches to study child language disorders: *the etiological-categorical* and *the descriptive-developmental*.

The etiological-categorical approach classifies the disorder according to medical-psychological standards and focuses on the causes and etiology by differentiating the language-disordered child from his/her typically developing peers via a cluster of behaviors. Language and communication disorders are classified according to the deficits they are associated with: motor disorders, sensory deficits, central nervous system damage, severe emotional-social dysfunction or other cognitive disorders. This classification is a 'convenient way of comparing and distinguishing autistic, learning disabled, mentally retarded and hearing impaired children. Each classification is like a label that summarizes how a child is similar to, or different from, other children both within and across the disability categories.'⁹

However, there are clear limitations of this approach: first, it is rather rare to find a child who painstakingly fits into one diagnostic category since it appears that almost always several contributing factors are responsible for the language disorder and secondly, the solely classification according to etiological categories clearly does not tell us what the language profile of the child is, i.e. what it really knows about language and what it needs to learn.

The second approach *describes* according to linguistic features, rather than classifies regarding etiological factors, the disorder. According to this approach a language disorder is "any disruption in the learning or use of the conventional system of arbitrary signals used by persons in the environment as a code for representing ideas about the world for communication."¹⁰ Based on this assumption, Bloom and Lahey (1978) classify five types of language disorders in children:

⁹ Bernstein & Tiegerman, *Language and Communication Disorders in Children*, A Bell and Howell Company, Ohio, 1985, p.13.

¹⁰ Bloom & Lahey, 1978, p.290, quoted in Bernstein & Tiegerman, *Language and Communication Disorders in Children*, Ohio, 1985, p.15.

1. Children demonstrating special difficulties in learning, understanding and using linguistic forms such as phonological, morphological and syntactic rules.
2. Children demonstrating special difficulties related to the semantic component.
3. Children demonstrating special difficulties in the correct use of language unable to adjust their language to the listener's need and the contextual pragmatic codes.
4. Children with special difficulties to integrate form, context and use having association problems.
5. Children with delayed but similar language and communication skills.

This approach evidently focuses on the strengths and weaknesses of the child and identifies an individual language profile of the affected individual. Clearly, it is also absurd to assume that therapy to a language-disordered child is solely based on his linguistic handicap irrelevant to his environmental conditions. Thus, neither of both above mentioned approaches provides a complete definition of language disorders. Alternatively, the American Speech-Language-Hearing Association (ASHA) defines language disorders in the following way:

'A language disorder is the abnormal acquisition, comprehension or expression of spoken or written language. The disorder may involve all, one or some of the phonologic, morphologic, semantic, syntactic or pragmatic components of the linguistic system.'¹¹ This definition lines out what components, modalities and processes might be affected in individuals with language disorders.

Concerning the language disorder this work is focusing on, namely Specific Language Impairment (hereafter SLI), the classification and delineation of the profile according to both, the etiological-categorical as well as the descriptive-developmental approach lacks integrity. In fact, thus far little is known about the exact etiological background while the incredible abundant and miscellaneous symptomatology of children with SLI shipwrecks somewhat the descriptive approach (cf. next section).

Concerning the etiology, much research has been done and different reasons on genetic and molecular basis have been considered responsible for the linguistic impairment of such children. Effectively, so far there is some indication for different brain regions to be more likely linked to SLI than others, yet there is still much uncertainty left. Besides brain abnormalities, some researchers also suggest a possible genetic link because evidently genes determine brain development and in several studies (Tallal et al., 2001) it has been proved that SLI can be passed down from parents to children.

¹¹ ASHA (American Speech Language Hearing Association), Definitions for communicative disorders and differences, 1980, pp.317-318.

But here again, one of the major stumbling blocks in finding out the etiological factors of this disease lies in the definition of the disorder itself, since children with SLI show many different kinds of symptoms making it hard to determine what the average profile of a child with SLI should look like.

1.3 SPECIFIC LANGUAGE IMPAIRMENT (SLI)

a.) Definition and Symptomatology

An individual that demonstrates language disorders shows impaired linguistic abilities within an abnormal acquisition, comprehension or expression of spoken and/or written language. 'According to the definition, impairment is in language comprehension (understanding), expression (formulation), or a combination of both. These deficits may be noted in listening and speaking or in reading and writing. Language-disordered children may have difficulty in processing linguistic information, organizing and storing it, and retrieving it from memory.'¹² Generally speaking, children with such deficits do not match the expected linguistic performance level of their age.

So far, there is still no consensus on the definition of the 'right' terminology to describe children who are not acquiring language normally; professionals use different terms, such as 'deviant language', 'language disorder', 'language disability', 'delayed language'. The term 'language disorder' will be used here as an umbrella term to describe 'certain behaviors, or the lack of certain other behaviors, in a child that are different from the behaviors that might be expected considering the child's chronological age.'¹³ Furthermore, it is important to note that the term 'language disorder' is a descriptive label rather than a diagnostic entity that explains the behavior. In fact, this term refers to any disruption in the acquisition of the conventional system of the arbitrary code for representing ideas about the world used by the people in the child's environment.

During the last three decades, the term **SLI** (Specific Language Impairment → in German: *SSES (spezifische Sprachentwicklungsstörung), Dysphasie, Entwicklungsdysphasie*) became more and more popular to describe individuals with serious but seemingly isolated deficits in language ability. In fact, Specific Language Impairment (SLI) is currently defined as a significant impairment of the child's linguistic abilities on one or several levels (phonology, morphology, lexical, syntax, narrative) by the presence of nonverbal IQ scores in the normal range; the diagnosis is based on a set of inclusionary and exclusionary criteria including performance at least one standard deviation below age expectations on a generic language assessment but 'normal' nonverbal intelligence. According to the classical definition (ICD-10-GM version 2009;

¹² Bernstein & Tiegerman *Language and Communication Disorders in Children*, Bell & Howell Company, Ohio, 1985, p. 16.

¹³ L. Bloom & M. Lahey, *Language Development and Language Disorders*, John Wiley and Sons, Inc., USA, 1978, p.290.

F80.- 'Umschriebene Entwicklungsstörungen des Sprechens und der Sprache') a child with SLI performs below age expectations on language measures despite having adequate cognitive and sensory skills for typical development with no obvious identifiable cause such as hearing loss, brain injuries or other neurological disorders.

*'Neueren Datums ist der Begriff der Spezifischen Sprachentwicklungsstörung (SSES, engl. SLI specific language impairment; Leonard 1998) (...) Definitionsgemäß ist allerdings festgelegt, dass bei dem Konstrukt einer SSES das eigenständige Bild einer Entwicklungsbeeinträchtigung vorliegt und andere Krankheitsbilder ausgeschlossen sind (Ausschlusskriterium). Neurologische oder neurophonetische Störungen wie Aphasie, verschiedene Formen von Dyspraxien oder Dysarthrien im Kindesalter (Entwicklungsdysarthrophonie) dürfen nicht bestehen.'*¹⁴

The study of SLI is not new, but the terminology to designate such impairment changed constantly (developmental dysphasia, language delay etc).

Already back in 1822 Gall published a description of children with language impairments, stating:

There are many children who do not speak to the same degree as other children although they understand well or are far from being idiotic. In these cases the trouble lies not in the vocal organ, as the ignorant sometimes insist, and still less in the apathetic state of the subject. Such children, on the contrary show great physical vivacity. They do not only skip about but pass from one idea to another with great rapidity.'¹⁵

Considerably is the heterogeneity of language profiles of affected children: the wide-ranging level and the area of impairment can be noticeably diverse among children with SLI. Usually, the impairment embraces several linguistic levels and is analyzed and treated according to the different components affected. The current literature on SLI seldom defines a language profile as "typical" for SLI since the spectrum of the disorder is very broad and yet unclear. However, children affected by SLI can have at different stages different deficits on all/some/one linguistic levels, that is phonological, morphological, lexical, syntax, semantic; consequently they usually reveal problems in the use of the written language and of course in pragmatics.

As already stated, the grammatical profile of a child with SLI embraces different levels and looks usually as following:

¹⁴ A. Welling, (2006) *„Einführung in die Sprachbehindertenpädagogik“*, Ernst Reinhardt GMBH&CO, München, pp.83-84.

¹⁵ Gall, Quoted in Laurence B. Leonard, *Children with Specific Language Impairment*, 2000, pp. 5-6.

→ Syntax:

Most individuals affected by SLI have syntactic impairments in both, their expressive and receptive language. In syntactic expression they especially have difficulty in producing and following appropriate word order constructions, in connecting more complex word patterns, in using adjuncts, in formulating wh-questions and especially in the representation and usage of grammatical elements belonging to the functional group. Since morphology interacts closely with syntactic arrangement, both, morphology and syntax are in SLI subjects usually impaired. When it comes to receptive tasks, they show impaired ability to assign thematic roles in passive constructions (this was also proven within this project with the TROG-D test), as well as assigning reference to reflexives (van der Lely, 1994) and pronouns. Moreover, children with SLI have troubles in identifying sentences with grammatical violations, that is, they do not easily recognize whether a sentence is grammatically correct or incorrect. However, they do realize when semantic mistakes occur (for instance: 'the water rides a bike'). It is to be underlined here that individuals with SLI demonstrate not in all aspects of syntax impairments. Ullman and Pierpont (2005) state in their work that children with specific language impairment have less difficulty with items stored in the lexical memory i.e. high frequency phrases are easier memorized and retrieved. Generally speaking, children with SLI tend to generalize syntactic structures which they have memorized ('syntactic bootstrapping'); furthermore, children with SLI tend to omit obligatory elements of the sentence, most often function words (auxiliary, articles, prepositions); thus, their use of syntax is very rigid and lacks variety.

