GÖTEBORG STUDIES

IN EDUCATIONAL SCIENCES 233

Ulrika Wolff

Characteristics and varieties of poor readers

ACTA UNIVERSITATIS GOTHOBURGENSIS

Institutionen för pedagogik och didaktik

Characteristics and varieties of poor readers

av

Ulrika Wolff

AKADEMISK AVHANDLING

som med tillstånd av utbildningsvetenskapliga fakulteten vid
Göteborgs universitet för vinnande av doktorsexamen
framläggs till offentlig granskning

Fredagen den 2 september, klockan 13.00 i Stora Hörsalen
Institutionen för pedagogik och didaktik
Frölundagatan 118, Mölndal

Fakultetsopponent:
Professor Linda Siegel, University of British Columbia, Canada

Abstract

Title: Characteristics and varieties of poor readers.
Language: English
Keywords: assessment, dyslexia, phonological awareness, reading difficulties, subtypes of readers
ISBN: 91-7346-537-2

This thesis is based on four empirical studies. The overall aim was to identify and examine different profiles of reading. In Study I, two latent profile analyses were conducted with the aim to identify subgroups, or profiles, of reading performance among 9-year old Swedish students. The latent profile analyses focussed on four aspects of reading performance: reading of continuous texts, reading of document texts (maps, charts etc.), word reading and reading speed. Eight performance profiles were obtained in the first study (N=5099), and were replicated with highly similar profiles in the second study (N=4184). The largest profiles, good and average readers, exhibited even reading performance across measures, implying that reading is a skill with high transfer and generality, whereas poor readers exhibited more heterogeneous performance patterns. The most stable profiles across studies were high performing students, poor comprehenders and dyslexic students. The phonological deficit hypothesis of dyslexia was assumed, which states that a phonological impairment is supposed to be the underlying cause of the manifest reading and writing problems. In Study II, a battery for group screening of dyslexia among adults was designed. The battery consisted of a self-report questionnaire, four tasks tapping phonology and one task tapping orthography. Administration time was 40 minutes. All tasks discriminated highly between a group of adults with dyslexia (N=50) and a control group (N=67). Thus, it was possible to meet the challenge of implementing a nonvocal, phonologically-based group screening of dyslexia problems. Study III attempted to investigate the often observed association between visual creativity and dyslexia, evidence for which is mainly anecdotal. Suggested causes of this observed association include different brain structures or functions, or compensation for deficiency in the area of reading and writing. In two studies, the prevalence of dyslexia among art university students as compared to non-art university students was examined. A total of 268 art students and 282 non-art students participated. The screening was based on word reading, a phonological choice test (in the second study) and a self-report questionnaire. In both studies the art students showed, as well as reported, significantly more dyslexia signs than the non-art students. In Study IV the incidence of phonological and surface dyslexia among Swedish dyslexic university students was examined. Participants were 40 university students with dyslexia, 40 academic-level matched students and 40 younger reading-level matched students. Two different methodologies were used. Firstly, a regression method was applied, where performance scores on a phonological choice task were plotted against performance scores on an orthographic choice task and vice versa. Confidence intervals (90%) were derived from the regressions of the control groups separately and superimposed on corresponding plots for the dyslexic group. When the academic-level control group was used as reference group, a substantial number of both phonological and surface dyslexia was found. However, when the reading-level group was used as reference the phonological dyslexia subgroup remained, but the surface dyslexia subgroup virtually disappeared. Secondly, a latent profile analysis was conducted on the dyslexia group based on five phonological and four orthographic measures. Seven profiles were obtained, of which none clearly exhibited poor performance on the orthographic tasks but not on the phonological tasks or vice versa. These results suggest a deviant development in phonological dyslexics and a delayed development in surface dyslexics. It thus supports the phonological deficit hypothesis. Educational consequences for varying reading problems are discussed and instructional intervention is suggested.

Characteristics and varieties of poor readers

GÖTEBORG STUDIES
IN EDUCATIONAL SCIENCES 233

Ulrika Wolff

Characteristics and varieties of poor readers

ACTA UNIVERSITATIS GOTHOBURGENSIS

ISBN 91-7346-537-2
ISSN 0436-1121

Photo: Ellen Wolff

Distribution: ACTA UNIVERSITATIS GOTHOBURGENSIS
Box 222
SE-405 30 Göteborg, Sweden

To
my children Hannes and Ellen, and
my parents, Bibbi and Göte.

Abstract

Title: Characteristics and varieties of poor readers.
Language: English
Keywords: assessment, dyslexia, phonological awareness, reading difficulties, subtypes of readers
ISBN: 91-7346-537-2

This thesis is based on four empirical studies. The overall aim was to identify and examine different profiles of reading. In Study I, two latent profile analyses were conducted with the aim to identify subgroups, or profiles, of reading performance among 9-year old Swedish students. The latent profile analyses focussed on four aspects of reading performance: reading of continuous texts, reading of document texts (maps, charts etc.), word reading and reading speed. Eight performance profiles were obtained in the first study (N=5099), and were replicated with highly similar profiles in the second study (N=4184). The largest profiles, good and average readers, exhibited even reading performance across measures, implying that reading is a skill with high transfer and generality, whereas poor readers exhibited more heterogeneous performance patterns. The most stable profiles across studies were high performing students, poor comprehenders and dyslexic students. The phonological deficit hypothesis of dyslexia was assumed, which states that a phonological impairment is supposed to be the underlying cause of the manifest reading and writing problems. In Study II, a battery for group screening of dyslexia among adults was designed. The battery consisted of a self-report questionnaire, four tasks tapping phonology and one task tapping orthography. Administration time was 40 minutes. All tasks discriminated highly between a group of adults with dyslexia (N=50) and a control group (N=67). Thus, it was possible to meet the challenge of implementing a nonvocal, phonologically-based group screening of dyslexia problems. Study III attempted to investigate the often observed association between visual creativity and dyslexia, evidence for which is mainly anecdotal. Suggested causes of this observed association include different brain structures or functions, or compensation for deficiency in the area of reading and writing. In two studies, the prevalence of dyslexia among art university students as compared to non-art university students was examined. A total of 268 art students and 282 non-art students participated. The screening was based on word reading, a phonological choice test (in the second study) and a self-report questionnaire. In both studies the art students showed, as well as reported, significantly more dyslexia signs than the non-art students. In Study IV the incidence of phonological and surface dyslexia among Swedish dyslexic university students was examined. Participants were 40 university students with dyslexia, 40 academic-level matched students and 40 younger reading-level matched students. Two different methodologies were used. Firstly, a regression method was applied, where performance scores on a phonological choice task were plotted against performance scores on an orthographic choice task and vice versa. Confidence intervals (90%) were derived from the regressions of the control groups separately and superimposed on corresponding plots for the dyslexic group. When the academic-level control group was used as reference group, a substantial number of both phonological and surface dyslexia was found. However, when the reading-level group was used as reference the phonological dyslexia subgroup remained, but the surface dyslexia subgroup virtually disappeared. Secondly, a latent profile analysis was conducted on the dyslexia group based on five phonological and four orthographic measures. Seven profiles were obtained, of which none clearly exhibited poor performance on the orthographic tasks but not on the phonological tasks or vice versa. These results suggest a deviant development in phonological dyslexics and a delayed development in surface dyslexics. It thus supports the phonological deficit hypothesis. Educational consequences for varying reading problems are discussed and instructional intervention is suggested.

List of publications

I Wolff, U. (2004). *Subgrouping of readers based on performance measures: A latent profile analysis.* Manuscript submitted for publication.

II Wolff, U. & Lundberg, I. (2003). A technique for group screening of dyslexia among adults. *Annals of Dyslexia, 53,* 324-339.

III Wolff, U. & Lundberg, I. (2002). The prevalence of dyslexia among art students. *Dyslexia, 8,* 34-42.

IV Wolff, U. (2004). *Phonological and surface subtypes among dyslexic university students.* Manuscript submitted for publication

Acknowledgements

I am very pleased to have two supervisors, both acknowledged experts in their fields. I would like to express my sincere gratitude to my supervisor Professor Jan-Eric Gustafsson for his generous support, and for guidance into new statistical domains. I would also like to express my sincere gratitude to my mentor Professor Ingvar Lundberg, who taught me so much and showed faith in me from the very beginning. I will remember to keep curious and to learn something new every day.

It is an honour that Professor Linda Siegel has agreed to examine me on this thesis. I am also obliged to Professor Stefan Samuelsson for invaluable comments on an earlier draft of this thesis.

This research has been supported by grants from the Swedish Research Council. I am very happy I have been a member of the SALS project together with the project leader Monica Rosén and the other members, Anders, Eva, Inga-Lill, Jan-Eric, Kajsa, and Lisa. It is also an honour to be a member of the research group, UR, under the leadership of Jan-Eric Gustafsson.

The Swedish network concerning dyslexia research has really meant a lot to me. For friendship and inspiration I would like to thank Anders, Christer, Idor, Ingvar, Karin, Mats, Stefan G., Stefan, S. and Åke.

For serious discussions, shared experiences and not least much laughter, thank you to the Göteborg network for dyslexia seminars, Barbro, Elisabeth J., Elisabeth T., Ing-Marie, Karin, Malin and Margreth, and to my best conference friends, Bodil and Elisabeth M. I have always felt your support!

I am indebted to all my students at Kungälv Adult Education Centre. You taught me something beyond what is in the books.

To my unit at the department, Sam-enheten, I am also thankful; to Ásdis and Kerstin for walks and talks, to Michael for unexpected help, and to everybody who usually gather around the lunch table.

Without all the students who participated in the studies, and without the teachers who made arrangements, this thesis would not have been possible. Thank you!

To Göran, thank you for support, and for always being there!

Ulrika Wolff, Göteborg, May 2005

1 Aims and outline of this thesis

If we want children to read lots, we have to induce them to read well.

Marilyn J. Adams

Reading is indeed a highly valued skill in our society, and successful reading often holds the key to education. Therefore, the most important task for school must be to teach children to read and write well. However, a substantial number of children fail to meet the literacy demands. A failure in this important area may lead to secondary problems, such as low self-esteem, poor socioemotional adjustment and failures in other academic fields. Thus, it may influence an individual's whole life. Therefore, it is important to understand the characteristics of various kinds of reading difficulties, and to recognize their educational implications.

According to the Simple View of Reading (Gough & Tunmer, 1986), reading consists of two components: decoding and linguistic comprehension. Both are necessary for skilled reading, but neither is sufficient. In this thesis it was hypothesized that reading is a skill with high generality and transferability, unless either word decoding or linguistic comprehension is deficient, or both. This implies that good and average readers could be expected to have even performance profiles, whereas poor readers have more heterogeneous performance patterns.

Based on four empirical studies this thesis addresses the issue of subgrouping of readers. In Study I different profiles of reading performance were identified and related to different home background variables. The three following studies included further examining and subtyping of dyslexia. A battery of phonological processing tasks was constructed, aimed at group screening of dyslexia among adults in Study II. Study III concerned the prevalence of dyslexia among art students at university level as compared to non-art students. In Study IV the prevalence of subtypes of dyslexia was examined.

In Part I of this thesis a theoretical framework is outlined, where components involved in reading are presented. The Simple View of Reading (Gough & Tunmer, 1986), the dual-route model (Castles & Coltheart, 1993; Høien & Lundberg, 2000) and a stage model of word reading (Frith, 1985, 1986; Høien & Lundberg, 1988, 2000) are introduced. Previous research of subtyping of readers are presented. Then different definitions of dyslexia follow. The

phonological deficit hypothesis of dyslexia is discussed in more detail and in comparison to alternative theories. In the next section of this thesis a summary of the empirical studies is presented, followed by a general discussion including methodological issues. The final section concerns educational aspects of different reading difficulties. The empirical studies are presented in the Appendix.

However, initially literacy and disability are discussed as well as their social and educational consequences.

2 Reading literacy as a key domain in education

Learning to read is not a natural process. It is a skill.

Reid Lyon

The human species acquires speech naturally. Language may not be innate but innately discoverable, drawing on a broad set of perceptual, cognitive and social abilities (Kuhl, Tsap & Liu, 2003). Speech is not explicitly taught (Lundberg, 1984; Shaywitz, 2003), but adults seem to adjust their talk to infants, so-called motherese or parentese (Hayes & Ahrens, 1988). Even at the phonetic level adults adjust their talk (Kuhl, 2000). In early infancy children can separate all phonetic units in use, for example a Japanese child can make a distinction between /l/ and /r/. This ability strongly, but not totally, declines between six and twelve months of age (Kuhl, et al., 2003), whereas the ability to perceive the phonetic units of the first language remains. Kuhl et al. have also demonstrated the importance of social interaction in language acquisition. Children, aged nine to ten months, reversed the decline in phonetic perception after first-time foreign-language exposure to live native speakers. Another group of children were exposed to foreign language from DVD:s. This did not lead to reversed decline in phonetic perception. Social interaction with a live person is obviously a critical factor in acquiring language. This early stage of language acquisition thus involves a specification of basic phonetic building blocks, which will be of critical importance in learning how to read.

All languages are of course used as tools for communication. They are also used as storehouses for knowledge and beliefs, which form the cumulative education of succeeding generations (Fries, 1963). Written language is an extension of that storehouse. All writing systems, alphabetic or not, represent spoken language (Perfetti, 2003). It is not possible to infer meaning directly from text but to link reading to phonemes and morphemes. It has been proposed (Goodman, 1985) that a reader should not focus on recoding letters to sounds. Instead reading should be regarded as a psycholinguistic guessing game. However, according to Share (1995) it is not possible to guess more than 10 per cent of content words and 40 per cent of function words in a given text. As content words are the most important, and low frequency words are the hardest to guess, Share concludes that contextual guessing seems to be least useful where it is most needed.