→ Morphology:

Individuals with SLI demonstrate impairments on the morpho-syntax as well as on the morpho-phonology level; their morphological production is rather poor and anomalous, they do not easily know what changes are required to individual words according to the way in which they are used (such as agreement pattern for instance). Children with SLI have especially problems with verbal and nominal inflection structures, in forming the agreement pattern, with the case markers and with pluralization. To sum up, they have significant difficulties in forming and using inflected forms. Also, children with SLI show abnormally few overregularizations (Clahsen et al., 1993) of past-tense forms and pluralizations; this means that they are not able to make use of their morphological knowledge productively. While most research with individuals affected by SLI has been done with English native speakers, there is also evidence from other languages such as German (Clahsen, 1995; Rothweiler and Clahsen, 1993), Italian (Bortolini et al., 2002;

Leonard et al., 1992a), Hebrew (Dromi et al., 1993), Japanese (Fukuda and Gopnik, 1994; Fukuda and Fukuda, 1999, 2001), Inuktitut (Crago and Allen, 1994, 1996), Swedish (Hansson and Nettelbladt, 1995), Finnish (Niemi, 1999), Dutch (Wexler et al., 1998) and Greek (Dalalakis, 1994).¹⁶ Hence, there is no doubt left about the morphological deficits in people with SLI all across the languages.

→ Phonology:

Children with SLI have difficulties in picking up and processing the phonological structure of words; however, also here not each aspect must be impaired. Novel phonological forms are remarkably difficult to process while memorized phonological representations stored in the lexical memory are mostly unproblematic (children tend to use repeatedly during the experiments stereotypes such as *'äh wie sagst'* or *'weiß ich nicht, musst mir helfen'*); this tactic, to memorize complex forms as chunks, is a typical compensation strategy used by children with SLI.

Children with SLI all show severe difficulties on the popular non-word repetition task suggesting therewith that their ability to phonologically process the language is mainly impaired. In sum, SLI subjects acquire the phonological inventory of their language at an extremely delayed rate and will not use as complex syllables structures as their peers do. 'Several investigators have argued that the phonological system of children with specific language impairment may not be as highly adaptive as that of normally developing children (Leonard, 1989; Kamhi and Catts, 1986; Kamhi et al., 1985): children with SLI have difficulty using the phonetic properties of a word to categorize, differentiate and generalize among words and their parts.'¹⁷

Children with SLI are most often also unable to uptake the rhythmic-prosodic aspects of their mother tongue.

→ Lexicon:

Their initial vocabulary is limited to sparse words (often names) and frequently the child produces utterances comprehensible exclusively by its attachment figure(s). These early words usually have a simple syllable structure ('homophones') and show a limited phoneme repertoire. The vocabulary of children with SLI increases very slowly. They usually have problems to access their mental lexicon and differ from typically developing children with longer latency periods; mismatching of words is common.

¹⁶ Ullman & Pierpont, *Specific Language Impairment is not Specific to Language: the Procedural Deficit Hypothesis*, Georgetown University, 2005, p.416.

¹⁷ Ibid, p.417.

However, some studies (Leonard, 1982; Dollaghan, 1987; Rice et al., 1994) reported unimpaired lexical processing in children with SLI under conditions of strong contextual support (when the child can infer the meaning by direct observation of an action or object) and repeated and focused input.

→ **Pronunciation:**

Some children have heavy pronunciation problems (sometimes they are so severe that other dimensions of this impairment are rather overlooked). Mispronunciation of certain phonemes is usual, and some children do not develop the ability to produce some or all sounds necessary for speech that are normally used at his or her age ('phonological disorder'). However, most articulation problems can be significantly and effectively diminished by therapy.

→ **Semantics:**

The child with SLI also often has difficulties learning language incidentally, that is, he/she demonstrates difficulties in fast mapping or generalizing a new form. This stands in decided contrast to the normal child's case, where incidental learning and generalization are the hallmarks of language acquisition. Children with SLI have most problems when meaning must be inferred by analyzing the grammatical structures, when linguistic information is presented speedily and when a large amount of linguistic data has to be held and processed in working memory.

Thus - the spontaneous speech of an affected child usually contains:

→ Incorrect or omitted morphological endings
→ Mistakes in word order
→ Telegraphic speech style
→ Omission of function words, auxiliary verbs
→ Wrongly selected negatives
→ Irrelevant details and contradictions
→ Inability to stay at the topic
→ Inability to answer questions appropriately

The occurrence of SLI is about 7% (Tomblin et al., 1997) in the overall population and generally males are more affected than females. Moreover it has been proven that children with SLI are more likely to be found in families with history of language learning problems.

The language problems in the group of SLI often persist beyond childhood; achievements, especially in children who are in therapy, can be seen over time, but a certain weakness in language is often still noticeable in adolescence and even in adulthood. Numerous retrospective studies testing young adolescents and adults have been done (cf. Tomblin, Freese and Records 1992; Gopnik et al., 1995;) and proved that the participants with a history of SLI scored on several measures employed lower than the control group at the same age without known language problems.

SLI is generally treated by speech and language intervention programs focusing on helping the child to develop whatever specific linguistic weakness he or she is having. Early intervention is necessary since the child with SLI may become increasingly aware of his or her difficulties with language and may lose spontaneity and avoid speaking as he or she gets older. Intensive and appropriate language intervention can allow children to make considerable gains, not only in developing the missing linguistic structures but also in helping the child to cope with its weaknesses. However, a proper therapy is based on the correct diagnosis embracing all developmental issues the child is having trouble with. Insofar, it is doubtlessly most important to delineate the realistic profile of this disease.

b.) Differential Diagnosis

The diagnosis of SLI is based on 'as much exclusion as on inclusion'¹⁸. This means that there are certain inclusionary criteria, such as of course a significant deficit in language ability on one or more linguistic levels, but 'the trick is to distinguish SLI from other disabling conditions of which language problems are a part'¹⁹. Effectively, there are certain knock-out criteria, according to which SLI is excluded. Schecker et al. (2006) illustrate when we *cannot* diagnose SLI:

- ➔ In case of sensory damage concerning the auditory and visual processing.
- ➔ In case of heavy neurological impairments such as structural and functional impairments because of tumors, infarcts or epileptic seizures.
- ➔ Emotional impairments such as childhood depression or attention-deficit hyperactivity disorder (ADHD) as far as they can be considered to cause the language difficulties.

¹⁸ Laurence B. Leonard, *Children with Specific Language Impairment*, MIT Press, 1997, p.10.

¹⁹ Ibid.

- ➔ Mental disorders in case they account for the linguistic deficits; usually children with a nonverbal IQ around 80 (two standard deviations below the mean compared to typically developing children of the same age) are excluded;
- ➔ In case of cultural deprivation, of lacking support and encouragement; influence of social and cultural factors;

If any of the above mentioned factors is present, the language disability can be considered the consequence of the physical or psychological impairment.

The following table sums up the ICD-10 Research Diagnostic Criteria for specific developmental language disorders:

FACTOR	CRITERION
Language ability	Standardized language test scores of -1.25 SD or lower
Nonverbal IQ	Performance IQ of 85 or higher
Hearing	Pass screening at conventional levels
Otitis media effusion	No recent episodes
Neurological Dysfunction	No evidence of seizure disorders, cerebral palsy, brain lesions;
Oral structure	No structural anomalies
Oral motor function	Pass screening using developmentally appropriate items
Social background	No deprivation

Tab. 2.2. Summary: criteria for the diagnosis of SLI

Thus, the term SLI refers nowadays to a significant impairment in a child's language ability when there is no accompanying condition such as mental or emotional retardation/impairment, neurological damage, auditory or visual impairment, social or cultural deprivation; the language disability in such cases is as severe that it interferes with academic achievement and with social communication.

‘Zusammengefasst zielt damit die Rede von einer Spezifischen Sprachentwicklungsstörung darauf ab, dass wir es einmal mit einem eigenständigen Krankheitsbild zu tun haben. Zum anderen wird dessen Selektivität betont – betroffen sind im Wesentlichen nur sprachliche Leistungen.’²⁰

In sum, the child fails to acquire language normally at an appropriate age although it shows no evident impairments accounting for such a deficit. Children with SLI may pass conventional audiometric screenings although they process sounds unusually and the vast majority of the affected children pass neurological sensorimotor examinations, too. (However, some studies report that children with SLI show problematic visual, auditory, tactile and phonetic processing; (cf. Bishop 1990; Powell and Bishop, 1992;).

As said before, the process of language acquisition begins in the case of SLI delayed, proceeds inconsistently and desynchronized by average nonverbal intelligence. Given the discrepancy between nonverbal and verbal IQ, some researches sustained the possibility that children with SLI cannot be considered disordered at all, but are ‘just’ at the lower end of the distribution concerning their linguistic abilities.

It is important to note that the language problems in such cases were present from birth on, they did not materialize at age two or three as the consequence or side effect of some illness or psychological trauma although they are often first recognized in preschool children.

According to the ‘classical’ definition we can characterize SLI when children have significant limitations in their linguistic performance, yet the factors usually accompanying and accounting for language learning problems – such as hearing impairment, low nonverbal intelligence or neurological damage – are not evident. The exclusivity of this impairment is according to Leonard a real ‘curiosity, especially in the light of the many language acquisition papers that begin with a statement to the “effect” that all normal children learn language rapidly and effortlessly.’ (L.B. Leonard, Children with Specific Language Impairment, 1998).

After all it is clear that the differential diagnosis, based on the selectivity of the disease, stands at the heart of this developmental disorder. This point of view is put within this work into question, assuming that the ‘exclusivity’ of the diagnostic procedure is not tenable in reality.

²⁰ Schecker et al., quoted in A. Welling, *Einführung in die Sprachbehindertenpädagogik*, Ernst Reinhardt GMBH&CO KG, München, 2006, p.89.

c.) Etiology

New imaging techniques aimed (and still aim) to find etiological factors for specific language impairment and tried to figure out the relationships between linguistic disabilities/abilities and the neurophysiological background. Investigations of genetic, neurocognitive, and molecular mechanisms are an attempt to find the biological reasons giving rise to language impairment out. So far, evidence from structural neuroimaging, metabolic neuroimaging, postmortem brain examination and functional neuroimaging point towards the following:

‘Despite the wide range of neural regions examined across studies, and the likelihood of etiological heterogeneity in the SLI populations across these studies, there appears to be consistent evidence that SLI is strongly associated with abnormalities of at least two structures: *frontal cortex* and *the basal ganglia*. To our knowledge, every study that has explicitly examined frontal regions has reported frontal abnormalities (Clark and Plante, 1998; Cohen et al., 1989; Denays et al., 1989; Gallagher and Watkin, 1997; Gauger et al., 1997; Jernigan et al., 1991; Kabani et al., 1997) (KE family: Liegeois et al., 2002; Vargha-Khadem et al., 1998). This seems to hold especially for inferior frontal regions (Clark and Plante, 1998; Cohen et al., 1989; Gauger et al., 1997; Jernigan et al., 1991; Lou et al., 1984) (KE family: Liegeois et al., 2002; Vargha-Khadem et al., 1998), in particular for Broca’s area (Gauger et al., 1997; Lou et al., 1984) (KE family: Liegeois et al., 2002; Vargha-Khadem et al., 1998). (...) Similarly, all studies that we are aware of that have examined the basal ganglia in developmental language impairment have reported abnormalities of these structures (Jernigan et al., 1991; Tallal et al., 1994) (KE family: Liegeois et al., 2002; Vargha-Khadem et al., 1998; Watkins et al., 1999).’²¹

Here, the main focus of attention was dedicated to the language-relevant brain areas and in fact some indication of an association between SLI and structural brain abnormalities could be found. However, while it seems to be proven that especially the frontal regions (Broca’s area) and the basal ganglia are affected (esp. caudate nucleus) also other regions, such as the posterior perisylvian regions, including the planum temporale seem to be affected in subjects with SLI (cf. Cohen et al., 1989; Gauger et al., 1997; Jernigan et al., 1991;) Thus, while some researchers (Ullman and Pierpont, 2005) claim that such abnormalities may not be directly linked to SLI and are tricky to interpret, there is clearly thus far no consensus on the anatomical brain structure of a person affected by SLI; effectively, some researchers such as Ullman and Pierpont postulate the so-called procedural deficit hypothesis (PDH), which can largely explain the abnormal language acquisition because of the impaired procedural memory function. The procedural memory is considered to be constituted by an ensemble of brain structures such as the

²¹ Ullman & Pierpont, *Specific Language Impairment is not Specific to Language: the Procedural Deficit Hypothesis*, Georgetown University, 2005, p.410.

frontal/basal-ganglia circuits which in fact seem to be in most individuals with language impairment abnormally developed. 'The PDH posits that a significant proportion of individuals with SLI suffer from abnormalities of this brain network, leading to impairments of the linguistic and non-linguistic functions that depend on it. In contrast, functions such as lexical and declarative memory, which depend on other brain structures, are expected to remain largely spared.'²²

Other findings suggest developmental brain abnormalities such as ventricular enlargement, white matter abnormalities and central volume loss (Tauner et al.; 2000), even others found neural migration anomalies at autopsy studies (Galaburda & Kemper, 1979).

In sum, the brain of affected children seem to differ from typically developing children in their anatomy; however, as heterogeneous the symptomatology of SLI is, as heterogeneous seems the anatomy of affected people's brain to be. Doubtlessly, different brain regions seem to account for the linguistic impairment of children with SLI and similar developmental disorders thus far only little is known about the exact cause or origin of specific language impairment. Yet little doubt is left that the underlying condition may be a form of brain abnormality. Thus,

'the exact ways in which the biological differences contribute to language impairment are unknown. (...) The studies of children with SLI have provided relatively precise details about the nature of the children's language impairments, although the investigations of etiological factors are at early, and inconclusive, stages of inquiry.'²³

Hence, so far there is some indication for different brain regions to be more likely linked to SLI than others, yet there is still much uncertainty left. However, besides brain abnormalities, there is some indication suggesting a possible genetic link because evidently genes determine brain development and in several studies (Tallal et al., 2001) it has been proved that SLI can be passed down from parents to children. But here again, one of the major stumbling blocks is the definition of the disorder, because children with SLI show many different kinds of symptoms which makes it hard to determine what the genetic cause of the disorder might be.

Recent studies examining the FOXP2 gene during different developmental stages came to the conclusion that mutations of this gene are likely to be found in individuals with language problems. The FOXP2 gene was found to be expressed in several brain regions such as the caudate nucleus, the substantia nigra and the cerebellum as well as

²² Ibid.

²³ Rice, Warren & Betz, *Language symptoms of developmental language disorders: An overview of autism, Down syndrome, fragile X, specific language impairment, and Williams syndrome*, Applied Psycholinguistics, 2005, Cambridge University Press, p.8.

in certain cortical regions. In consequence researchers conclude that the problematic development of brain structures responsible for language acquisition may arise from mutations of the FOXP2 gene. However, it is most important to underline here that the source of linguistic disorders is expected to be various among all individuals affected. In fact,

'some may have mutations of the FOXP2 gene, while many others show no evidence of such mutations (Meaburn et al., 2002; Newbury et al., 2002), and instead suffer from other etiologies. Moreover, FOXP2 is not expected to be the only gene involved in PLD – although a recent study found that SLI was strongly associated with genetic markers adjacent to FOXP2, suggesting that “genetic factors for regulation of language impairment reside in the vicinity of FOXP2” (O'Brien et al., 2003). Note that even if a genetic component can lead to the disorder, an environmental component may also be necessary. (...) Even if the abnormality in an individual with SLI is initially circumscribed to specific brain structures, other structures may also be affected as development ensues. Thus evidence suggests that a dysfunction which is at first restricted to one structure can lead to problems in others during development, partly due to their inter-connectivity (Levitt, 2000; Neville and Bavelier, 2000; Rakic et al., 1991; Sur and Leamey, 2001).'²⁴

Hence, so far we can certainly link language impairments to brain abnormalities given raise by different and very probably genetic causes. However, since the developing brain is highly plastic, functions of abnormal developing tissue can be compensated by similar healthy tissue. Thus abnormalities in different above mentioned brain regions can be compensated by other structures and may account for the gradual improvement of the linguistic abilities in children with language impairments.

Besides neurological and genetic investigations, some investigators have accredited the difficulties of children with SLI to problems with speech sound perception, suggesting that inflection and word forms such as endings are hard for the child to perceive because those items are fleeting and unstressed in speech. This means, that the child has particularly problems in discriminating some speech sounds.

Others argue that this difficulty is not specifically linked to speech but reflects rather a general perceptual difficulty with the processing of rapidly timed events; clearly, speech is one of the most demanding examples of highly timed events. Here it is assumed that brain regions specialized for processing rapid acoustic events in the left hemisphere are impaired.

To sum up, different etiological factors accounting for language impairments have been proposed; so far, the exact ways in which neurophysiological causes contribute to impaired linguistic development are not fully clear, however there are considerable

²⁴ Ullman & Pierpont, *Specific Language Impairment is not Specific to Language: the Procedural Deficit Hypothesis*, Georgetown University, 2005, p.407-408.

indications that specific brain regions as well as genetic mutations are partly responsible for the disorder.

d.) Inconsistency of the Diagnosis

The above given definition clearly lines out that children with SLI are typically developing in all issues except for language. The only apparently “abnormal” feature of these youngsters is that they do not acquire language effortlessly and rapidly within age-expected levels.

However, the clear discrepancy between the verbal and nonverbal abilities of such children has also been questioned. Effectively, *‘habe eine Vielzahl der betroffenen Leistungsbereiche bislang noch nicht zu schlüssigen Erklärungen für eine differenzialdiagnostische Differenzierung geführt, so auch nicht für SSES (...)’*²⁵

In fact, as said before, SLI as a classification is rather heterogeneous, there is doubtlessly symptomatological variation within and across subgroups of SLI; particular aspects of language can and cannot be affected among individuals diagnosed with SLI and the severity with which these linguistic deficits are found can vary a great many. Unfortunately, too less research in this area has focused on classification of distinct SLI subgroups and yet there is no clear categorization of the different SLI-types.