Written language has only existed for about 5000 years, and yet 500 years ago only a small percentage of the population of any country could read.

Still today, it is only a minority of the world's population that is literate, and the majority of them read in non-alphabetic scripts (Frith, 1985). However, in Western society today, people are expected to reach a high level of reading literacy. As citizens we are presumed to be able to utilize written information as well as to communicate by writing. The literacy demands have through the centuries steadily been increasing. However, during the last few decades the demands have changed in nature. It is no longer, as was the case in the 1970s, a matter of being so-called functional literate (Myrberg, 2000), that is handling easy literacy tasks such as filling in postal forms or reading sign posts. Both at work and in private life we are now faced with demanding tasks and we have to be highly competent in absorbing and also rejecting information. In modern working life there are hardly any remaining non-literate occupations. On the contrary, there is a high pressure on a wide variety of literacy skills. It is important to be able to communicate with electronic mail, to deliver a written report on a project and locate information on the web. We have to comprehend complex information and respond in writing in order to administer our personal financial situation, when dealing with banks, insurance offices and tax authorities.

However, a substantial number of people fail to reach an acceptable level of mastery of reading and writing skills. There are numerous possible causes of reading failures, as reading is a complex activity in at least two ways. Firstly, it is a multidimensional phenomenon, composed of decoding and comprehension, and requiring, for example, vocabulary, syntactic competence, fluency and the ability to make inferences. Secondly, factors like general ability, habits, and social, linguistic, cultural and educational circumstances influence reading performance. Failures may also have a constitutional background characterized by developmental dyslexia (henceforth dyslexia), primarily revealed in poor word recognition and decoding.

Recently, disquieting signs have emerged from international studies like PIRLS (Gustafsson & Rosén, 2005), PISA (2001) and from Skolverket (2005) concerning Swedish children's and adolescents' reading performance. There is a trend of poorer performance during the last decade. The quite alarming reports exhibit the need for a closer understanding of the nature of the poor readers' problems, so that sensible educational strategies can be implemented. If we perceive the features of the reading problem we can help students to break the vicious circle in which they may have ended up. It is an important educational challenge to understand the characteristics and features of poor reading. Unfortunately, this field has not been in focus for educational

research in Sweden for a long period of time, even though it was formerly an attractive research field (Edfeldt, 1959; Lindell, 1972; Malmquist, 1958; Wallin, 1967), and in other parts of the world reading research plays a more important role in education (Adams, 1990; Chall, 1996; Høien, 1999; Juel & Minden-Cupp, 2000; Lesaux & Siegel, 2003; Stanovich, 2000; Torgesen, 2000). Now, as literacy demands are increasing and in times of worrying reports of decreasing reading performance among Swedish students it may be time to focus on the critical features and components of reading with the intention to mobilize analytic tools for identification and intervention of various types of poor reading.

3 Models of reading

...reading- an extraordinary ability, peculiarly human and yet distinctly unnatural.

Sally Shaywitz

The Simple View of Reading

The reading process is, as noted, a very complex activity, involving a host of higher mental processes. However, Fries (1963) claimed that even though this was certainly true, these higher mental processes are involved in oral language too, not only in reading. What happens is that these abilities are used in response to graphic signals in reading, whereas they are responses to acoustic signals in speech. Thus, even if we use the abilities of thinking, evaluating, analyzing, reflecting and so forth in reading, the use of these abilities does not constitute the reading process. Yet, to produce an utterance, which does not elicit a meaning response to the producer, is not talking. In the same way a response (word pronouncing) to graphic signs must elicit meaning, to be called reading according to Fries.

Consistent with this idea, the Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990) was proposed. The Simple View is expressed in the equation R=D x L (Reading=Decoding x Linguistic comprehension). Both decoding and comprehension are necessary for reading, but neither is sufficient. If either of the factors in the equation is zero, the product will equal zero as well. According to Gough and Tunmer reading ability is the product of a combination of decoding and comprehension. Reading disability, however, can result from three conditions: deficient decoding skills (dyslexia), deficient comprehension skills (by the authors named hyperlexia, although that term usually is reserved for very extreme cases) or deficient decoding and comprehension skills (garden variety reading disability).

Many researchers share the view that decoding and linguistic comprehension are dissociable skills (Aaron, Joshi & Williams, 1999; Catts, Hogan & Fey, 2003; Hoover & Gough, 1990; Høien & Lundberg, 2000). Nevertheless, linguistic context may influence word recognition. It appears as if dyslexic students as well as beginner readers benefit comparably more from context than other students (Snowling & Nation, 1997). However, in general the dependence on contextual cues will decrease when word decoding skills increase (Hoover & Gough, 1990; Høien & Lundberg, 2000; Stanovich, 1980).

Described below (p. 22) is a stage model of word recognition development proposed by Høien and Lundberg (1988; 2000), which has taken this decreasing dependence of context into account.

Word reading development

The dual-route model (Castles & Coltheart, 1993; Høien & Lundberg, 2000; Morton, 1979) is a word processing model. Figure 1 shows one version of this model (Høien & Lundberg, 2000), which posits two routes into the mental lexicon. The mental lexicon (symbolized by the square in the middle of Figure 1) refers to the location of knowledge about how morphemes are pronounced, what they mean and how they are read and spelled (Høien & Lundberg, 2000). One pathway is the indirect route where the reader uses a phonological strategy, and the direct route where an orthographic strategy is used, that is whole words or chunks of words are recognized in one glance. The bold-face arrows in Figure 1 show the orthographic strategy, whereas the lighter arrows show the phonological strategy. Visual Analysis (VA), Letter Recognition (LR) and Parsing Process (P, where words are divided into manageable segments, e.g. morhemes) are activated in both the sublexical (phonological) and lexical (orthographic) strategies, and so are the Semantic Activation (SA) and the Articulation Process (AP). If any of these are impaired both strategies will be negatively influenced. If Phonological Recoding (PhR), the Verbal Short-Term Memory (STM), Phonological Synthesis (PhS, segments are tied together) and the Phonological Word Recognition (PhR1) are deficient, the phonological strategy will be affected. Orthographic Word Recognition (OR1) and Phonological Word Retrieval (PhR2) are used in the orthographic strategy only, hence a deficiency in any of those will affect the orthographic strategy.

The broken feed-back lines from the lexicon to the processes in the phonological strategy indicate that the word processing is influenced by the reader's lexical knowledge. The relationship between the subskills in word reading is, of course, more complex than this model. For example, for a skilled reader the sublexical strategy functions as a back-up system to the lexical strategy.

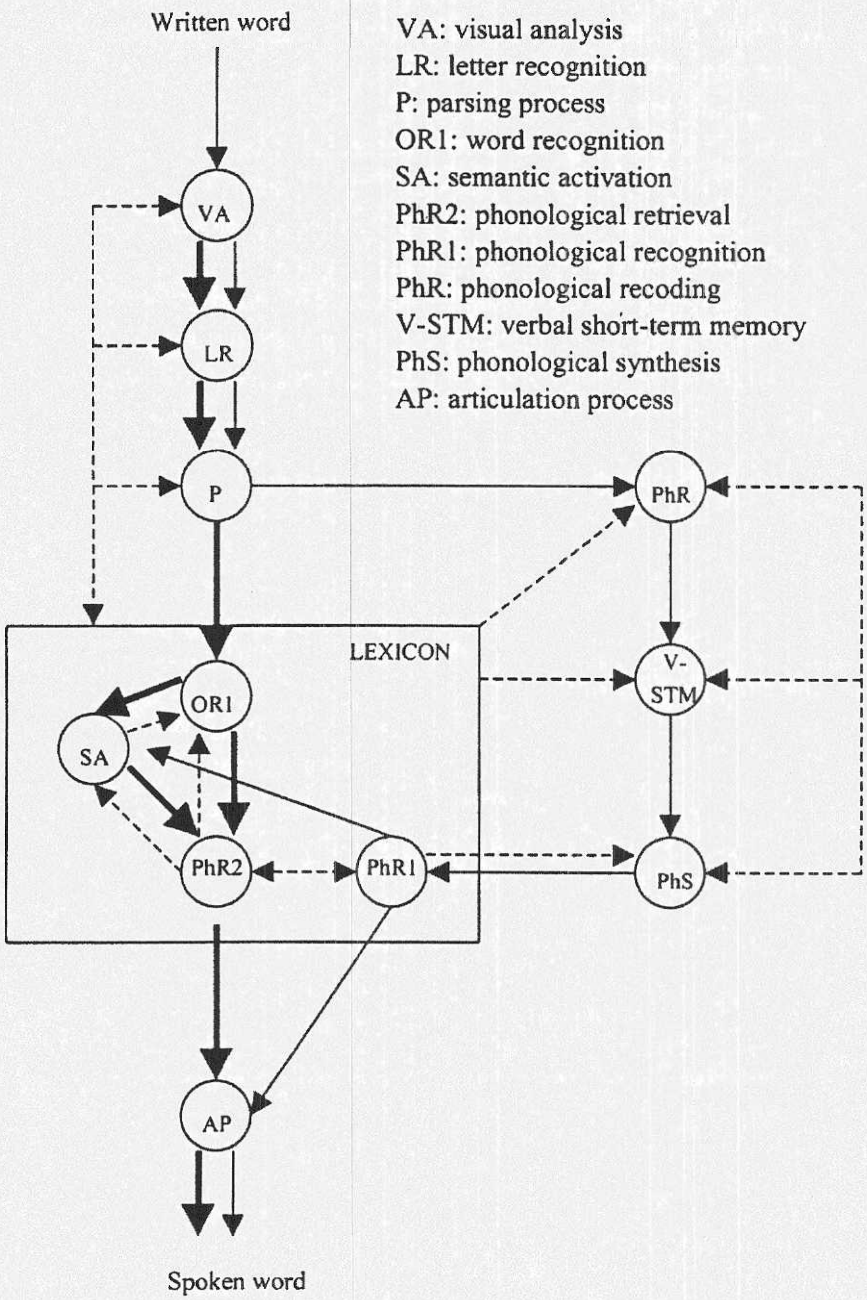


Figure 1. A model of word decoding (Høien & Lundberg, 2000). Reprinted with permission from the authors.

For analyzing the mode of word recognition such a model is applicable. However, reading development implies change, which can be illustrated in a stage model of word reading, which is the natural framework for a developmental disorder, like dyslexia (Frith, 1986). If we suppose that reading normally develops in a fixed order, a developmental disorder is present when a strategy of one of the stages is not achieved. Thus, it can also serve as the rationale for subtyping of dyslexia (Frith, 1985; 1986), as breakdowns at different stages will result in different manifestations.

Høien and Lundberg (1988; 2000) have outlined a stage model of word recognition development. It is a modification and extension of Frith's (1985; 1986) three-stage model of reading acquisition, and partly the same terminology is used.

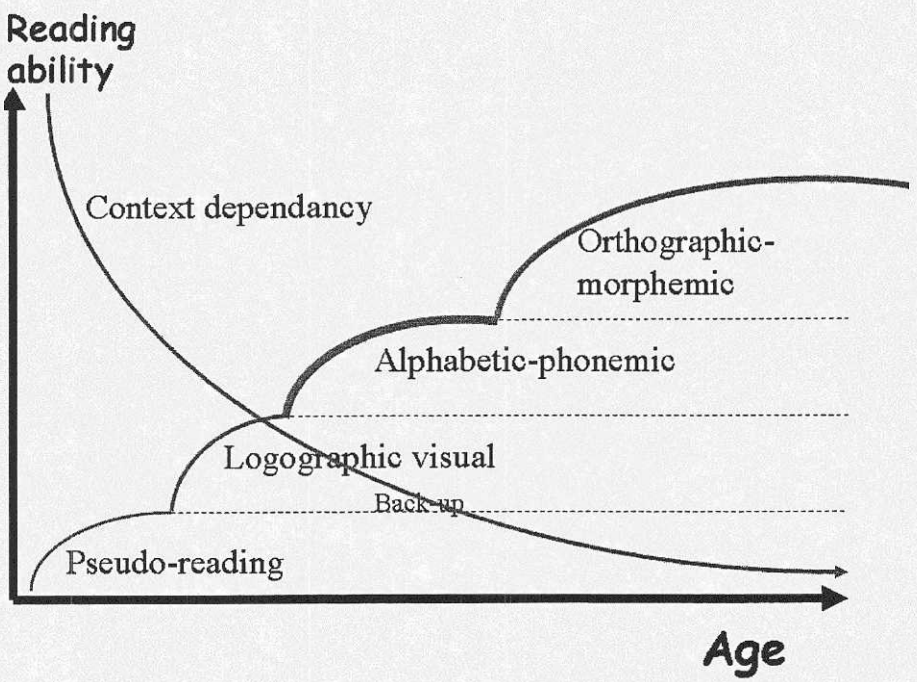


Figure 2. A stage model of word recognition development modified after Høien and Lundberg (2000).

The four depicted stages in Figure 2 should not be interpreted as pure or isolated stages, that is a child does not move to one stage leaving the earlier stage behind. Rather the earlier stages have back-up functions. For

example, even skilled orthographic-morphemic readers have to use the alphabetic-phonemic strategy, when they encounter a new word or a new name.