However, there is some indication that despite the standard use of exclusionary criteria, the disorder is not limited to language. ‘Rather, the linguistic impairments co-occur with a number of non-linguistic deficits, including impairments of motor skills and working memory, and with other disorders, such as Attention Deficit Hyperactivity Disorder (Hill, 2001; Leonard, 1998; Tirosh and Cohen, 1998).’²⁶ Moreover, also Ullman and Pierpont (2005) underline with their research the co-occurrence of SLI with other non-linguistic deficits causes by abnormal development of brain structures forming the basis of the procedural memory system.

Also Judith Johnston (1993) suggests that researchers and speech and language pathologists overestimate the nonverbal cognitive performance of children with SLI since in her experiments children with SLI performed less well compared to their age peers on a range of nonverbal test items (cf. Schöler, 1992; Schöler & Fromm, 1995).

²⁵ A. Welling, (2006) *„Einführung in die Sprachbehindertenpädagogik“*, Ernst Reinhardt GMBH&CO KG, München, p.90.

²⁶ Ullman & Pierpont, *Specific Language Impairment is not Specific to Language: the Procedural Deficit Hypothesis*, Georgetown University, 2005, p.399.

In 2004 Bishop notes that measures of verbal - nonverbal discrepancy may have poor reliability and according to Johnston (1997) children with SLI show evidence that their visuo-spatial skills are also impaired: 'In summary, data from studies of symbolic play, visual imagery, perception and attention strongly suggest that the cognitive dysfunction and/or limitations of SLI children do extend to the nonverbal areas. All but the play studies (...) point to abnormalities in rate and/or efficiency with which the information is handled.'²⁷

All these studies demonstrate that the range of SLI is still weakly bordered and the real spectrum of the disorder is still not fully identified.

In fact, SLI is still somewhat a mystery when it comes to delineate the profile since children have on the one hand evident language problems with a rather unclear etiological background and on the other hand they can clearly not be considered mentally retarded given that their average nonverbal intelligence is usually not conspicuous.

²⁷ J. R. Johnston, *Specific Language Impairment, Cognition and the Biological Basis of Language* in *The Inheritance and Innateness of Grammars*, Vancouver Studies in Cognitive Science 6, New York, Oxford University Press, 1997, p.170.

2. QUESTIONS AND HYPOTHESES

a. Questions

Based on the discrepancy and vagueness of current literature in defining the profile of children with SLI, especially regarding their nonverbal performance, the following issues were raised:

- ➔ 1. Are there differences between the performance level of the nonverbal tasks in typically developing children and in children with specific language impairment?
- ➔ 2. Is the performance level of children with SLI considerably lower in standardized nonverbal tests compared to typically developing children? I.e. are typically developing children outbalancing children with SLI in both, verbal and nonverbal, tests?

b. Hypotheses

Contrariwise to the above (first section) mentioned classical characteristics of SLI, the following **hypotheses** were assumed:

- ➔ Children with language impairment show significantly worse performance on both verbal but also nonverbal tests compared to typically developing children without language problems.
- ➔ Children with so-called SLI score not only under age-expected levels on verbal, but also on nonverbal tasks
- ➔ The difficulties children with SLI are having do not only regard the processing of language, but embrace also other cognitive functions.

3. METHODS

The premises for the build-up of an adequate test battery for this project were basically two: first, the test material must assess verbal as well as nonverbal abilities and secondly, the material used must be standardized for German speaking children aged 6-10 years. Finally, the choice was made for four different test items to assess the verbal respectively the nonverbal abilities of the participant: to 'measure' the child's nonverbal performances level the *Raven's Coloured Progressive Matrices* (parallel form) and the 'Zahlensymboltest' of the HAWIK-R (*Hamburg Wechsler Intelligenztest für Kinder*) was used. The verbal part of the test session consisted of the TROG-D and the popular 'Zahlennachsprechen'-test again taken out of the HAWIK-R.

a.) *Raven's Coloured Progressive Matrices (parallel set)*

Description: This nonverbal test is used to measure the child's ability to form perceptual relations and to reason by analogy independent of language and formal schooling. The Raven's Coloured Progressive Matrices (hereafter CPM) measure clear-thinking ability and is designed for young children aged 5;0-11;0 years and older adults. Effectively, the CPM can be used to assess the degree to which children and adults can think clearly, or the level to which their intellectual abilities have deteriorated in cases where the intellectual ability has become impaired.

The test consists of 36 items in three sets (A, Ab, B), with 12 items per set. The three sets of 12 items are arranged to assess the chief cognitive processes of which children under 11 years are usually capable. The CPM items are progressively increasing in difficulty and arranged to assess cognitive development up to the stage when a person is sufficiently able to reason by analogy and adopt this way of thinking as a consistent method of inference. This stage in intellectual maturation appears to be one of the earliest to decline as the result of organic dysfunction.

The test is said to be a reliable measures of Spearman's g.

Author: J.C. Raven

Time: depending on the child's ability, the test lasted between 6-10 minutes.

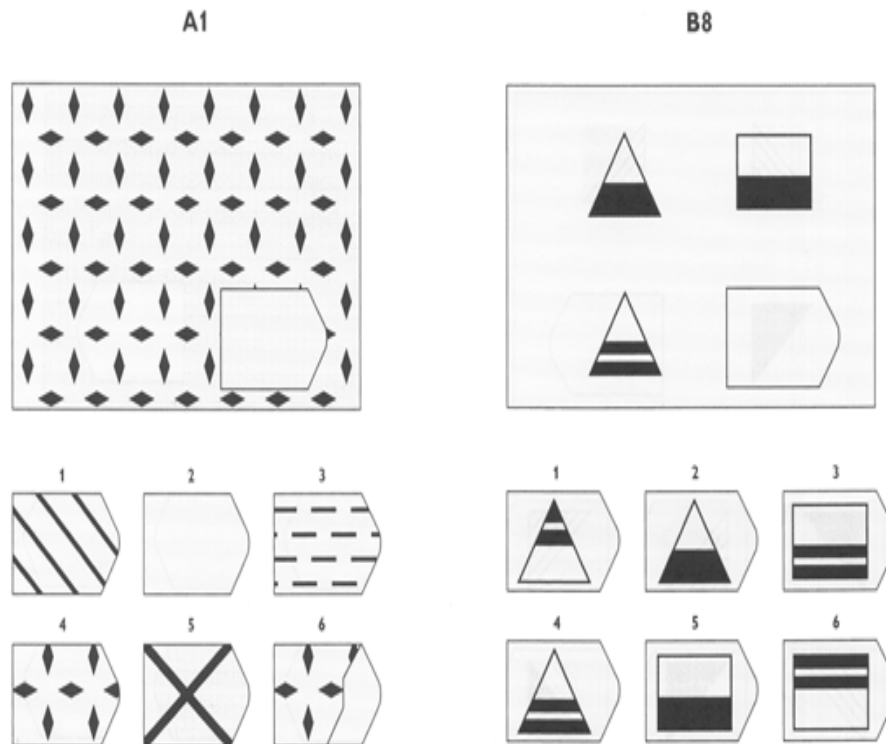
Score: The Raven's CPM produces a single raw score that can be converted to a percentile based on normative data collected from various groups; as said before, the Raven's Coloured Progressive Matrices consist of 36 items arranged in three sets (A, AB & B) of 12 items each. Each rectangular item contains a form with a missing piece. Below the figure are six alternative pieces to complete the fragmentary figure, only one of the presented choices is correct. Each of the three different sets entails a different principle or theme for obtaining the missing piece, and within one set the twelve items are arranged the way they become increasingly more difficult ('progressive' matrices). The raw score is converted to a percentile rank by using the appropriate norms. The norm groups in the manual included in the presented and used version of CMP children from 3;9 to 11;8 years.

Reliability: Different studies proofed to internal consistency using either the split-half method corrected for length or KR20 estimates result in values ranging from .60 to .98, median of .90. Test-retest correlations range from a low of .46 for an eleven-year interval to a high of .97 for a two-day interval while the median test-retest significance is approximately .82.

Validity: Spearman himself considered the Standard Progressive Matrices to be one of the most reliable measures of g. When statistical evaluated by factor analytic methods which were used to define g initially, the Standard Progressive Matrices come 'as close to measuring it as one might expect. The majority of studies which have factor analyzed the SPM along with other cognitive measures in Western cultures report loadings higher than .75 on a general factor. Concurrent validity coefficients between the SPM and the Stanford-Binet and Wechsler scales range between .54 and .88, with the majority in the .70s and .80s.'²⁸

Norms: Norm groups included in the manual are: German children between the ages of 3;9 – 11;8; Swiss children (5;9 – 10;2), Spanish children (3;9 – 9;8), American children (5;3 - 11;8).

²⁸ Center for Psychological Studies, NOVA, Southeastern University;
www.cps.nova.edu/~cphelp/RSPM.html



Tab.3.1 Examples from the Coloured Progressive Matrices

b.) TROG-D

Description: The verbal abilities were assessed with the German version of the standardized *TROG-D* which is used to test a child's (3;0-10;11) general linguistic and grammatical comprehension. However, some items (Set 'R') were discarded since the linguistic construction is not common in the children's dialect and therefore not recognizable by the young participants.