Environmental and individual factors may cause children to stay for longer or shorter periods at one stage. The stages are also differently important to them. Commonly, though, the learning curve is steeper in the initial phase of the stage, as indicated in Figure 2. The falling line indicates that contextual dependence decreases with improved word decoding skills. Context is, of course, always of importance: A skilled reader uses the context in their struggle to comprehend a text, whereas a poor reader uses the context in their struggle to decode a word (Bruck, 1990).

Pseudo-word reading

At this early stage children are aware of the existence of print, perhaps even of the importance of print. A child may point to his or her name above the coat hook at kindergarten and pronounce the name. It might appear as if the child was reading, but actually at this stage the child "reads" the environment rather than paying attention to the letters. Some children imitate reading; they turn over pages in their books telling stories they know by heart (Hagtvet, 2004).

Logographic-visual reading

In Swedish this stage is sometimes called camel-reading, because the word camel is identified by the humps of the letter m. At this stage children have not yet broken the code of phoneme-grapheme correspondence. Each word is independently recognized on the basis of some conspicuous features. The internal order of the letters in the middle of a word is not always critical to the child's ability to identify the word. For example, Swedish speaking children claimed that both a Swedish and a Finnish milk carton were labelled with the Swedish word *mjölk*, even though the Finnish word for milk is *maitoa.* The initial letter is the same in both words, and they are embedded in the same environment. The logographic-visual strategy can be refined to a certain extent, but eventually, the system will break down, as words are recognized as a whole and the memory load will be too high.

Alphabetic-phonemic reading

At this stage children have broken the code of phoneme-grapheme correspondence of the alphabetic system. Initially, they learn about one-to-one

mapping of phonemes and graphemes, and successively they learn about more complex roles, for example that one phoneme may correspond to two or several graphemes, and vice versa. They also learn the importance of context-sensitive rules, for example soft c before "soft vowel". The vast majority of words, also names and pseudowords are now possible to read. The process of reading acquisition is certainly complex, and how children reach this point is not known in detail. It is not simply a matter of blending phonemes together, even if it happens ever so fast it will not result in a proper word. /d/, /o/ and /g/ blended together will rather sound something like /dəogə/. A considerable amount of evidence supports that phonemic awareness is an important precursor to enter this stage (e.g. Adams, 1990; Lundberg, Frost & Petersen, 1988; Torgesen, Morgan & Davis, 1992). It is suggested by Frith (1986) that early spelling, so-called invented spelling, may give an impetus towards acquiring alphabetic-phonemic reading skills (Hagtvet & Pálsdóttir, 1992).

Orthographic-morphemic reading

At this stage the decoding process is now fully automatic. Morphemes are instantly recognized in one glance. Yet, the reader is actually attending every feature, every grapheme, of the word. This stage is not built upon the wavering logographic-visual stage, but the phonemic-alphabetic stage. A child, who could not acquire phonemic-alphabetic reading, can not reach this stage. However, the child may develop compensatory strategies, which might resemble orthographic-morphemic reading (Frith, 1986). These strategies will not be as smooth and effortless, though.

Figure 2 implies that the word reading process is not a linear development. It is not a matter of cumulatively improving one certain strategy and getting better and better on the same sort of strategy (Frith, 1986). Rather, it is a matter of qualitative changes. Sometimes the transition from one stage to another is a very sudden improvement, and sometimes it is a very slow process. It may appear as if a child will fail to acquire the strategies of one stage, when the development really only is delayed. A child who actually fails to acquire one strategy is not delayed in development, but it is a matter of deviant development. His or her performance does not have to be very much like a normal reader's at this stage, as compensatory factors may be added to the strategies and influence his or her reading behaviour. The later a break-down in the development occurs, the milder the form of reading difficulties (Frith, 1986). This model fits well with the phonological deficit hypothesis of dyslexia, which in this thesis is interpreted within this framework.

4 Subtyping of readers

The nature of the problem dictates the nature of intervention.

Louisa Cook Moates

It is a rather simple task to identify a group of children with reading disabilities (Share & Silva, 1986). However, individuals with reading disabilities do not comprise a homogeneous group. During the last four decades, clinicians and researchers have made attempts to classify them into different subgroups. Early attempts were made by Myklebust and Johnson (1962). They divided children with dyslexia into two subgroups: Children with *auditive dyslexia*, who had difficulties in discriminating between similar phonemes and children with *visual dyslexia*, who had problems in remembering orthographic patterns. Boder (1971, 1973) identified three subgroups based on a qualitative analysis of children's reading and writing errors. Children with *dysphonetic dyslexia* (67%) were deficient in phonological decoding and spelling, children with *dyseidetic dyslexia* (10%) were reading and spelling with a phonological strategy and had difficulties in remembering irregular words. Children with *alexia* (23%) had both types of problem. A similar classification was made by Gjessing (1977). According to his research, five subtypes of dyslexia could be identified. *Auditive dyslexia* was characterized by metaphonological problems; *visual dyslexia* by phonological reading and difficulties with remembering orthographic patterns; and *audio-visual dyslexia,* a combination of those problems. *Emotional* and *pedagogical dyslexia* were due to environmental factors and could not easily be identified by different manifest reading and writing problems. Instead, more indirect indications were needed.

These early studies have been followed by numerous subtyping studies. They have had various starting points, taking their departures from different kinds of samples and using different measures. This may be one reason why it has proven difficult to identify distinct separable subgroups.

Population studies

The common approach in subtyping studies is to conduct subtype analyses on a previously delineated group of poor readers. However, Satz and Morris (1981) used cluster analysis to identify reading disabled children in a school population of 11-year old boys. Nine subtypes emerged, of which two were reading disabled. These two subgroups were subjected to further subtyping

based on language and perceptual variables. This time five subgroups emerged. Subgroup 1 was defined as global language impairment type (N=27). Subgroup 2 was a specific language (naming) type (N=14). Subgroup 3 was global language and perceptually impaired (N=10). Subgroup 4 was a visual-perceptual-motor impaired type (N=23). Subgroup 5 was an unexpected learning disabled subtype (N=12), as their performances on all tests (language and perceptual) were average to superior. However, in this study, verbal fluency was the only measure tapping phonological ability. Morris et al. (1998) did not classify a whole population, but they included children who had disabilities in reading, in math, or both; children without disabilities, children with full-scale IQ less than 80 and children with ADHD. They found nine subgroups, of which seven were reading disabled. The vast majority of the children in the seven reading disabled subgroups demonstrated impaired phonological awareness skills across subgroups. Thus, both of these studies conducted subtyping based on broader samples than merely students with reading disabilities. However, the studies were not population studies in the sense that a representative sample was used. Satz and Morris (1981) initially subtyped an unselected sample from a school, but in the search for reading disabled subtypes, they performed their analysis on the reading disabled students only.

IQ discrepancy

The discrepancy definition (see p. 33) of dyslexia based on IQ and reading has been challenged in several studies. In a school population of boys (N=570) aged seven to eight years, 80 boys were reading two grades below expectation (Taylor, Satz & Friel, 1979). Half of them met the discrepancy criterion and the remainder did not. These groups could not be distinguished from each other on measures such as math, neurobehavioral performance, personal functions and severity of reading disturbance. Fletcher et al. (1994) included children with a discrepancy definition and children defined as reading disabled with reading scores below the 25th percentile with verbal IQ scores or performance IQ scores above 79. Phonological awareness was the most robust indicator of poor reading regardless of how the reading disability was defined. Stanovich and Siegel (1994) showed that the cognitive differences found between children with reading disabilities with and without a discrepancy diagnose did not include the subskills phonological and orthographic coding, which determine word recognition.

Shankweiler et al. (1995) examined cognitive profiles among children with learning disabilities. They found that phonological deficits were

present when reading problems were, regardless of whether the phonological deficits were pure or were coexisting with other problems such as attention deficit or arithmetic disability. Phonological deficits also seemed to cause morphological, but not syntactic problems.

Decoding and comprehension

Some subtyping studies (e.g. Aaron et al., 1999; Catts, Hogan, Adlof & Barth, 2003; Catts, Hogan & Fey, 2003) have been based on the Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990). According to this model (see p. 19) three subgroups of poor readers can be expected: poor decoders, poor comprehenders and individuals who are poor on both comprehension and decoding. Catts, Hogan, Adlof et al. (2003) demonstrated that in early grades word recognition is particularly important for reading comprehension, but over time listening comprehension ability becomes more influential than word recognition. This is also in line with findings by Sterner and Lundberg (2005). However, a group of good or average decoders with poor comprehension is supposed to comprise between 10 (Snowling & Nation, 1997) and 15 (Aaron, 1997) per cent of the school population. Cain, Oakhill and Bryant (2000) demonstrated comparable performance on phonological skills between children with poor and good comprehension skills. However, on tasks with greater demands on working memory the children with poor comprehension performed more poorly.

Surface and phonological dyslexia

Besides comparing groups of discrepancy defined and not discrepancy defined reading disabled, the most common approach has been to conduct subtyping based on the dual-route model (Castles & Coltheart, 1993; Høien & Lundberg, 2000; Morton, 1979) in order to identify surface and phonological dyslexia. Surface dyslexics are supposed to have impaired orthographic abilities whereas phonological dyslexics are supposed to have difficulties in phonological processing.

Castles and Coltheart (1993) conducted a study where non-word reading was regressed on exception word reading and vice versa to identify children with relatively strong skills on either sublexical (phonological) or lexical (orthographic) processing. By imposing a 90 per cent confidence interval from a control group onto the dyslexia group it was possible to identify subgroups with relative imbalance in the two skills. In this study 54 per cent of the dyslexic children were identified as phonological dyslexics and 30 per cent

as surface dyslexics. Later, Stanovich, Siegel and Gottardo (1997) named these subgroups "soft" subtypes. However, Castles and Coltheart only used a chronological-age control group as reference not taking the overall reading level of the dyslexia group into account. Several subsequent studies have applied both a confidence interval from a chronological-age control group and a reading-level control group (e.g. Gustafson, 2001; Manis, Seidenberg, Doi, McBride-Chang and Petersen, 1996; Sprenger-Charolles, Colé, Lacert & Serniclaes, 2000; Stanovich et al., 1997). These studies showed that when a chronological-age control group was used a similar pattern as in the Castles and Coltheart-study appeared. A substantial number of students belonged to either a soft surface dyslexia subtype or a soft phonological dyslexia subtype. When a reading-level control group was used the phonological dyslexia subtype remained about the same, whereas the surface dyslexia subtype almost disappeared. These findings indicate a delayed development in surface dyslexia and a deviant development in phonological dyslexia. Also, phonological dyslexia seems to be the most reliable of the two subtypes.

Creativity and dyslexia

Although dyslexia is usually regarded as a serious handicap, there is a widely held opinion that dyslexic individuals may possess enhanced creativity. It is usually assumed to be either a common cognitive feature in the dyslexia population, or it is assumed to be a specific feature in a subtype of the dyslexia population. However, surprisingly few studies have been reported to confirm any of these assumptions. On the other hand, informal observations of a more anecdotal character, confirm one or other belief. The internet, for example, is replete with information about the relation between dyslexia and creativity (e.g. dyslexia.com/Pages/Common.htm). This information is often presented as fact, but without reference to any empirical studies. An example is taken from an information sheet from Tri Services National Institute of Training and Research in Dyslexia, United States of America:

> Dyslexics also have uncommon gifts, skills and talents in many fields; the creative arts, architecture, engineering, construction, mathematics, physics, electronics, computer sciences, law, medicine, banking and finance, sports, entertainment and others.

A host of skills is attributed to dyslexic individuals, but there is no empirical support for such relationships. However, several professionals, like psychologists and educators, have informally noted that dyslexic students often

exhibit creative skills. Also, a number of case studies have been published about visual-spatial talented individuals who may have been dyslexic (e.g. Aaron & Guillemarde, 1993; Aaron, Phillips & Larsen, 1988; West, 1997). Names often mentioned of famous, successful dyslexic individuals are for example Edison, Leonardo da Vinci, Maxwell, Rodin, Pasteur, and Aalto. Agatha Christie has also been supposed to have suffered from a mild form of dyslexia (Siegel, 1988).

As early as 1925 Samuel Orton suggested an association between spatial skills and dyslexia. Geschwind and Galaburda (1987) also noted a higher incidence of dyslexic individuals than expected in professions such as engineering and architecture, which require spatial abilities. They assumed that the distribution of both talents and deficits in dyslexic individuals was caused by different brain organization, that is an unusual symmetry of planum temporale in dyslexic individuals. This makes sense in an evolutionary perspective. If it is supposed that dyslexia and creative talents emerge together, then only the talents would be apparent in a pre-historic non-literate society. Deficient phonological skills would be too mild to be an obstacle in speech (Ramus, 2001). Thus, a dyslexic predisposition was advantageous, explaining the evolutionary resistance of dyslexia.

There have been a few empirical studies conducted on the putative association between dyslexia and creativity, and on some related areas (for a review see Winner et al., 2001). However, the evidence for such an association is inconsistent. Everatt, Steffert and Smythe (1999) assessed children and adults on several measures concerning creativity in a series of studies. Dyslexic adults showed greater creativity and more innovative styles of thinking on both tasks and self report measures, compared to the non-dyslexic adults. No differences were found between dyslexic and non-dyslexic adults on any of the visual-spatial tasks. No clear differences were observed between the dyslexic and the non-dyslexic children on any of these measures. As Everatt et al. note, creativity is a rather vague concept. Mostly creativity is described as innovation, novelty or insightfulness, according to the authors. The studies hence supply some support for the view that dyslexic individuals are creative.

Winner et al. (2001) reported that young dyslexic adults performed worse or equivalent to non-dyslexic young adults on visual spatial tests, with and without time constraints. In a study conducted by Winner, von Károlyi & Malinsky (2000) dyslexic high school students were compared with controls on eight spatial tasks. The dyslexic students were superior on one task only, namely speed of recognition of impossible figures. Wolff and Lundberg (2001) failed to

replicate this finding; 40 dyslexic university students did not differ in performance from 40 non-dyslexic university students on recognition of impossible figures.

Other empirical studies have investigated creative talents in children with learning disabilities (of average intelligence) and have reported conflicting results. In a study by Eisen (1989) learning disabled children (8 to 12 years old) scored higher on non-verbal tasks on creativity but not on a verbal control task, whereas children (around two years younger) scored average on all tasks but one, where they scored significantly below average (Argulewicz, Mealor & Richmond, 1979).

There is an ongoing discussion about the nature, and existence, of the association between dyslexia and creativity. Given the inconsistent evidence, it may be plausible to expect dyslexic individuals with superior creative skills to constitute a subgroup of the dyslexic population.

Second language learners

Young children, who are second language learners (L2), are often capable after a short period of time to handle the phonological dimension of the new language (Lundberg, 1999a). They pronounce words well and speak without accent. To reach the deeper layer of language is more complex, where the task is, for example, to understand nuances of words, metaphors or idiomatic expressions (Lundberg, 1999a). Hence, vocabulary acquisition and syntactic competence may be obstacles in L2 children's reading comprehension. One could expect a subgroup comprised of L2 children with poor reading comprehension due to poor listening comprehension, even though general comprehension is normal. They may do well on arithmetic tasks (Lesaux & Siegel, 2003), and on tasks where they should interpret for example tables, charts and maps (see Study 1).

There is no reason to believe that L2 students would have more, or less, phonological processing deficits resulting in poor word reading than L1 students (Da Fontura & Siegel, 1995). Frederickson and Frith (1998), Fredriksson (2002), and Taube (1996) have all observed that word reading skills are superior to reading comprehension among L2 students. There are even some indications that bilingualism can lead to superior word reading (Abu-Rabia & Siegel, 2003; Yelland, Pollard & Mercuri, 1993) as well as pseudoword reading and spelling (Abu-Rabia & Siegel, 2002; Da Fontura & Siegel, 1995; Lesaux & Siegel, 2003).

Language proficiency does not necessarily precede reading development (Geva, 2000), at least not in the same way as it does when students learn to read in their first language. The two skills develop more in tandem. This may confuse teachers who often focus on reading comprehension (Geva, 2000) and therefore too often attribute reading difficulties to language proficiency. In order to tease apart reading difficulties associated with normal L2 development and reading disabilities (dyslexia), it is necessary that assessments involve at least two basic criteria, one related to word reading and one related to linguistic comprehension (Geva, 2000; Lundberg, 1999a; cf. the Simple View of Reading), and a careful comparison between listening and reading comprehension. Geva demonstrated that approximately the same rate of typical dyslexia profiles were present in a group of native English speaking students (6%), in a group of Punjabi speaking students (7%) and in a group of students speaking Cantonese (5.5%).

Summary

Commonly, subtyping studies have been conducted among a group of poor readers. Most of them have concerned internal classifications of dyslexic students into different subtypes, or classifications of dyslexic students in relation to non-dyslexic poor readers according to the discrepancy definition. There has also been some focus on poor comprehenders as well as second language learners. In contrast to previous studies, this thesis includes a subtyping study of readers in a representative sample of students. The advantage with this approach is that no a priori assumptions about reading difficulties hamper the possibility of identifying various subtypes.

The dyslexia subtype of poor reading has been the subject of research for many years. As dyslexia is involved in different kinds of subtyping studies, aspects of this critical subgroup will be discussed in the following chapter.

5 Dyslexia

Biology is not destiny

Definitions of dyslexia

In 1896 the first case of developmental dyslexia was reported in the British Medical Journal by Pringle-Morgan, a general medical practitioner. Pringle-Morgan described a 14-year old boy, who was unable to learn to read in spite of being of normal intelligence. According to Pringle-Morgan this was probably due to "congenital word-blindness".

Pringle-Morgan's early report was followed by systematic research for understanding developmental dyslexia and identifying differences between dyslexic readers and normal readers. Around 70 years later a definition of dyslexia, which has been widely used was proposed by the World Federation of Neurology in 1968 (Critchley, 1970).

> (Dyslexia is) a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence and socio-cultural opportunity. It is dependent upon fundamental cognitive disabilities which are frequently of constitutional origin (p. 11).

Some conceptual problems occur in this definition: What is conventional instruction? What is adequate intelligence? And it is not clear how to interpret socio-cultural opportunity.

This classical definition, often referred to as the discrepancy definition, takes intelligence into account. A discrepancy between general intelligence and reading is required. Many researchers, though, claim that the correlation between children's early reading ability and intelligence is rather low, on average only 0.30 to 0.40 (see Høien & Lundberg, 2000; Stanovich, 1989). This means that only 10 per cent to 15 per cent of the variance in word reading ability can be explained by intelligence. The phenotypic and the genotypic indicators of poor reading are not reliably linked to the word recognition module (Stanovich & Siegel, 2000). Children's performance on word reading and pseudoword reading could not be explained to any extent by non-verbal intelligence once verbal memory was accounted for (Geva and Siegel, 2000). Stanovich (2000) states that poor readers who are not defined as dyslexics, due to low IQ, display the same phonological difficulties as persons who have discrepancy diagnoses. Siegel and Himel (1998) demonstrate that the use of the discrepancy criterion sometimes could result in that children

diagnosed as dyslexics are reclassified as poor readers without dyslexia diagnoses at older ages. Altogether, there is a growing body of evidence against involving IQ-measures in the dyslexia definition (Hatcher, 2000; Høien & Lundberg, 2000; Siegel, 1989; Snowling, 2000; Stanovich & Siegel, 1994; Vellutino & Scanlon, 2001).

Another recognized problem with the definition above is that it is a definition by exclusion. It rather tells us what dyslexia is not. In response to such arguments, Høien and Lundberg (1991, 2000) proposed a definition with a positive diagnosis.

> Dyslexia is a disturbance in certain language functions which are important for using the alphabetic principle in the decoding of language. The disturbance first appears as a difficulty in obtaining automatic word decoding in the reading process. The disturbance is also revealed in poor writing ability. The dyslexic disturbance is generally passed on in families and one can suppose that a genetic disposition underlies the condition. A characteristic of dyslexia is that the disturbance is persistent. Even though reading ability can eventually reach an acceptable performance level, poor writing skills most often remain. With a more thorough testing of the phonological abilities, one finds that weakness in this area often persists into adulthood (2000, p. 8).

Two years later Orton Dyslexia Society (today International Dyslexia Association) adopted a very similar definition, and in 2002 the definition was revised by the board of International Dyslexia Association (Lyon, Shaywitz & Shaywitz, 2003):

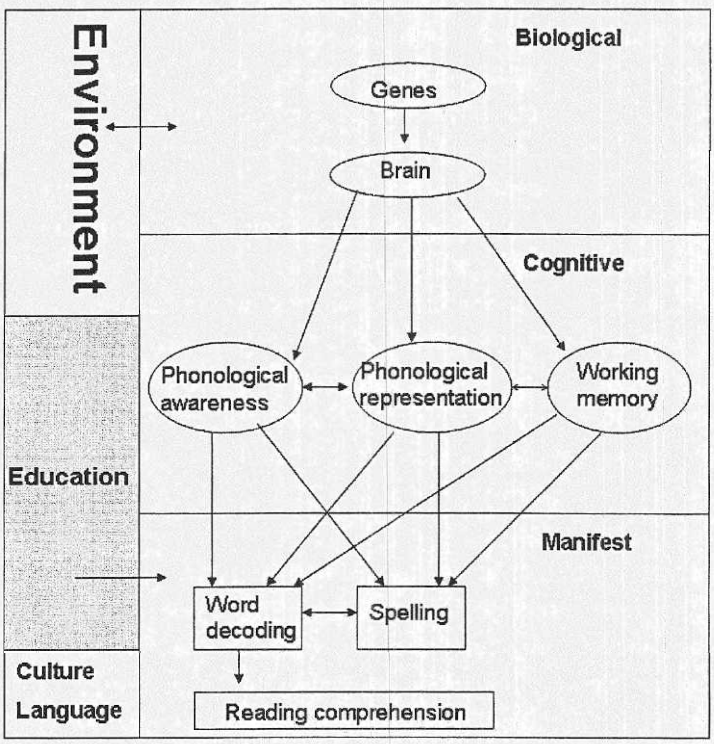
> Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede the growth of vocabulary and background knowledge (p. 2).

These kinds of definitions attempt to explain the underlying causes of dyslexia. The aim is to go beneath the surface of manifest reading and writing problems to get hold of the more basal cognitive-linguistic levels of functions.

The phonological deficit hypothesis

With the aim to obtain understanding for dyslexia and individuals with dyslexia, a common every-day definition is expressed as unexpected reading and writing difficulties in comparison to other abilities. In that sense it has been useful. However, it only refers to manifest measures of reading performance. In contrast, the phonological deficit hypothesis takes three levels of explanation into account; the biological, cognitive and manifest level.

Figure 3 depicts such a three-level model (Lundberg & Wolff, 2003), which is similar to models developed by Frith (1997, 1999), further modified by Lundberg (1999b), Ramus (in press) and Svensson (2003).



Figur 3. A three-level model (Lundberg & Wolff, 2003), showing the biological, cognitive and manifest level assumed in the phonological deficit hypothesis of dyslexia.

Dyslexia is by no means an uncontroversial concept. The debate concerning dyslexia has sometimes been rather fierce. Debaters who advocate an extreme biological explanation of dyslexia claim that the learning disability is

due to the biological-genetic constitution of the individual (e.g. Geschwind & Galaburda, 1987). Dyslexia is assumed to be a congenital disorder solely determined by neurobiological structures. On the other hand the antagonists of this view, often represented by educationalists and sociologists, refer the problems to social and environmental factors (Cole, 1989; McGuiness, 1998; Sundblad, 1993). The assumption is that social conditions and inadequate education are responsible for children's literacy failures. These polarized views might develop in a climate where fight for resources, power and preferential right of interpretation are of more importance than a deep, balanced understanding of severe problems which need practical solutions. Thus, I would maintain that as human beings we are both biological and social creatures seeking for understanding of our environment, interpreting ourselves and our existential position. This basic assumption makes it natural to regard individuals' social and cognitive short-comings as a result of a complex interaction between biological and environmental factors. Thus, it is not a question about either an individual perspective or a social perspective- both perspectives have to be held simultaneously. This does not imply that environmental and biological factors necessarily have the same level of impact on dyslexia. One could conceive of a child with strong genetic disposition for dyslexia, who gets sufficient support from both home and school. Nevertheless, this child may exhibit severe manifest reading and writing problems. However, environmental factors may both moderate and augment the manifest outcome of dyslexia.

The left column in Figure 3 indicates that environmental influence is present at all levels, the biological, the cognitive and the manifest level.

The manifest level

The most obvious thing observed by teachers and parents is that some children have surprisingly great difficulties in learning to read and spell. An abundance of research has demonstrated that the core manifestation of dyslexia is poor word decoding (e.g. Høien & Lundberg, 2000; Snowling, 2000). In alphabetic languages, this is the manifest problem to be explained by going beneath this surface and examine underlying cognitive and biological aspects. The manifest level in many ways reflects environmental influences.

The phonological level

A link goes from the biological level to the cognitive level and from the cognitive level to the manifest level. Manifest problems can be caused by a

cognitive dysfunction, which in turn can be caused by a brain dysfunction. These are not deterministic causes, but probabilistic (Frith, 1997). The predominant cognitive explanation of dyslexia is that it is due to a phonological deficit (Høien & Lundberg, 2000; Pennington, van Orden, Smith, Green & Haith, 1990; Ramus, 2001; Snowling, 2000; Stanovich & Siegel, 1994). Phonological processing is selectively impaired (Pugh et al., 2000). Other language skills such as vocabulary and grammatical skills are assumed to be normal (Goulandris, Snowling & Walker, 2000). However, poor vocabulary may emanate from phonological deficits; see section on working memory below. The phonological module is here (Figure 3) decomposed into three components, where dyslexics are expected to show impaired abilities (see Study II in this thesis). The three components are phonological awareness, phonological representation, and phonological (or verbal) working memory.

Phonological awareness is related to the explicit capacity to conscious manipulation of speech sounds (Lundberg, 2002a). This capacity can, for example, be revealed in spoonerism tasks (Ramus, 2004; Wolff & Lundberg, 2001). Many studies have demonstrated the strong connection between phonological awareness and learning to read (Bradley & Bryant, 1983; Lundberg et al., 1988; Wagner & Torgesen, 1987). The relationship is assumed to be reciprocal (Rayner, Foorman, Perfetti, Pestsky & Seidenberg, 2001).

Phonological representation concerns the distinctiveness of words. Dyslexic individuals are expected to have less precise, or imprecise, phonological representations of words (Elbro, 1996; Elbro, Nielsen & Petersen, 1994). In speech this deficient phonological representation may not be noticeable (Lundberg & Høien, 2001; Ramus, 2001). Instead, a phonological choice task (Lundberg & Wolff, 2003; Olson, Forsberg, Wise & Rack, 1994) or a multiple-choice vocabulary task with phonologically confusable alternatives can reveal vague phonological representations (see Study II in this thesis).