TROG-D is a receptive language test which assesses understanding of German grammatical contrasts such as inflections, word order, prepositions and case markers. The test is administered as a work-book and can be used with children aged four years and upwards. Through comparison with the provided normative data, the *TROG-D* allows to determine a client's level of grammatical comprehension. The test also allows identifying and diagnosing specific areas of grammatical difficulty displayed by the participant.

The *TROG-D* is made up of 80 four choice items. These items are arranged in blocks of four to amount to 20 subtests, one for each grammatical contrast. They're arranged in increasing order of difficulty, where the first item of each subtest is a practice item. The examiner reads the sentence off the scoring sheet

and the child has to point at the right response out of four pictures. For each item, the child is scored as either correct or incorrect. This number can then be converted into percentiles relative to the child's age and standard scores and then be compared with the age equivalents provided.

In case the participant asks for a repetition of the statement then it is given and the examiner indicates the repetition on the scoring form. If the child did not respond to the statement it was repeated after five seconds. If there was no response after a further five seconds, the examiner moves on to the next item, however the children tested in this study always answered to each item. The discontinuation rule is five consecutively failed subtests.

Since all pictures are clearly drawn, brightly colored and age appropriate, most children enthusiastically collaborated.

Author: original edition by D.V.M. Bishop, 1983; the used version was of course the German one by Annette V. Fox and Susanne Vogt, 2006.

Time: The TROG-D manual states that the administration time is ten to 20 minutes. However, the actual time taken in trials conducted was below this range since the duration may vary depending on the examiner and their rate of speech as well as the response time of the examinee. Also, since most children were older than six years, the test started at the set D. All in all, in this study depending on the child's ability, the test lasted between 8-15 minutes.

Score: For each item, the participant is scored as either correct or incorrect. Once all items in a subtest have been administered, the client is scored with either a pass (P) for all items correctly answered or a fail (F) for any incorrect answers. The in-/correct answers are recorded on the quantitative results summary page on the record form. Once all subtests have been administered the examiner counts the total number of blocks passed and records the number at the foot of the table. This number can then be converted into percentiles relative to the client's age and standard scores and then be compared with the age equivalents provided. Overall, the scoring is straightforward and not overly time consuming.

Reliability/Norms: In 2004 data of 739 monolingual normally developing children aged 3;0-9;11, of 108 monolingual children currently in speech and language therapy, 119 bilingual typically developing children and 96 adults were collected

using the TROG-D. The collected data lead to sound T-scores and percentiles for normally developing children aged 3;0-9;11. Moreover, 'they showed

- ceiling effects for the adults assessed
- that children with phonological delays or disorders only performed age equivalent
- that children with SLI performed one or two standard deviations below the norm
- that successive bilingual children in kindergarten scored about two standard deviations below the norm.' ²⁹

After the findings of this data collection, the test was revisited and a second data collection was carried out 'assessing 870 monolingual normally developing children aged 3;0-10;11 (T-scores and percentiles available), and 160 adults. Additionally a validation study was carried out testing 53 children with a) the TROG-D and b) the language comprehension subtest of SETK3-5 (Grimm, 2002). Correlations between Language Comprehension subtest of SETK 3-5 and TROG-D high: $r = .72$.'³⁰

c.) HAWIK-R

Hamburg Wechsler Intelligenztest für Kinder

Description: The first Wechsler Intelligence Scale for Adults was developed in 1939 by David Wechsler. The Wechsler Intelligence scale for children derived from these first tests in 1967. Originally, Wechsler produced these tests since he found the then-current Binet IQ test insufficient. Wechsler's tests are still based on his philosophy that intelligence is "the global capacity to act purposefully, to think rationally, and to deal effectively with [one's] environment" ³¹ Thus, Wechsler believed that intelligence has a global quality that is reflected in a variety of measurable skills within the subtests he created. Thus, since intelligence is multifaceted, a test measuring intelligence must reflect this diversity and must assess different types of skills. Throughout factor analysis Wechsler determined which specific skills fit within the two major domains verbal and performance.

²⁹ Human Communication Science *News Bulletin*, Issue 56, University of Sheffield, May 2006, p.4.

³⁰ Ibid.

³¹ Kaplan & Saccuzzo, *Psychological Testing: Principles, Applications, and Issues*, Cengage Learning, 2008, p. 256.

Clearly, intelligence must be considered in the context of the person's overall personality.

However, the Wechsler Intelligence Scale for Children (often abbreviated in English with WISC) is an individually administered 'measure' of intelligence intended for children aged six years to sixteen years and 11 months. It is used in neuropsychological settings with regard to mental retardation, learning disabilities and brain dysfunction since huge differences in verbal and nonverbal intelligence may indicate specific types of brain damage as well as in school placement evaluations. As said before, the WISC is designed to measure human intelligence in both verbal and nonverbal abilities. For this project one verbal (*'Forward and Backward Digit Span'*) and one nonverbal (*'Zahlensymboltest'*) was used.

The Digit Span subtest requires the child to repeat strings of digits recited by the examiner forward and backward. Thus, a list of random numbers where recognizable pattern are avoided (such as 5,4,3,2 or 4,6,8) are read aloud and at the end of a sequence the child is asked to recall the items in order. The test begins with three numbers increasing until the participant commits two errors per set. As a second test, backward memory span was used as a more challenging variation which involves recalling items in reverse order. This test assesses the children's ability to store new information, hold it in short-term memory, concentrate, and in the second task to manipulate upon the given information to produce some results. This test is considered to tap concentration, working memory (especially the so-called 'phonological working memory'), cognitive flexibility and sequencing skill.

As a second nonverbal test, the *Zahlensymboltest* (digit-symbol-test) was used; here, the child is asked to transcribe a digit-symbol code as quickly as possible for 1;20 minutes. This test assesses the children's abilities to focus attention and to discriminate between symbols and sequentially order visual information. It requires persistence and planning ability, but is sensitive to motivation, difficulty working under a time pressure, and motor coordination, too. Moreover, it is related to reading performance and it challenges the child's working memory.

However, the Intelligence Scales by Wechsler cannot be considered an absolute measure of intelligence and clearly, such tests must be handled with care. Nevertheless, the scoring process of the two tests used, allows a clear ranking and comparison of typically developing children and children with SLI.

Author: David Wechsler

Time: a.) Digit Span (forward, backward): depending on the child's ability between 5-8 minutes

b.) Zahlensymboltest: the child had 1;20 minutes to fill in the right symbols

Score: a.) Digit Span: Each correct repetition one point until both examples of one set were repeated incorrectly.

b.) Zahlensymboltest: each correct answer given within the time limit gets one point.

The sum of correct answers is then converted and analyzed relative to the child's age and standard scores.

Clearly, it has to be taken into account that such tests provide only some basic levels in order to judge a child's 'intelligence'. One cannot infer from a normal verbal score that the child does not have a language impairment, nor can an average or good IQ guarantee that the child is typically developing in all cognitive issues. However, as previously mentioned, the debate about the concept 'intelligence' and how effective such tests are shall not be topic of this work; for this project the above mentioned tests were selected and used since they provide within an appropriate framework the information needed for this research.

4. PARTICIPANTS

A sample of boys and girls aged from 6;8 to 10;0 years with no demonstrable neurological dysfunction, hearing loss or mental retardation were examined using the above mentioned standard psychological tests of general cognitive and specific linguistic behaviour. In total 38 children were tested, 13 children were diagnosed with SLI while the data of the 25 typically developing children formed the control group.

It is most important to note that the participants with SLI were all currently enrolled in speech therapy intervention programs and were classified as SLI according to their speech and language pathologists; thus, only pre-diagnosed children were tested.

All participants were from South Tyrol or Vienna and therefore German native speakers with dialectal colouring; some had a bilingual background, this fact was of course taken into consideration while analyzing the results. The children of the control group (hereafter TDC 'Typically Developing Children') were either tested at the elementary school 'Msgr.J.Tschurtschenthaler' in Brixen/Bressanone or in Vienna. All children with SLI were tested at three different logopaedics practices in Vienna during their usual speech and language therapy. Thus, the children were tested in a familiar surrounding where they felt less nervous. The speech and language pathologists were present in some experiments; however the child was not aware of their presence since they were always sitting behind the child's back.

Out of financial, timely and organisational matters not more than 13 participants with SLI could be traced and tested; however, the data of only 11 children could be used since two children were not able to follow the test instructions and thus the experiments were stopped.

Note that all ethical issues have been previously cleared.