Reading often requires integration of information from different parts of a text (Lundberg, 1984).That is, in order to comprehend a text one must temporarily retain representations of words, phrases, and sentences. *Working memory* is thus involved in this processing (Gathercole & Baddeley, 1986). The concept of working memory needs some further clarification.

Working memory

Most research on working memory and reading comprehension has been made in the context of a model developed by Baddeley (1986). He proposed a working-memory system that is responsible not only for the storage

of information but also for the simultaneous processing of information. There are three elements in this model: the visuo-spatial sketch-pad, the phonological loop and the central executive. The visuo-spatial sketch-pad is not assumed to be very much involved in reading and will therefore not be further discussed here.

The phonological part refers to a system that includes a phonological store coupled with an articulatory loop (Baddeley, 2000; Baddeley, Gathercole & Papagno, 1998). The phonological store maintains short-lived representations resulting from speech-based coding and appears to be particularly important in the retention of order information. The articulatory loop is required to refresh the quickly decaying representations maintained in the phonological store.

Printed words are transformed into phonological form by the articulatory loop to be retained in the store. The phonological storage can hold linguistic information only briefly, perhaps just for a second or two, unless the material is maintained by continuous rehearsal by the phonological loop. The limit of capacity of the buffer means that the information must be rapidly encoded in a more durable form, if it is to be retained for higher level processing.

The second component of working memory, the central executive, has the task of relaying the results of the lower level processing upward through the system. It is assumed to be an attentional control system with limited resources for strategy selection, integration, coordination and control of information from several sources. A deficit in processing phonological information obstructs the transfer of information to the higher levels in the system. According to this processing limitation hypothesis the poor comprehension observed among poor readers should be more pronounced in contexts that tax working memory.

Word decoding involves working memory because phonological information has to be retained (or even articulated, perhaps sub-vocally). At the same time meaning from text can be extracted. So, one would expect an extra load on working memory at the initial stages of reading acquisition when word decoding is a slow and effortful process.

Thus, poor readers' difficulties do not seem to lie in the storage of information, but rather in the processing of that information (Høien & Lundberg, 2000). This suggests that poor comprehenders might show impaired performance on more complex memory tasks (Cain et al., 2000), requiring both storage and processing functions simultaneously. Even though dyslexia does not imply generally poor comprehension, it may imply poor reading comprehension as a secondary problem. It may also imply that dyslexic individuals meet with

difficulties in vocabulary acquisition because of poor working memory. According to Jarrold, Baddeley, Hewes, Leeke & Phillips (2004) verbal short-term memory is crucial in the acquisition of the phonological form of a new word, but not in the pairing of form with meaning.

The complexity of the working memory system also implies complexity in the interpretation of processing failures, for example, attention problems might be a more basic problem than limited capacity of the working memory.

The biological level

Twin-studies and family-studies have shown that dyslexia to a considerable extent is inheritable (Olson, 1999). Several independent teams of researchers have by molecular genetic linkage studies indicated localization of critical genes on chromosomes 1, 2, 3, 6, 15 and 18 (see e.g. Grigorenko, 2001). Obviously no single gene is responsible for dyslexia. It is rather a multi-genetic condition with complex interactions between several genes. This also implies a vulnerability model where different levels of genetic load are interacting with different levels of environmental load. Thus, a high level of genetic load combined with a low level of environmental load might result in a non-dyslexic manifest condition. Another individual with a low level of genetic load combined with a high level of environmental load might acquire reading difficulties (Høien & Lundberg, 2000). Reading is a cultural activity and consequently deeply affected by environmental factors.

However, a child is not a passive recipient of the environmental impact. He or she rather actively chooses niches from the environment available, niches which suits the child's temperament and disposition (Bouchard, 1997). The set of genes all individuals inherit from their biological parents do not determine what an individual will become but what he or she will experience, genes drive experience (Lundberg, 2002a). Thus, individuals actively model their environment by influencing people around them to behave in a certain way, by choosing activities and surroundings which suits the character they are about to develop.

One point of departure in this thesis is that dyslexia is a syndrome (Frith, 1999; Snowling, 2001). As long as the phenotype of dyslexia is not clearly defined, it will not be possible to locate a clear genotype of dyslexia. Thus, there are both practical and theoretical reasons to delineate the dyslexia phenotype.

Alternative theories

As noted previously, the vast majority of researchers agree on the phonological hypothesis of dyslexia, that is dyslexia is primarily a phonological deficit in alphabetic languages (e.g. Høien & Lundberg, 2000; Ramus, 2001; Snowling, 2000). Nevertheless, there are some alternative theories, suggesting more general information processing disorders. These theories do not deny the importance of phonology in dyslexia, but they attempt to explain the deficits with reference to more basic information processing functions. Three of these major alternative theories will be briefly described.

- The auditory processing deficit theory (Tallal, 1980; Tallal, Miller, Jenkins & Merzenich, 1997) claims that dyslexic individuals have auditory deficits causing the phonological deficit. Dyslexic individuals show difficulties in perceiving rapid sounds and with temporal discrimination of simple sound sequences.
- The cerebellar theory (Fawcett & Nicolson, 2001) describes an automatization deficit at the cognitive level, which is caused by a cerebellar deficit at the biological level. Cerebellum is involved in motor control, and hence in speech articulation, and if impaired leading to deficient phonological representations.
- The magnocellular theory (Stein, 2001; Stein, Talcott, & Witton, 2001) asserts that dyslexic individuals have impaired visual contrast sensitivity at low spatial and high temporal frequencies. The saccades (rapid shifts between fixations) during reading cause letter images to move around on the retina, leading to unsteady fixations confusing the letter order. It is a selective impairment in the magnocellular system, as the other part of the visual system, the parvocellular system, is intact. Stein, Talcott, & Witton also suggest a unifying theory, implying common genetic control, for the three theories presented here, thereby also including the phonological aspect.

Many advocators of the phonological deficit hypothesis of dyslexia have discussed the co-occurrence of difficulties with automatization, motor co-ordination, sequencing problems and other symptoms associated with the theories above (e.g. Chiappe, Stringer, Siegel & Stanovich, 2002; Høien & Lundberg, 2000; Kronbichler, Hutzler & Wimmer, 2002; Lundberg & Høien, 2001; Snowling, 2000; Stanovich, 1988a), but have not identified these problems as crucial to dyslexia.

The inability to explain the occurrence of motor and sensory disorders in a substantial proportion of dyslexic individuals is a major weakness in the phonological theory, according to Ramus et al. (2003). They performed a multiple case study with a battery of psychometric, phonological, auditory, visual and cerebellar tests. In a sample of 16 dyslexic students, ten students

showed to have auditory problems, four students had motor problems and two students had visual problems of a magnocellular nature, whereas all students had impaired phonological skills. Thus, sensory and motor disorders were restricted to a subset of dyslexics, and not a necessary component of a phonological disorder. These findings are consistent with other studies (e.g. Kronbichler, Hutzler & Wimmer, 2002; White et al., 2005) supporting the phonological deficit hypothesis.

Ramus (in press) outlined a model attempting to explain why sensory and motor disorders are present in many dyslexic individuals besides the phonological disorder. He has reinterpreted previous hypotheses into one new neurological model. Ramus takes his departure from the three-level model presented above (see Figure 3).

Concerning the biological level, most individuals have assymetric planum temporale (an area of the cerebral cortex), in contrast to most dyslexic individuals who have been found to have symmetric plana (Geschwind & Galaburda, 1987; Larsen, Høien, Lundberg & Odegaard, 1990). This is assumed to be linked to the presence of numerous ectopias in the left side of cortex (Galburda, Rosen & Sherman, 1989), especially concentrated to areas round the sylvian fissure. These ectopias are malformations of cortical tissue originating in focal life. The ectopias send axons to areas where the parietal and temporal regions meet, which are supposed to affect the phonological system.

The second part of the Ramus' hypothesis is that as a secondary problem, under certain hormonal conditions, the axons reach areas in thalamus; the medial geniculate nucleus and the lateral geniculate nucleus. Indirectly, these axons also reach the cerebellum. This only happens in a subset of the dyslexic population, and when it does it causes visual, auditory and/or motor impairment at the cognitive level. For the dyslexic population in general poor phonological awareness, poor grapheme-phoneme mapping, poor verbal short-term memory, and slow lexical retrieval are present at the cognitive level, as a result of the biological level and pointing down to the manifest level.

These brain dysfunctions result in poor reading, poor phonological skills, poor digit span, and slow automatic naming. For the sensorimotor syndrome, poor frequency discrimination, poor coherent motion detection and/or clumsiness are present.

Thus, according to this model phonological impairment is present in all dyslexic individuals. Sometimes, and under certain hormonal circumstances, a sensorimotor syndrome arises in addition to the phonological deficit. An

additional load of visual, auditory or motor deficits may of course aggravate the reading impairment.

Ramus also suggests that the model can be extended to other developmental disorders if the anomalies are focal, and a sensorimotor syndrome is optionally present in some individuals, for example to SLI (Specific Language Impairment), autism and ADHD.

This model appears to be the most innovative effort in the understanding of the complexity of dyslexia and the co-morbidity issue. Suppose now the model is valid for developmental disorders and additional deficits: Could it possibly explain talents too? Could extraordinary creative talents, observed among some dyslexic individuals, be a consequence of axons reaching specific areas under certain hormonal conditions? It is in many ways an appealing thought probably impossible to verify with current methods.

6 The empirical studies

It is easy to lie with statistics, but it is even easier to lie without.

Anders Skarlind

The aim of the four empirical studies was to identify different subgroups of poor readers and relate them to different socioeconomic and cultural background variables. Another aim was to examine different aspects of dyslexia, both concerning deficits and the association between dyslexia and creativity in the sense of visual creativity as embodied in artistic talents. The main assumption concerning dyslexia was the phonological deficit hypothesis. More specific research questions were:

- Which subgroups of readers can be identified among a representative sample of 9-year old Swedish students?
- How are these subgroups related to socioeconomic and cultural home background?

Three studies were conducted with the aim to understand more of the various features of the dyslexia phenotype. In order to do that further subtyping within the dyslexia subgroup and in relation to normal readers was carried out. More specifically:

- Is assessment of phonological skills possible in group administration?
- Does assessment of phonological skills have high power in discriminating between dyslexic and non-dyslexic students?
- Is there an overrepresentation of students with dyslexia among art university students?
- Are phonological and surface dyslexia two distinct subtypes of dyslexia?
- In general: Do these studies support the phonological deficit hypothesis of dyslexia?

Both large and smaller samples have been included in the analyses depending on the character of the research question. Different methodological approaches have also been used. In both Study I and Study IV latent profile analysis has been conducted. As this method has not been used in this context before, a further aim was to investigate latent profile analysis as a method to conduct subtype analysis of reading performance and of abilities related to reading.

Based on the theories presented in previous chapters, five subgroups of readers were hypothesized.

- *Good and average readers.* A majority of all readers is assumed to belong to this subgroup. They are expected to have generally good or average reading skills, with good or sufficient decoding and comprehension. The transferability and generality of reading skills are assumed to be high (Metha, Foorman, Branum-Martin & Taylor, 2005), unless texts are very domain specific.
- *Garden variety poor readers*. They may be students from poor socioeconomic background and with insufficient literacy encouragement. They may exhibit generally low performance on different aspects of reading (Gough & Tunmer, 1986; Stanovich, 1988b), such as reading comprehension and fluency due to limited reading practice.
- *Bilingual students*. This group is expected to perform good or average on word reading (Abu-Rabia & Siegel, 2003). Vocabulary, syntactic competence and limited exposure to long texts may cause poor reading comprehension. Cultural differences may, for example, make it difficult to draw inferences from texts.
- *Students with hyperlexic features.* These students have limited general cognitive capacity resulting in poor reading comprehension. However, as word reading and IQ are not strongly related, these students are expected to have average or good performance on word decoding. Hyperlexia is a very extreme condition (Snowling & Frith, 1986), therefore this subgroup is only said to have features of hyperlexia.
- *Dyslexic students.* The core manifestation of dyslexia is poor and error-prone word decoding (Høien & Lundberg, 2000). Dyslexic students are not assumed to have poor comprehension. However, impaired word reading may as a secondary problem result in poor reading comprehension, even though the linguistic comprehension is intact.

The purpose of this thesis is to gain and confirm knowledge about varying profiles of reading performance, including associated skills and background variables. Another essential purpose is to link those findings to instructional practice.

Study I

Aims

Study I had two aims. The first aim was to identify different subgroups, or profiles, of reading performance among 9-year old Swedish students, and to relate the profiles to possible differences in socioeconomic and cultural background variables. A second aim was to investigate latent profile analysis as a method to conduct subtype analyses. A critical issue was also the generality and transferability of reading skills among the majority of students,

and the assumption of more heterogeneous performance patterns among poor readers.

Five profiles were hypothesized to be identified: *good and average readers, garden variety poor readers, bilingual students, students with hyperlexic features* and *dyslexic students.* Two studies were conducted.

Participants

In Study Ia 5099 9-year old students (50.6% boys, 49.4% girls) participated, and in Study Ib 4184 students (50.3% boys, 49.7% girls). The samples were drawn from the Swedish part of the the International Association for the Evaluation of Educational Achievement (IEA) Reading Literacy study in 2001 (RL 2001) and in 1991 (RL 1991), on the basis of having valid data on the test booklets (A and B) involved in the analyses conducted in Study I. The sample from RL 2001 was used in Study Ia, and the sample from RL 1991 was used in Study Ib.

Tasks

In RL 1991 and RL 2001, the participants were given exactly the same performance tasks. Ten of these tasks were included in the analyses in Study I, tapping four aspects of reading: *comprehension of connected prose, document reading, word reading* and *reading speed.* For the selection of tasks a basic assumption was that decoding and linguistic comprehension are dissociable skills (Gough & Tunmer, 1986). As there are no measures of linguistic comprehension, the dissociation between performances on the two measures of connected prose and word reading (high load on decoding skills) and document reading (low load on word decoding) is supposed to capture the relation between comprehension and decoding. Speed is an additional aspect of decoding.

In RL 1991 as well as in RL 2001 a student questionnaire was given. However, a parent questionnaire was not given in RL 1991, only in RL 2001. Thus, more background variables were available in Study Ia than in Study Ib. As a consequence of this, the background variables used in the analyses of obtained profiles were not the same in Study Ia and Study Ib. In Study Ia four background variables were taken from the parent questionnaire (number of books at home, parents' highest educational level, parents' highest professional level and household income) and two from the student questionnaire (gender and language at home). In Study Ib three background variables were taken from the student questionnaire (gender, number of books at home and language at home).

Method of analysis

The method used for identifying subgroups of readers was latent profile analysis, which is a kind of cluster analysis. It has not been used in this context before, and may need some further clarification.

Most methods of cluster analysis are case-centred, in contrast to factor analysis, which is variable-centred (Croll, 1986). In the analysis, there should be a limited number of clearly interpretable variables (Rapkin & Luke, 1993).

The particular method of latent profile analysis used here has been developed by Muthén (Muthén & Muthén, 2004) and implemented in the Mplus program, which was used in the STREAMS 2.5 modelling environment (Gustafsson & Stahl, 2001). Latent profile analysis allows specification of models with categorical latent variables using continuous manifest variables as indicators. One advantage of latent profile analysis is that the fit of the model can be assessed. Each student was not only classified into a certain profile by Mplus but a probability for belonging to each profile was also estimated.

The model fit was assessed by so-called information criteria. The best-fitting model is obtained when the Sample-Size BIC (the Bayesian Information Criterion) value is as low as possible combined with as high an Entropy as possible. The BIC value is a log-likelihood measure used for model selection. It does not require any a priori profile information. Entropy is a measure of disorder in a given dispersion. When an individual has a high estimated probability for belonging to one profile and low probabilities for belonging to the remaining profiles the Entropy will be high. To determine the number of profiles, or subgroups, the two methods were combined with a "scree"-type test where levelling-off points of the curves for the Entropy and Sample-Size Adjusted BIC values for models with a different number of profiles were found.

Results and discussion

In Study I eight distinct and interpretable performance profiles of reading were obtained in both Study Ia and Study Ib. The method used for subgrouping was latent profile analysis. The two sets of profiles in the two studies were compared. Each of the performance patterns of the eight profiles showed to be highly similar in the two studies.

In Study Ia, one-way between-groups multivariate analysis of variance (MANOVA) was performed with the six background variables as

dependent variables, and each profile versus the remaining group was by rotation the independent variable.

Based on the performance patterns and the analysis of background variables the profiles were tentatively labelled according to their characteristics. The tentative labels were:

- Profile 1. High performers with favourable social background.
- Profile 2. Average performers.
- Profile 3. Poor document readers, predominantly girls.
- Profile 4. Average word decoders with poor comprehension (hyperlexic features).
- Profile 5. Generally poor and slow readers with poor cultural and socioeconomic background, garden-variety poor readers.
- Profile 6. Generally poor readers, less deficient on word reading and from poor cultural and socioeconomic background, garden-variety poor readers.
- Profile 7. Particularly poor on connected prose, possibly due to limited language skills.
- Profile 8. A dyslexic group.

Thus, the expected profiles were obtained. However, the profiles composed of good and average readers as well as garden-variety poor readers were divided into two distinct profiles respectively, and an additional profile composed of poor document readers was identified. The most stable profiles seemed to be high performing students, poor comprehenders (with good or average word decoding) and dyslexic students, as these profiles were identified in all model solutions obtained by latent profile analysis from a 4-model solution up to a 26-model solution. Also, a K-means cluster analysis was conducted concerning the dyslexia profile, indicating internal validity.

Study Ib was performed with the purpose of replicating Study Ia. The same tasks as in Study Ia formed the basis for latent profile analysis. The performance patterns of the profiles in Study Ib were largely close to identical with the profiles of Study Ia, even though students in Profile 7 in Study Ib were average readers rather than poor readers.

Only three of the six background variables included in Study Ia were available in Study Ib. A MANOVA was performed with the three background variables as dependent variables and each profile versus the remaining group as independent variables. No assumptions about socioeconomic status were possible to make in Study Ib, and was thus removed from the tentative labels of Profile 5 and Profile 6.

In Study I three main conclusions were made: latent profile analysis proved to be a feasible methodology, a majority of the students showed an even profile of performance implying that reading is a skill with high transferability and generality, and several subgroups of poor readers with heterogeneous performance patterns were identified. This has certainly educational implications, emphasizing the need for differentiated remedial programs for poor readers.

Study II

Aims

The aim of Study II was to design a test battery for group screening of dyslexia among adults. Most researchers in the dyslexia field agree that dyslexia is not synonymous with reading and writing difficulties per se, even though the core symptom of dyslexia is poor word decoding. The underlying proximal cause is assumed to be deficits in the phonological domain (Frith, 1997; Høien & Lundberg, 2000; Ramus, in press; Snowling, 2000; Stanovich, 1988a). Therefore, the focus of the screening procedure was on phonological weakness. However, tests of phonological ability normally require vocal responses, and hence are administered individually. This is in most educational circumstances far too time-consuming. A challenge was thus to design a screening battery of phonological processing tasks aimed at group administration.

Participants

In Study II 117 students (38 males, 79 females) participated. They were recruited from adult education centres for secondary education (high school level) in Western Sweden. The students were divided into two groups; one composed of 50 dyslexic students, who were defined as dyslexic by experienced dyslexia educators, and some of them had a dyslexia diagnose. The other group comprised of 67 students without any known reading disability. Their mean age was 33 years and 30 years respectively. The dyslexic students were taking courses designed for adults with reading disabilities. The control group was composed of students who had not completed any education above compulsory school, hence the two student groups were expected to be relatively equivalent regarding educational level, intellectual habits and professional experience.

Tasks and procedures

A screening battery of paper and pencil tasks was designed, tapping three subskills of phonological processing: phonological awareness, phonological representations and working memory. Apart from the phonological tasks, that is working memory, reversed spoonerism, phonological choice and vocabulary with phonologically confusable alternatives, a self-report questionnaire and an orthographic choice task were also included in the battery. A subset composed of 50 students was also administered a word reading test (wordchains).

The screening was administered in group settings by the same test leader at all occasions. Around 20 students participated in each session. Testing time was about 40 minutes.

Results and discussion

One-way between-groups multivariate analysis of variance was performed. Dependent variables were the six subtests. There was a significant group difference between the dyslexic and the nondyslexic group on the combined dependent variable. Also, the two groups differed significantly on each individual test in the battery.

The self-report questionnaire was the strongest discriminator between the two groups, implying that adults are aware of, and do not seem to hesitate to report difficulties related to reading. This seems to be especially true when the questionnaire includes reports concerning reading interest and nonreading functions related to dyslexia. In comparison to the other subtests in the battery, the vocabulary task with phonologically confusable alternatives had relatively weak discriminative power. Print exposure enhances vocabulary (Biemiller, 2000) in general, but the phonological element in this task is assumed to be an obstacle for the dyslexic students. In a previous study (Wolff & Lundberg, 2001) dyslexic university students performed significantly more poorly on a vocabulary test with confusable alternatives than non-dyslexic university students, whereas they performed equally well on an ordinary vocabulary test. However, in the present study the students were recruited from adult education centers. This probably indicates low educational levels and sparse print exposure, even for the control students, resulting in poor vocabulary. Moreover, another contribution to the weaker discriminative power may be different reasons for failing at school between the groups. Social and cultural causes, implying poor vocabulary, among control students are more likely than among dyslexic students.

The only gender difference observed was in the dyslexic group, where females performed significantly better than males on the orthographic choice task, which may indicate more print exposure among females. In the control group the gender difference on this task did not reach significance.

A principal component analysis was conducted, with the intention to obtain a composite measure of the six tasks in the screening battery. The single component extracted explained 60.2 per cent of the total variance. An inspection of the distribution of the factor scores between the dyslexic group and the control group revealed almost no overlap; the distribution of the groups was close to a so-called fine-cut (Lundberg, 1999b).

To further validate the power of the screening battery all tasks were entered into a logistic regression analysis with the dichotomy dyslexia/nondyslexia as the dependent variable. In this regression a perfect discrimination between the groups was obtained.

A subgroup of the dyslexia group (n=22) and the control group (n=28) performed a wordchains test (Jacobson, 1993). The control group had significantly higher scores than the dyslexic group (means 33.3 vs. 20.0; t=7.691; p< .001). A multiple regression analysis showed that the complete battery could explain 76.6 per cent of the variance in word reading.

The results of this study suggest that paper and pen administration of a phonologically based group assessment for screening of dyslexic problems is a feasible method. Also, it is little time consuming, around 40 minutes, and discriminates clearly between reading disabled and nondisabled adults.

Study III

Aims

Although dyslexia generally is described as a deficit in reading and writing, numerous informal and anecdotal observations indicate an association with artistic creativity out of the ordinary. However, most reports are based upon single cases.

In a few empirical studies on dyslexia and creative talents, dyslexic and non-dyslexic students' creative talents have been assessed and compared (e.g. Everatt et al., 1999; Winner et al., 2000). In Study III two studies were performed. The main objective was to determine the incidence of dyslexia among art university students and compare it to the incidence of dyslexia among non-art university students. A subsequent aim was also to design an adequate questionnaire, a self report of dyslexia traits and reading interest.

Participants

Participants in Study IIIa were 74 art students (34 females and 40 males) and 80 non-art students (43 females and 37 males). Their mean ages were 27.5 years and 24.5 years respectively. They were all students at Göteborg University, Sweden. The art students studied either at the Department of Fine Arts Valand or at the Department of Photography, and the non-art students at the School of Economics and Commercial law.

In Study IIIb, 194 art students (148 females and 46 males) and 202 non-art students (98 females and 104 males) participated. The mean age was about 26 years in both groups. The number of university departments was extended in Study IIIb to include four departments of art: Department of Fine Arts Valand, Department of Photography, School of Design and Crafts, Chalmers University of Technology (architecture), and four non-art departments: School of Economics and Commercial law, Department of Political Science, Department of Psychology and Chalmers University of Technology (civil engineering).

Tasks and procedures

The assessments were administered in groups of between approximately 10 to 40 students, and lasted for about 20 minutes. The same test leader presented the test battery at all occasions. There was no attrition in Study IIIa, but one student chose not to participate in Study IIIb.

The tasks differed partly in the two studies. Study IIIa included a wordchains test, indicating word recognition skills, an author recognition test, indicating reading habits, and a self report, indicating dyslexic problems as well as reading interest. The wordchains test was also included in Study IIIb, together with an extended version of the self report. A third task was phonological choice, indicating phonological skills. The author recognition test was excluded for administrative reasons.

Efficiency scores were computed for the wordchains test and for the phonological choice test, and accuracy scores for the author recognition test. A four-point scale was used for the self report. The items indicating reading interest and dyslexic problems were computed separately.

Results and discussion

The primary aim of Study III was to examine the prevalence of dyslexia in the two groups of art and non-art students. The screening criterion used for dyslexia in Study IIIa was 1 SD below the mean on both the self report

(dyslexic problems) and the wordchains test. According to this criterion 11 (15%) art students and 1 (1.2%) non-art student were dyslexic. At a more conservative estimate (1.5 SD below the means) 7% of the art students and 0% of the non-art students met the dyslexia criterion.

In Study IIIb, 13% of the art students reported dyslexia signs (1.5 SD below the mean) compared to 5% of the non-art students. With a cut-off of 1 SD below the mean on both self report and phonological choice 8.8% of the art students vs. 2.5% of the non-art students were dyslexic. Adding wordchains to the cut-off criterion decreased the incidence of dyslexia to 4% vs. 1.5%. Obviously, the prevalence of dyslexia varies depending of measures and cut-off points. Yet, the incidence of dyslexia remains relatively higher among art students irrespective of cut-off points.

The art students exhibited greater interest in reading and more developed reading habits as compared to the non-art students, in spite of significantly poorer word recognition performance in Study IIIa and poorer phonological skills in Study IIIb. This probably reflects a stronger cultural orientation among art students. More exposure to literacy among art students might explain the fact that the two student groups in Study IIIb performed statistically equally well on wordchains, even though the art students performed more poorly on phonological choice. If we assume that poor phonological skills are typical dyslexia signs, it is still not surprising that dyslexic university students perform within the normal range on rather simple orthographic tasks, because they may be so-called compensated dyslexics.