Participant SLI	Birth Date	Chronological Age (Test Date)
Maurice	05.10.2003	6;7
Terry	04.05.2002	7;11
Florian	03.07.2001	8;10
Tim	04.09.2003	6;8
Kathi	25.02.2001	9;2
Caroline	07.12.2002	7;5
Anastasia	24.01.2003	7;3
Anna-Lisa	09.09.2003	6;8

Richard	23.04.2004	6;2
Jonas	28.01.2004	6;4
Isabel	07.04.2004	6;2

Tab. 1.1.: Participants with Specific Language Impairment

Participant TDC	Birth Date	Chronological Age
Hannah	16.09.2000	9;7
Julia	11.04.2000	10;0
Julian	23.09.2000	9;6
Maximilian	17.08.2001	8;7
Sarah	28.08.2001	8;7
Marcel	29.01.2002	8;0
Lisa	18.05.2002	7;11
Anita	27.01.2002	8;2
Laura Marei	23.04.2003	6;11
Philipp	22.08.2002	7;6
Alex	26.04.2002	7;11
Stefan	03.01.2002	8;2
Roberta	12.12.2002	7;3
Philipp	08.09.2002	7;7
Nathan	20.01.2002	8;2
Lukas	07.11.2002	7;4
Florian	10.08.2003	6;8
Leonie	30.04.2003	6;11
Samantha	09.01.2003	7;2
Celina	19.09.2003	7;6
Sonja	20.09.2003	7;5
Lisa	19.11.2001	8;5
Sophie	08.05.2000	9;10
Lia Susannah	29.11.2002	7;4
Leo	06.03.2001	9;1

Tab.1.2.: Typically developing children (control group)

5. RESULTS

The results point toward a slight tendency towards underage-expected performance of the children diagnosed with SLI in the nonverbal tests. As expected, the children diagnosed with SLI performed worse on the verbal test items compared to the control group, however, they showed lower results also on nonverbal tests. Within the light of previously mentioned sensitive research, this seems quite unsurprising; however it stands in clear contrast with the classical definition and diagnosis of SLI.

The results in this project show that SLI is in the presented and analyzed cases not specific to language. At least for the cases here examined, the umbrella term SLI does not accurately classify and represent the nature of the disorder, since the children's deficits seem to embrace also nonverbal areas.

Unsurprisingly, the children with SLI performed much worse on both linguistic tests. On both tests, the TROG-D and the Digit Span, they had significant difficulties and often they were quite aware of their problems. In fact, for the children with SLI both nonverbal tests were not frustrating at all and they collaborated willingly, while both verbal tests usually provoked disappointment and even anger in some participants. The children with SLI had significant problems with the TROG-D test were they showed difficulties in their receptive language. They mismatched the verbal constructions to the pictures and had considerable problems in following appropriate word order constructions. Up to the set I most of those children had few problems, but as the difficulty increased and more complex constructions were used, they were largely not able to identify the right picture matching the sentence. Especially when analysing a passive construction such as 'the cow is pushed by the boy' they were regularly unable to assign the thematic roles:

B (experimenter): *Die Kuh wird vom Bub geschoben.*

M(participant): *Da isser.*

B.: *Wer schiebt denn hier wen?*

M.: *Die Kuuuh ... den Bub.*

B.: *Und wenn die Kuh vom Bub geschoben wird?*

M.: *Dann wird der Bub... die Kuh schubsen.*

B.: *Ja genau. Und dann ist es welches?*

M.: *Dann kommt das.*

B.: *Hm. Was passiert hier?*

M.: *Das Schaf schubst die Kuh.*

B.: *Das Schaf schubst die Kuh. Und hier, wer schubst hier was?*

M.: *Mmmm...*

B.: *Was ist das?*

M.: *-- Kinderwagen.*

B.: *Genau. Was liegt denn da drinnen?*
M.: *Ein Baby.*

In this dialog recorded by the experimenter we can clearly see that the boy (6;7) was unable to identify the agent. Moreover, longer latency periods in accessing the mental lexicon could be seen.

In 7 cases out of 11 the TROG-D was stopped between the set M and R (constructions using prepositions, relative and other subordinated clauses and passive constructions) since the children with SLI made more than one mistake in five consecutive subtests. However, within the typically developing group the TROG-D test was mostly considered 'too easy' and 'a little boring' by the youngsters themselves. Effectively, except for two participants all typically developing children had no problems with the test and could follow and match the constructions up to the last set U. Clearly, just as their SLI peers they made mistakes especially in the passive construction as well, however they had usually no problems with preposition and secondary clauses. As already mentioned, except for two participants none of the typically developing children failed on five consecutive subtests. The results of the TROG-D test are fairly unsurprising, since it is clear that children with SLI have problems with their receptive language.

Even more difficulties were experienced during the second verbal test, the Digit Span. Phonological short term memory is one clinical marker for SLI and in fact converging evidence from different studies demonstrate deficits in verbal short term memory in children with specific language impairment (Gathercole, Hitch, Service & Martin, 1997; Hick, Botting & Conti-Ramsden, 2005; Alloway, Rajendran & Archibald, 2009; and many more). Working memory is defined as the ability to store and manipulate information for short periods and it has been proposed that impairments in this area are especially linked to the processing and learning of new phonological forms which might be a major reason for the disrupted language acquisition in children with SLI. However, while it seems pretty much evident that children with SLI tend to have some kind of phonological working memory deficit, not all researchers quite agree and claim that solely the phonological processing is impaired rather than the verbal short term memory. 'Phonological working memory impairments may be largely or completely responsible for language and other deficits in children with developmental language disorders (Gathercole and Baddeley, 1990, 1993; Montgomery, 1995). However, other investigators dispute this claim (Howard and van der Lely, 1995; Rice et al., 1994; van der Lely and Howard, 1993). Indeed, it has been argued that the impairments shown by children with SLI at tasks probing phonological working memory might be explained by deficits of phonological processing

rather than of working memory (Chiat, 2001; Gillam et al., 1998).³² Yet, at this point it remains to be questioned how anything could be phonologically processed without verbal short term memory.

The Digit Span, where the child is asked to repeat an arbitrary set of numbers is known to test the participant's phonological working memory performance. While in the first task the child has to repeat the numbers the way they are pronounced by the experimenter, in the second task the child has to act upon the stored item and repeat them in the reverse order. Both experiments were most demanding for the participants with SLI and they performed worse than their age matching peers from the control group. Significant difference among the two groups was statistically demonstrated (*Eq. variances assumed: ,014; Eq. Variances not assumed: ,026*). Once more, it could be shown that children with specific language impairment exhibited depressed performance in verbal short-term memory tasks. The following diagram nicely illustrates the mean performance of both groups. The children with SLI scored lower ($\bar{x}= 8,1818$) than their peers from the control group ($\bar{x}= 11,8182$) and this difference is statistically different.

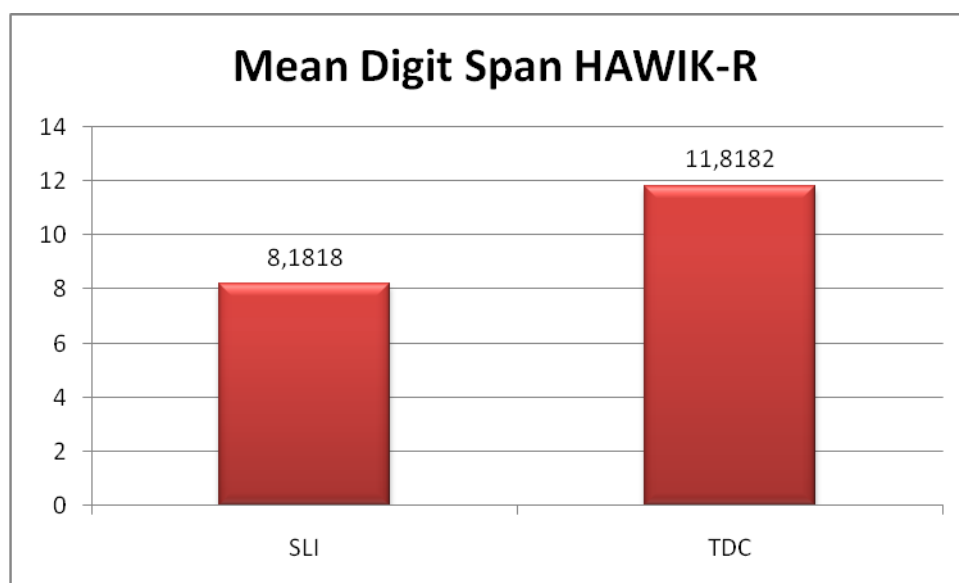


FIG.1.1.: Mean differences TDC/SLI in Digit Span task of the HAWIK-R

Consequently we can draw the conclusion that phonological short term memory appears to be a major deficit in children with this developmental disorder. Effectively, as other studies have confirmed, these children are less able to store, act upon and retrieve linguistically coded information. This underlines the previously mentioned, and in many

³² Ullman & Pierpont, *Specific Language Impairment is not Specific to Language: the Procedural Deficit Hypothesis*, Georgetown University, 2005, p.422.

studies confirmed (e.g. Gathercole and Baddeley, 1990), linkage between SLI and working memory impairments associated to verbal performance.

After all, on both verbal tests the participants diagnosed with SLI met the diagnostic criteria previously mentioned: each participant scored at least 1,25 standard deviations below the mean on at least two (in this case the TROG-D and the Digit Span) language assessments, including one receptive test (criteria consistent with Records and Tomblin, 1994).

More interesting for this study were surely the nonverbal tests, conducted in order to find out how well children with language deficits perform on nonverbal tasks. While according to the classical definition of SLI, children affected by this developmental disease show no remarkable impairments in nonverbal cognitive areas, the hypotheses of this project assumed the opposite. Hence, besides the evident deficits in linguistic performance, children with SLI will also have more difficulty to successfully accomplish the required cognitive processing for tasks within nonverbal conditions.

In fact, in both nonverbal tasks children with SLI did not score within age-expected levels, but rather all of them fell below age-expected ranks.

The Raven's Coloured Progressive Matrices are widely used in both clinical practice and research and provide a reliable measurement of nonverbal performance ability. As previously explained, the CPM measures eductive and reproductive abilities asking the participant to generate high-level and nonverbal schemata; in order to successfully carry out the given task the child has also to be able to take up, recall and reproduce information. The CPM consists in a series of designs where one small part is missing and the participant is asked to select among six given pieces the correct form to complete the pattern. All children enthusiastically collaborated and even when choosing the wrong form they would be convinced they successfully fulfilled the task. Effectively, the CPM was experienced to be most child-friendly since the participants would not even realise when they selected the wrong form and consequently they never felt frustrated. However, both groups had increasingly more problems, especially with set B.

As predicted, children with SLI performed even worse than the control group on this nonverbal task. The difference among the two groups was again statistically significant (*Sig. EQ.Var.Ass.: 0,023; EQ.Var.N.Ass.: 0,031*). In the following diagram we can see that the performance level of the control group exceeds the performance level of the children with SLI.

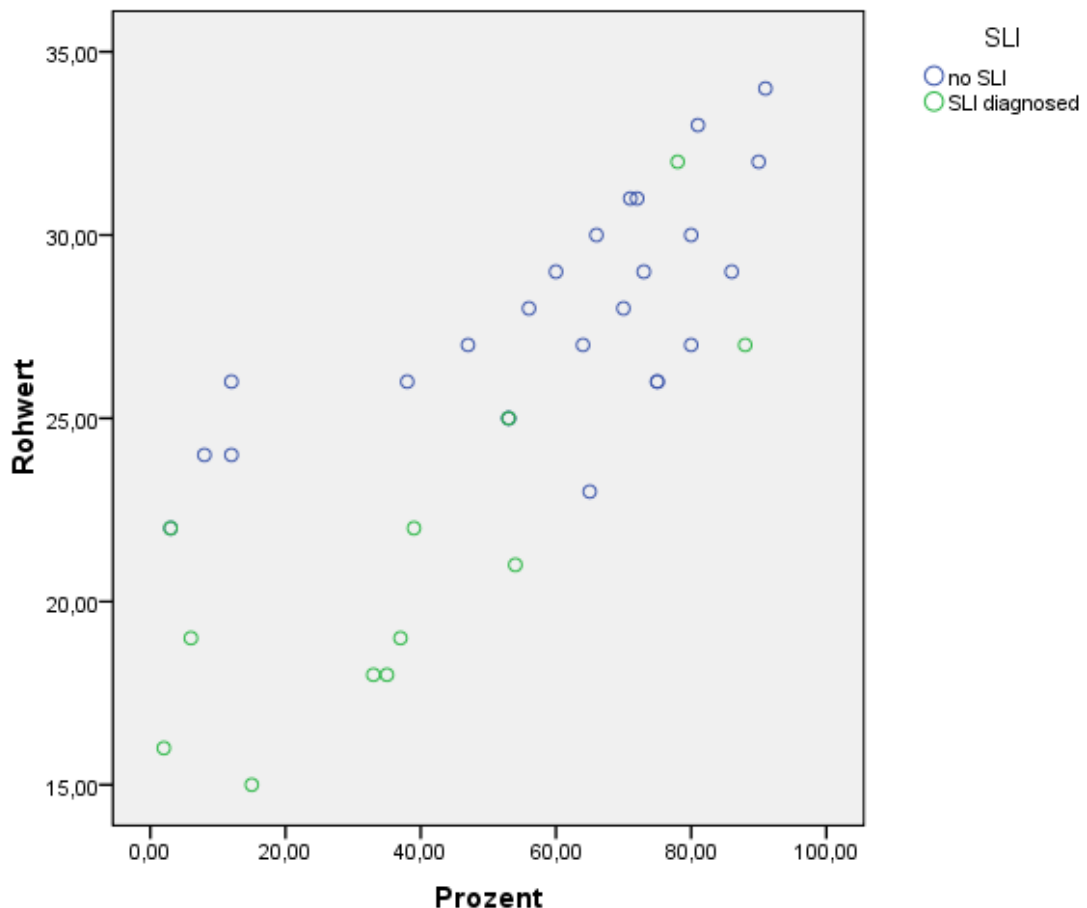


Fig.1.2.: Scatter plot of the variances SLI/TDC for the Raven's Coloured Progressive Matrices

While the blue dots, representing the typically developing children are grouped together in the upper zone (60%-100%) of the diagram, the participants with SLI (green dots) are generally concentrated at the lower end of the distribution. Noticeably is however, that two children with SLI performed within age expected levels; since these two children were diagnosed as SLI, both in speech and language intervention programmes and their language assessments were at an average 1,25 SD below the age-expected mean, they were not considered as outliers but included in the statistical analysis.

Yet, these two cases clearly demonstrate that the results obtained in this project should be interpreted with caution, first because of the small number of subjects, and second because the distribution of their errors shows obviously a clear tendency easily to notice, but not easy to classify. And again, it is worth retaining that the apparent existence of different profiles inside the group of SLI is a plausible explanation for the occurrence of certain 'outliers'.

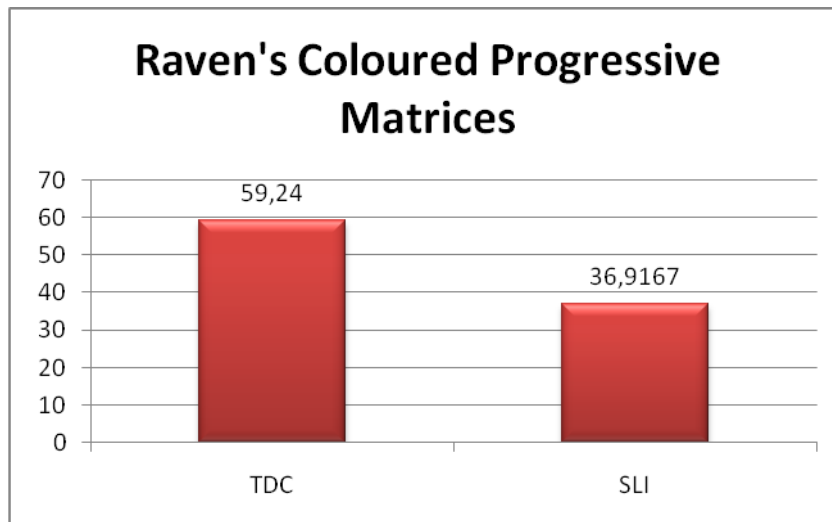


FIG.1.3. Mean differences SLI/TDC in Raven's Coloured Progressive Matrices

Fig.1.3. represents the mean differences in the performance level among the two groups. Noticeably, there is a significant difference; children with SLI achieved noteworthy less correct answers.

The same goes for the second nonverbal task, the *Zahlensymboltest* (digit-symbol-test) taken out of the HAWIK-R. Here, the child is asked to transcribe a series of symbols to the corresponding numbers within 1;20 minutes. In this test the child was asked to discriminate between symbols and to sequentially order, store and recall visual presented information. Moreover, the child must be highly concentrated and is exposed to a certain pressure since there is a time limit.

Along with the other tests, also here the SLI group demonstrated less ability to successfully accomplish the task compared to the typically developing children. The differences were again statistically significant (Sig. EQ.Var.Ass.: 0,019; EQ.Var.N.Ass.: 0,025).

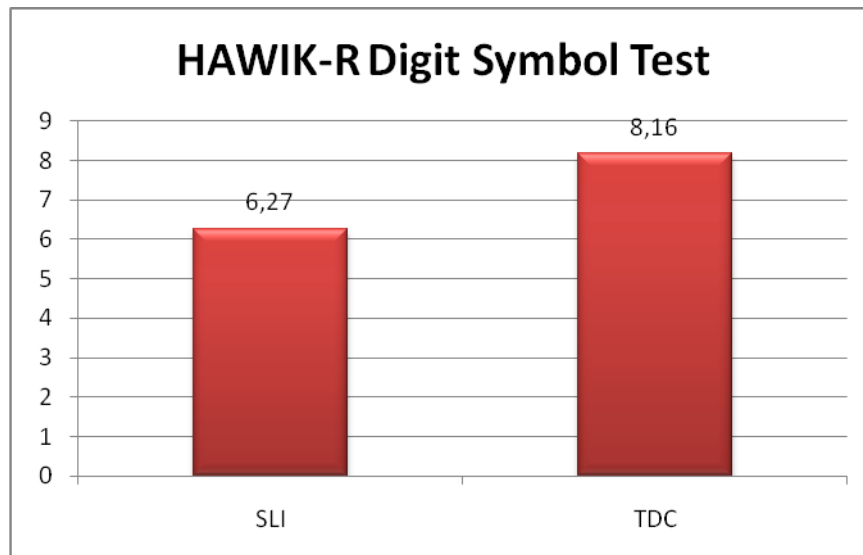


FIG.1.4.:Mean differences SLI/TDC HAWIK-R Digit Symbol Test

As it is clearly illustrated in figure 1.4., again here is a noticeable dissimilarity between the control group and the SLI group.

To sum up, in all four tests conducted the control group achieved significantly higher results than the SLI group.