The two studies were correlational in nature, hence we cannot make any casual interpretation of the results why the prevalence among art students was higher than among non-art students. However, there were some suggestions on possible causes of the relationship. The fact that we actually found a higher prevalence of dyslexia among art students as compared to non-art students could possibly simply be a result of compensation for failure in reading and writing. The dyslexic art students may have been dedicated to succeed in another more reachable field than literacy. Another possibility is that it is a question of co-morbidity without any causal relationship between the reading deficit and the artistic talent. In a third alternative explanation, the activation of innovative strategies and different modes of thinking is the product of long-term struggle with reading and writing problems. A fourth possibility is that the relationship is an illusion. Dyslexic individuals are no more talented compared to the rest of the population, but whereas non-dyslexic individuals can chose any professional field, dyslexic individuals are restricted to non-verbal domains. Also the creative

talents become more conspicuous under the circumstances of a cognitive disorder. Another way to interpret the enhanced creative talents in dyslexic individuals is to assume that it is neuro-biologically based. Both different structures (Galaburda et al.,1989; Larsen et al.,1990) of the brain as well as different activity patterns (Eden et al., 2004; Pugh et al., 2000; Pugh et al., 2001; Ramus, in press) have been observed among dyslexic individuals as compared to normal readers. It has been speculated that the unusual symmetric brain with larger right-hemisphere planum temporale often observed in the dyslexic brain and different activity patterns could be an indication of different distributions of talents. Thus, the fifth hypothesis is that the association between dyslexia and creativity is genuine and based on specific neurological wiring of the dyslexic brain.

Study IV

Aims

The aim of Study IV was to examine the prevalence of phonological and surface dyslexia subtypes among Swedish dyslexic university students. The study was conducted with the assumption of a dual-route model, which posits that two different strategies, a phonological or an orthographic, can be used to recognize a written word.

Castles and Coltheart (1993) developed a method to identify dyslexia subgroups, where orthographic skills were regressed on phonological skills and vice versa. The students who fell below a 90% confidence interval were then classified as surface or phonological dyslexia subtypes respectively. These students performed poorly on one of these skills relative to the other. In the search for dyslexia subtypes, this regression method was used in Study IV. A latent profile analysis was also performed on the dyslexia group for the same purpose.

Participants

Based on a self report, a word recognition test and a phonological test, 40 dyslexic university students (19 male, 21 female) were drawn from a sample of 396 Swedish university students. The dyslexic students were matched on gender, age and academic courses with 40 non-dyslexic university students (an academic-level matched group).

A younger group of 40 13- to 14-year-old students with normal reading for their age was matched on their word recognition scores on the

dyslexic students. Thus, 40 dyslexic university students, 40 academic-level matched students and 40 reading-level matched students were included in the analyses.

Tasks and procedures

An assessment battery for individual administration was designed. It included four phonological (sublexical) tasks and three orthographic (lexical) tasks. The phonological tasks were non-word reading (accuracy and latency), non-word spelling (accuracy), spoonerism (efficiency, a combined measure of accuracy and latency), reversed spoonerism (efficiency, a combined measure of accuracy and latency) and phonological choice (efficiency, a combined measure of accuracy and latency). The orthographic tasks were orthographic choice (efficiency, a combined measure of accuracy and latency in the regression analyses; accuracy and latency in the latent profile analysis), orthographic reading (accuracy and latency) and exception word spelling (accuracy).

Participants were individually tested. Including an in-depth interview and two additional subtests not reported here, the session lasted between 1.5 to 3 hours.

A wordchains test and a phonological task were administered in groups of 12 to 30 students.

Results and discussion

Using the regression method, orthographic choice scores were plotted against phonological choice scores, and vice versa. Analyses were performed on both academic-level controls and reading-level controls. Confidence intervals (90%) were derived from these regressions and were superimposed on corresponding plots for the dyslexic group.

When the academic-level controls were used as the comparison group 16 students were defined as surface dyslexics, and eight students were defined as phonological dyslexics. Another 11 students were low on both the lexical and sublexical task, and thus did not qualify for any subgroup. Similar to previous research (Gustafson, 2001; Manis et al., 1996; Stanovich et al., 1997), the number of surface dyslexics decreased when the reading-level controls were used as comparison group, and in the present study two students were defined as surface dyslexics, whereas 20 students were defined as phonological dyslexics. Two students were low on both.

There were five phonological measures and four orthographic measures included in the latent profile analysis. The mean differences between

the dyslexic group and the academic-level control group were significant on all tasks. Only the dyslexic group was included in the analysis. However, the dyslexic group's performance scores were standardized together with the academic-level control group in order to keep a reference to a group of normal readers.

A 7-profile model showed to be the best-fitting model. Profile 1 and Profile 2 comprised 37.5% (n=15) and 40.0% (n=16) of the students respectively. Their performance profiles were rather even. Profile 3 and Profile 4 comprised 7.5% (n=3) of the students each. The students in Profile 3 performed poorly on tasks involving latency, whereas students in Profile 4 were comparatively performing more poorly on the orthographic tasks. Profiles 5, Profile 6 and Profile 7 comprised only one student each (2.5%). The student in Profile 7 performed more poorly on all the phonological tasks in comparison to the orthographic tasks. None of the seven profiles showed a clear profile of poor performance on the lexical tasks but not on the sublexical tasks or vice versa.

In conclusion, Study IV supports the phonological deficit hypothesis. The dyslexic group was phonologically and orthographically impaired compared to the academic-level control group. The regression analyses indicated that the dyslexic group performed equally well as the reading-level group on the orthographic tasks but more poorly on the phonological tasks. These results suggest a deviant development in phonological dyslexics and a delayed development in surface dyslexics.

General discussion

In this section the results from the four empirical studies and related methodological issues will be discussed.

Reading performance profiles

Study I examined patterns of reading among 9-year old students. Five subgroups, or profiles, of readers were hypothesized based on the Simple View of Reading (Gough & Tunmer, 1986), the dual-route model (Castles & Coltheart, 1993; Høien & Lundberg, 2000), a stage model of word reading (Frith, 1985, 1986; Høien & Lundberg, 1988, 2000), and the impact of home background variables (e.g. Abu-Rabia, & Siegel, 2003; Snow, Burns, & Griffin, 1998). However, using latent profile analyses eight profiles were obtained, three more than expected. There are three reasons for this.

Firstly, good and average readers were expected to form one profile only, but were divided into one profile comprised of good readers, Profile 1, and

one profile comprised of average readers, Profile 2. As hypothesized, their performance profiles were even (Metha, Foorman, Branum-Martin & Taylor, 2005), so they only exhibited a difference in elevation. The profiles relations to different home background variables were examined. The students in Profile 1 more often spoke Swedish at home, their parents were more highly educated, held higher professions and earned more money compared to the remaining group of students. Profile 1 also had significantly more books at home, whereas Profile 2 had fewer books at home compared to the remaining group of students. This may indicate the importance of the home cultural environment in enhancing reading skills.

Secondly, the third profile was not expected. These students performed average on word decoding and connected prose, but performed poorly on document tasks. However, this pattern fits well with the assumption that document tasks require other cognitive skills than connected prose (Gustafsson, 1995). It is also in line with previous research, as there were more girls than boys in this profile, and girls have shown to perform worse on document tasks relative to reading of connected prose in comparison to boys (Gustafsson, 1995; Wagemaker, Taube, Munck, Kontogiannopoulou-Polydorides & Martin, 1996).

Thirdly, generally low performers, garden-variety poor readers (Gough & Tunmer, 1986; Stanovich, 1988a), also split into two subgroups, Profile 5 and Profile 6. Students in both profiles seemed to come from poor cultural and socioeconomic background compared to the other students. Profile 5 was more deficient on word reading compared to profile 6. However, these two profiles may not be stable enough to enable meaningful interpretation of performance differences.

Thus, all the hypothesized subgroups were obtained, even though an additional subgroup besides them arose, and two of the subgroups were split. Yet, altogether the expected pattern was observed. High or average performance profiles were even, and poor performance profiles were more uneven.

Profile 4 exhibited normal word recognition skills, but reading comprehension was poor on both connected prose and documents. Possibly, most students in this profile have low linguistic comprehension, due to low general comprehension. Yet, around 20% of the students in this profile never, or only sometimes, spoke Swedish at home. Their poor performance on reading comprehension may be due to poor vocabulary and/or cultural factors. Good or normal word decoding could be expected both from students with low general comprehension (Høien & Lundberg, 2000) and from second language learners (Taube, 1996).

There were more children who never, or only sometimes, spoke Swedish at home in Profile 7 than in the remaining group of students. They

performed just below average on word decoding and document tasks, and slightly lower on connected prose. This is in line with the assumption that immigrant children may have impaired vocabulary and have limited exposure to long texts, but there is no reason to assume that they should have deficient word reading skills (Abu-Rabia & Siegel, 2002). Therefore, they manage word reading and short texts, as documents, better than reading continuous texts.

Profile 8 exhibited a typical dyslexic pattern on the manifest reading level. This profile comprised around 7 per cent of the students in both studies, RL 1991 and RL 2001, a frequency for dyslexia in line with previous reports (Frith, 1999; Habib, 2000; Lundberg, 1985; Ramus, 2004; Zeffiro & Eden, 2000). Low-performing profiles generally comprised more boys and their parents were less educated, held lower professions and earned less money than the parents of the remaining group of students. They also less often spoke Swedish at home and had fewer books at home. However, the only significant background variable for Profile 8 was less educated parents, which is further support for the assumption of a dyslexia profile. Dyslexia is not assumed to be caused by cultural or socioeconomic factors, it is rather assumed to be constitutional by nature. One could then conceive of dyslexic students with dyslexic parents, and lower educational level among parents is thus not a surprise. However, they may be creative and gifted enough to get high employments and incomes.

Study 1 demonstrated the existence of theoretically expected subgroups of poor readers. These subgroups were differently associated to socioeconomic, cultural and linguistic home background variables. The study was in strong support of the view that reading is a skill with high generality and transferability. The most stable profiles showed to be high performing students, poor comprehenders and dyslexic students in both studies.

In both Study I and Study IV latent profile analysis was used as a method. In Study I, an 8-profile model was selected as the best fitting model. Each profile was given a tentative label. The reliability of this labelling was examined. Two well-known and highly respected researchers in the field of dyslexia and reading were asked individually to match the eight subgroups with the eight tentative labels. One researcher was Swedish and one was English. Both researchers agreed with the study on the labelling of seven of the profiles. They did not disagree with the study on the same profile, though. The disagreement lead to the swapping of two profiles, even though they noted that they wanted the same label as in Study I on one of the labels. Thus, the researchers agreed on seven of the eight labels, which may be regarded as high concordance.

Prevalence of dyslexia among art students

Study IIIa and Study IIIb examined the prevalence of dyslexia among art university students as compared to non-art university students. The screening was based on a word reading test, a phonological choice test (in Study IIIb) and self report of dyslexia signs. The main finding of Study III was a higher incidence of dyslexia among art university students. The non-art students performed significantly higher than the art students on all performance scores, except wordchains scores in Study IIIb, and the non-art students also reported significantly less dyslexia signs.

The cut-off point for deciding whether there is a case of dyslexia has an arbitrary character. This is also true in the results; the incidence of dyslexia varied depending on measures and cut-off points, and between Study IIIa and Study IIIb. There may be several reasons for this. Firstly, in Study IIIa only two art schools and one non-art university course were included in the analysis. The two art schools have probably more restrictive admission criteria than the additional art schools in Study IIIb, and some of the non-art university courses included in Study IIIb had less restrictive admission criteria than the one included in Study IIIa. On the only directly comparable measure (wordchains) between the studies, the non-art students had about the same mean, even though the standard deviation was larger in Study IIIb. The mean on the wordchains test for the art students was higher in Study IIIb than in Study IIIa. Interpreted in this context, the case might be that the higher artistic demands on the art students in Study IIIa may imply higher incidence of dyslexia. Secondly, in Study IIIb a phonological test was included and the self report questionnaire was extended. As an improved questionnaire was included and dyslexia is a phonological deficit with poor word decoding as its major manifestation (Frith, 1997; Lundberg, 1999b; Snowling, 2000) the instruments in Study IIIb may be sharper in the screening for dyslexia. Thirdly, measurement errors could be expected to be found in both studies. However, regardless of cut-off points and measures applied the incidence of dyslexia was clearly higher among art students.

Word reading in relation to reading interest and phonology

The author recognition test in Study IIIa indicated reading habits. The art students had significantly higher scores than the non-art students. In Study IIIb the art students also reported more reading interest than the non-art students. These results thus indicated a stronger literate-cultural orientation among the art students. This may also serve as a possible explanation of the unexpectedly high word reading performance of the art students in Study IIIb.

Although the art students performed more poorly on the phonological task and more dyslexia signs were reported, they performed as well on the word reading test as the non-art students. Enhanced reading interest probably leads to more print exposure, which could be assumed to lead to better word recognition skills. This raises a question concerning the Reading-stage model (see p. 22). Is it possible to develop good orthographic-morphemic reading without developing proficient alphabetic-phonemic reading? Studies have shown that phonological deficits persist in adults with compensated dyslexia (Bruck, 1992; Paulesu et al., 1996; Svensson & Jacobson, in press), that is their word reading is rather normal. However, with higher demands on the orthographic skills, such as spelling of exception words, the dyslexic students would presumably fail to perform within the normal range. A substantial gender imbalance with more females in Study IIIb may also have contributed to the rather high word reading performance, as females generally perform better than males. The same pattern of better performance among female dyslexics than male dyslexics on an orthographic task (orthographic choice) also appeared in Study II, even though the females did not perform better on the phonological tasks.