The here presented evidence makes strong case that SLI is associated with other cognitive impairments, however it is not easy to determine whether the evident cognitive difficulties should be considered a cause or a consequence.

The SLI group showed abnormal pattern in non-linguistic tasks, some nonverbal difficulties seem evidently to co-occur with their language disorder. Regardless of the variation of profiles within the group of SLI children, according to the data it seems necessary to acknowledge that SLI co-occurs with non-linguistic deficits. Thus, the assignation of SLI children's difficulties into nonverbal areas is both useful and necessary with many theoretical and practical consequences.

Evidently, the here presented results must be interpreted with caution but so far the here presented data follows the prediction previously made about nonverbal cognitive dysfunction in children with SLI.

6. CONCLUSIONS

SLI is characterized by an unexpected failure to develop language at the usual rate despite having adequate general intellectual abilities, sensory functions and environmental exposure. According to the classical diagnostic criteria, the affected children demonstrate selective deficits in their language while they are typically developing in all other issues.

Yet, the profiles of children with SLI are quite various and it is hard to define the border of this disease. Different researcher have meanwhile expanded the symptomatology of SLI into nonverbal domains, however there is still no consensus in the definition and delineation of the 'SLI-profile'. Clearly, not knowing about the profile of a disease means not knowing what should be included in the therapy and how the applied therapy methods should look like; necessarily, this has a negative impact on the prognostic outcome of the treatment.

In order to illuminate the complex interaction between language and cognition in children with SLI, it is worth checking the non-linguistic abilities of the affected children. Within this project, respectively two tests to measure the nonverbal and verbal performance of children with SLI were used. The SLI subjects and their controls were all German native speakers; all language impaired participants were diagnosed by Viennese speech and language pathologists as SLI and currently enrolled in speech and language therapy.

As predicted, children with SLI not only performed much worse on both linguistic tests, but they demonstrated also several difficulties in both other nonverbal test items compared to the control group. In both nonverbal tests, the Raven's Coloured Progressive Matrices and the Digit-Symbol-Test of the HAWIK-R, the group of children with SLI performed significantly worse than their age-matched typically developing peers. Now, these difficulties seem easy to note but difficult to classify. Are children with SLI having language problems because of cognitive difficulties or can the linguistic deficits vice versa be considered the cause for the cognitive problems? I.e. can the apparent cognitive difficulties of SLI children be considered a cause or a consequence? Serra-Raventos and Bosch-Galceran (1992) state that the general belatedly and strenuous learning process of such children 'has surely affected both their language and cognition. The cognitive difficulties they have may lie in the operations that are essential for

adequate representations and transformations and this in turn may affect their communication and thinking.³³

While it seems thus far impossible to answer these questions, it is doubtlessly necessary to integrate the non-linguistic deficits of children with SLI in their diagnosis and, more importantly, in their therapy. Effectively, to acknowledge the expansion of SLI children's difficulties into nonverbal areas is both useful and necessary with many theoretical and even more practical consequences.

It shall be clear, that the here presented results should be interpreted with caution and the assignation of SLI children's deficits into nonverbal cognitive domains does not have fully reliable value yet, however it can give support for ulterior research. The sample size in this project was rather small, yet it was most challenging to find even this small number of participants. The reason for the difficulties in finding such children tells us already that it is quite rare to find selectively apparent language impairments. Most children in speech and language therapy intervention programmes have either speech and articulation problems or have besides their language problems other known deficits.

Effectively, the weak point of this study is the classification according to the speech and language pathologists. All children were diagnosed as 'specifically language impaired' by their therapists; this means that I tested solely children DIAGNOSED as SLI, which does not necessarily mean that those children are really affected by this developmental disease. In such case we could not draw any valid conclusion, since maybe there are individuals with selectively occurred language problems. However, in most recent studies done with SLI children and focusing on their nonverbal performance, the participants always exhibited one or even more nonverbal deficit in co-occurrence to their language problems. 'Although in some cases non-linguistic deficits have not been found in individuals with SLI (van der Lely, 1993), it may be that in these cases not all deficits were probed for, or that the deficits are subtle and hard to detect.'³⁴ Moreover, there might be variation in the degree to which verbal and nonverbal impairments co-occur in children with SLI. In fact, children with clear nonverbal deficits were so far a priori excluded from the studies about SLI although their language profile and development

³³ M. Serra-Raventós, L. Bosch-Galceran, *Cognitive and linguistic errors in SLI children: a New Perspective From Language Production Models*, Barcelona, 1992, p.1.

³⁴ Ullman & Pierpont, *Specific Language Impairment is not Specific to Language: the Procedural Deficit Hypothesis*, Georgetown University, 2005, p.420.

was characteristic for SLI. But for now, it seems unrealistic to exclude these children since selectively arisen developmental language disorders seem very rare.

Eventually, it is questionable whether the used test material is really as nonverbal as it claims to be. While there is little doubt left for the Raven's Coloured Progressive Matrices, the second nonverbal test item (Digit Symbol Span) might not be considered exclusively nonverbal since the children were able to verbally label the presented stimuli and often used this strategy in order to support their working memory performance. Children with SLI would obviously be unable to use this seemingly more economic strategy (instead of memorizing the stimuli only on a visual basis) and thus they were slower in accomplishing the task.

After all, this research alludes to a range of nonverbal cognitive mechanisms interacting with language and having its implications in delineating the profile of SLI. Accordingly, it seems clear that the classical definition of SLI exclusively linked to language impairment is not tenable in most patients' cases. Still, much remains to be known about the intersection of language and cognition in children with SLI. Further research might focus on the interpretation of the here obtained results in order to reliably classify children as SLI or non-SLI during diagnosis. Doubtlessly, further research to find out what is actually impaired in the language and cognition of children with SLI will be of great help for the development of efficient therapy methods.

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Zusammenfassung:

Die Diagnose spezifische Sprachentwicklungsstörung (auch Entwicklungsdysphasie) beschreibt Kinder mit massiven Störungen der Sprachentwicklung welche jedoch nicht in einem funktionalen Zusammenhang mit anderen Primärbeeinträchtigungen stehen; sensorische oder neurologische Beeinträchtigungen, sowie kognitive Retardierung oder soziopsychische Fehlentwicklungen werden ausgeschlossen. Das Störungsbild der von SSES betroffenen Kinder ist ausgesprochen heterogen, wobei verschiedene Sprachkomponenten unterschiedlich stark betroffen sein können. Insgesamt sind morphologische und syntaktische Aspekte häufig stärker betroffen als andere, infolge entsteht ein unübliches und unausbalanciertes Symptombild.

Das Ziel dieser Arbeit war es nun, die nichtverbalen Fähigkeiten von Kindern mit diagnostizierter SSES zu erfassen und mit denen von normalentwickelten Kindern zu vergleichen um feststellen zu können, ob entgegen der klassische Definition einer SSES die Beeinträchtigungen der betroffenen Kinder auch nichtverbale Bereiche umfassen.

25 normalentwickelte Kinder und 13 Kinder mit SSES (6;2 – 10;0) wurden auf ihre verbalen und nicht-verbalen Fähigkeiten getestet. Die Kinder mit SSES waren von Wiener Logopäden diagnostiziert worden und gegenwärtig alle in logopädischer Behandlung. Alle Kinder sind deutscher Muttersprache und stammen entweder aus Österreich oder aus Südtirol (zweisprachige Kinder wurden von den Untersuchungen ausgeschlossen).

Um die nonverbalen Fähigkeiten der Kinder zu untersuchen, wurden die Teilnehmer mit den *Raven's Coloured Progressive Matrices* sowie dem *Zahlensymboltest* des *HAWIK-R* getestet. Die verbalen Fähigkeiten wurden vom *TROG-D* sowie vom *Zahlennachsprechentest* (ebenso aus *HAWIK-R*) erfasst.

Der statistische Vergleich zwischen der Kontrollgruppe und den Kinder mit SSES ergab signifikante Unterschiede nicht nur in den verbalen, sondern auch in den nichtverbalen Fähigkeiten der jungen Probanden. Kinder mit SSES schnitten sowohl in den verbalen, als auch in den nichtverbalen Testeinheiten signifikant unter dem Normbereich ab.

Die Ergebnisse dieser Studie deuten auf ein breiteres Symptombild dieser Krankheit hin, welches offensichtlich neben den sprachlichen Defiziten auch Beeinträchtigungen im nichtverbalen Bereich umfasst.

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And

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Native Language

Foreign Languages

European level ()*

Italian
(Zweisprachigkeitsnachweis ,A' /Esame di Bilinguismo ,A' della provincia di Bolzano)

English

French

Latin

Understanding				Speaking				Writing	
Listening		Reading		Spoken interaction		Spoken production			
C2	Proficient User	C2	Proficient User	C2	Proficient User	C2	Proficient User	C2	Proficient User
C2	Proficient User	C2	Proficient User	C2	Proficient User	C2	Proficient User	C2	Proficient User
B2	Independent User	B2	Independent User	B2	Independent User	B2	Independent User	B2	Independent User
B1	Basic User	B1	Basic User	A1	Basic User	A1	Basic User	A1	Basic User

(*) Common European Framework of Reference (CEF) level

Research Interests

Neural bases of cognitive processes with special reference to brain pathology (neurodegeneration, developmental disorders, autism spectrum disorders, language disorders etc.)

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Software for data analysis: SPSS

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