Possible explanations of enhanced creativity among dyslexic students

The results of a higher incidence of dyslexia among art university students support the common assumptions and the many reported observations of enhanced creativity among dyslexic individuals. Yet, a crucial question remains: Why? The answer is beyond the scope for Study III, so only some speculations can be made. It may simply be a question of compensation in fields not involving reading and writing, because of early failure. However, a study (Wolff, 2002) of individual assessments suggests that this is not the case. Interviews were held with 80 university students, of which half were art students. All of the art students claimed that they and/or their parents had felt that they were artistically talented before school-age, that is before they were seven years old. This was true for both the dyslexic (n=20) and the non-dyslexic (n=20) students. Thus, observed artistic talents preceded possible failures in reading and writing. Also, the strict admission policies at art schools indicate genuine enhanced visual talents among these students.

Previous research (e.g. Everatt et al., 1999; Winner et al. 2000) has not been able to show consistent results concerning these putative enhanced visual talents among dyslexic students. The present study contributes with a new approach taking departure from a group of art students rather than dyslexic students. In the light of previous inconsistent research the results presented here

may indicate the existence of a subtype of dyslexia students with extraordinary talents.

Thus, dyslexia seems in many individuals to contain double-edged qualities. On the one hand there are reading and writing difficulties, and on the other hand are artistic and creative talents beyond the ordinary. This potential connection and what it originates from certainly deserves further research. An interesting type of research would be longitudinal studies, starting off with children in preschool, including neurological measures like functional magnetic resonance images (fMRI) and with carefully examined measures of creativity.

Screening for dyslexia

During the work with Study III, the absence of and the need for efficient screening tools for dyslexia became obvious. In Study II, a group screening battery for dyslexia among adults was thus designed. The tasks included in the battery were not simply designed to distinguish individuals with potential dyslexia problems, but were also designed to have diagnostic implications for further individual assessments and remedial interventions. The questionnaire used in both studies in Study III was elaborated and included in the battery. It was an essential part of the battery and served several purposes. The questionnaire contained two scales of self report; one concerned dyslexia signs and one concerned reading interest and habits. The latter part was not accounted for in the screening for dyslexia. This part could give educational guidelines as well as tools to interpret performance outcomes.

The part concerning dyslexia signs was included in the screening for dyslexia. In fact, it was the most discriminatory instrument of the tasks in the battery. As opposed to some studies (e.g. Myrberg, 2000) the respondents in this study do not seem to under-report dyslexia problems. A possible explanation may be found in the character of the questions. In the present questionnaire questions are definite and concrete, like: "Do you have trouble in following the subtitles on TV?" It is easier to respond to this kind of question than the vaguer question: "Do you have learning difficulties?" The former question also implies that it could be expected, even among adults, that some individuals are slow readers and cannot follow the subtitles. Presumably, the fact that the questions of the battery concerned not only reading and writing but also non-reading functions related to dyslexia probably induced more honest responses.

The least discriminatory task of the battery, vocabulary with phonologically confusable alternatives, would probably hold even more information if it was compared to an ordinary vocabulary test. The phonological

component of the test would then be "isolated" by dissociation. The intention is that such a vocabulary test should be included in a forthcoming individual assessment battery.

The orthographic and phonological choice tasks indicated poor strategies in both orthographic and phonological skills in dyslexic students. A few students, though, showed poor orthographic skills and rather normal phonological skills. In the questionnaire these students reported problems with spelling, but did not report problems with reading. This emphasizes the importance of scrutinizing the responses from different tasks and to interpret them taken together. According to Castles and Coltheart (1993) a subgroup of dyslexic students may have normal phonological skills and impaired orthographic skills (surface dyslexics). The issue concerning phonological and surface dyslexia was examined in Study IV.

Subgrouping of dyslexic students

Although medical, educational and psychology specialists have studied dyslexia for 100 years, little is known about the individual variations among dyslexics. Practitioners, like educators and psychologists, have been aware for some decades that dyslexic students do not form a homogenous group. There is substantial variability in reading and writing performance, both in types of errors and in the way students approach reading. As in many other clinical fields it has been quite natural to attempt to find homogenous subgroups with differential responses to specific treatments or interactions. These attempts have been based on phenotypic diagnostic criteria. In future research, modern molecular genetic technology may offer a potential in helping us understand dyslexia subgroups. Grigorenko et al. (1997) have proposed that different chromosomal regions correspond to different dyslexic phenotypes. However, the individual variability in reading and uncertain measurements make the definition of behavioural phenotypes very difficult. Modern technologies, such as PET (positron emission tomography) and fMRI (functional magnetic resonance imaging), have been used in several studies to understand the reading brain and to decipher the process of reading (for an overview see Grigorenko, 2001). Different distinct patterns of activation in the brain could together with manifest reading performance form the basis from which to identify subgroups of dyslexia. Thus, brain imaging has the potential to identify phenotypes and molecular genetic technology makes it possible to identify the gene, or genes, involved in different sub-processes in reading. It would certainly be strong support for the subgrouping issue, if brain imaging and molecular genetic

technology in combination could contribute to identification of genes and corresponding phenotypes.

Another possible source of different subgroups may be differences in print exposure and compensation. Many dyslexics have cognitive and linguistic strengths from which they can benefit, and thereby overcome some orthographic deficits, whereas the more persistent phonological deficits remain. This would result in more separated phonological and orthographic skills among older dyslexics as compared to younger dyslexics (Stanovich et al., 1997).

Based on the assumption of the dual-route model, attempts were made to identify dyslexia subgroups in Study IV. Firstly, the regression method (Castles & Coltheart, 1993) was used with both an academic-level control group and a reading-level control group as reference groups to a dyslexic group. Convergent with previous research (Gustafson, 2001; Manis et al., 1996; Stanovich et al., 1997), a phonological dyslexia subgroup was identified in both cases, but a "surface dyslexia" subgroup was only identified when the academic-level control group was used as reference group. This implies a deviant development in phonological dyslexia and a delayed development in "surface dyslexia".

Secondly, a latent profile analysis was conducted on the dyslexic group. Seven performance profiles of phonological and orthographic tasks were obtained. A majority of the students showed even performance profiles, as was expected. The students in one profile exhibited generally poorer orthographic skills than phonological skills, and one student exhibited poorer phonological skills than orthographic skills. However, no student performed poorly on all orthographic tasks and in the normal range on the phonological tasks or vice versa.

The dyslexic students had significantly lower scores than the academic level control group on all the phonological and orthographic tasks included in the latent profile analysis. This could be explained accordingly to the word reading model (Frith, 1985; Høien & Lundberg, 2000) described in this thesis; deficient phonological ability will restrain the orthographic skills.

The present study supported the view of delayed development in "surface dyslexics" and deviant development in phonological dyslexics, thus a support of the phonological deficit hypothesis.

Orthographic and phonological skills were assessed in Studies II, III and IV, with different purposes but all based on the phonological deficit hypothesis of dyslexia. In Study II an assessment battery for identifying students with dyslexia was designed. The prevalence of dyslexia among art and non-art

university students was examined in Study III. In Study IV attempts were made to identify surface and phonological dyslexia among university students. Strong support was only seen for the phonological dyslexia group.

Methodological issues

This thesis rests on the theoretical framework described in previous chapters, where the most important theoretical assumptions are the phonological deficit hypothesis of dyslexia (e.g. Høien & Lundberg, 2000; Ramus, 2001, Snowling, 2000), the dual-route model (Castles & Coltheart, 1993; Høien & Lundberg, 2000), the Simple View of Reading (Gough & Tunmer, 1986), a developmental word reading model (Frith, 1985, 1986; Høien & Lundberg, 1988, 2000), and the impact of home background variables (e.g. Abu-Rabia, & Siegel, 2003; Snow, Burns, & Griffin, 1998). The overall approach in the analyses of the results in the empirical studies has been a reliance on statistical methods as tools to evaluate the theoretical assumptions.

One aim was to investigate latent profile analysis as a method to identify subgroups of readers. The obtained profiles showed to be theoretically interpretable. In Study IV the results were in line with the phonological deficit hypothesis of dyslexia, and with the results from the regression method conducted in the same study, but with different variables. The entropy was high in both studies, and the probability for the individuals to belong to another profile was low. Some of the profiles in Study I, high performing students, poor comprehenders and dyslexic students, were the most stable profiles, and could be identified in all models suggested from a 4-profile model upwards. The very successful cross-validation of profiles in Study 1a and Study 1b indicated that latent profile analysis is a useful tool in this context. Largely, the corresponding profiles in the two studies were related in the same way to the home background variables, and the distribution of the home background variables was in accordance with what was hypothesized. Altogether, latent profile analysis proved to be a feasible methodology. The results were robust, stable and interpretable.

The thesis has a multiple-methods approach. The empirical studies include both large-scale data as well as data from smaller samples due to the nature of the research questions. Study I is the only one of the four studies which concerns subgrouping of all kind of readers, whereas Studies II, III and IV investigate different features of dyslexia.

As the aim of Study I was to identify distinct subgroups of all readers, a large representative sample was required. For this purpose the IEA-

data of 9-year old students offered a unique opportunity. However, to use large-scale data may imply that one has to compromise, at least it did in this case; it was not possible to collect data on all aspects desired. I consider one important measure to be missing, as a phonological task could have facilitated the analysis of the obtained subgroups. It may also have contributed to clarification of the role of phonology in reading. On the other hand, the reading measures included in the analysis contained very rich and valuable information. The tasks were of multiple-choice format, which essentially measures the same abilities as open-ended items (Elley, 1992), but without the interference of writing, the "outlier" in literacy (Metha et al., 2005). The reading passages were carefully designed to avoid cultural bias as far as possible, and different passages put quite distinct demands on different cognitive skills (see Study I in this thesis). The range of topics was wide, and the IEA-study in 1991 indicated high validity of these passages (Elley, 1994). Concerning phonology and the phonological deficit hypothesis the core manifest symptom of dyslexia is poor word decoding (Bruck, 1990), and word decoding was one of the measures included in the battery of tasks. If word decoding solely is impaired it may imply weak phonological skills (Frith, 1997; Høien & Lundberg, 2000, Wilson & Lesaux, 2001) as the underlying cause.

In Study II dyslexic and non-dyslexic adults were compared on phonological and orthographic tasks, with the aim of examining these characteristics within the dyslexia group. In this study the traditional way of assessing phonological skills was challenged. Usually phonological skills are assessed individually (but see Miller Guron & Lundberg, 2003). For obvious reasons oral answers have normally been considered to be required in phonological tasks. However, the challenge here was to screen for dyslexia in group settings with paper and pencil tasks. Experienced teachers, specialized in dyslexia, selected 50 dyslexic students from adult education centres in Western Sweden. As a comparison group, 67 students without any known history of reading impairment were recruited from the same adult education centres. There is, of course, one risk involved that some of the control students actually were dyslexic, and that some of the students in the dyslexic group had other reading problems not related to dyslexia. However, the screening battery discriminated well between the two groups, validating both the instruments and the procedure used to select the samples. Apart from more objective tasks, students were required to fill in a self report questionnaire concerning reading and writing as well as non-reading tasks related to dyslexia. However, the reliability and validity of self report have been questioned. Myrberg (2000) reported that

almost four out of five individuals performing at the lowest level in the IALS-study (International Adult Literacy Survey) were satisfied with their literacy skills. One reason they were satisfied may be that adults with poor literacy skills simply tend to adjust to their own level, and do not challenge their literacy skills (Myrberg, 2000). Another problem in the IALS-study may be the generality of the questions. Other self report questionnaires have more specific questions and show high reliability and concordance with objective measures (Decker, Vogler & DeFries, 1989; Lefly & Pennington, 2000). This is also the case with the self report used in Study II and Study III. The correlation between a composite score of phonological tasks and items in the self report (alpha=0.84) related to dyslexia was as high as 0.80 (Wolff & Lundberg, 2001).

Study III concerned the association between dyslexia and creativity. It may be doubtful if a particular task really assesses creative ability (Everatt et al., 1999). To avoid this pitfall no creativity tasks were used. Instead it was assumed that art university students in very prestigious schools would be exceptionally visually talented, or creative. Studies conducted on dyslexia and creativity show inconsistent results (for an overview see Winner et al., 2001). One reason may be the difficulty involved in defining and measuring creativity, as noted above. Another reason may be that dyslexia is not a clear concept, and may be defined diversely in different studies. In Study III the core of dyslexia is assumed to be a phonological deficit, as there is convergent evidence for this. Apart from more objective tasks, students were required to fill in a self report questionnaire concerning reading and writing as well as non-reading tasks related to dyslexia. The intention was to approach a consensus view of dyslexia.

In Study III, it was necessary to include a substantial number of students in the sample to make it meaningful to examine the incidence of dyslexia among the art university students. In the two studies in Study III a total of 268 art students and 282 non-art students participated. The art students were all students available in certain schools with very demanding admission policy, and there was virtually no attrition.

Most subtyping studies have been conducted on English-speaking children. In contrast, Study IV was conducted on an adult sample (cf. Zabell & Everatt, 2002). The point was that it has been proposed that phonological and orthographic skills will be more separated in older dyslexics (Stanovich et al., 1997). Another point was to explore the prevalence of dyslexia subtypes among students who read an orthography less opaque than English. Often, the dyslexic participants in subtyping studies have been assessed on word reading compared to non-word reading (Castles & Coltheart, 1993). These measures were not

suitable in the present study, as Swedish is a rather transparent orthography. Usually, there are several ways to spell a phoneme in Swedish but only one or two possible pronunciations of a grapheme, thus spelling is more complex than reading (Landerl, 2001; Lundberg, 1985). The most frequent spelling mistake in Swedish concerns the doubling of consonants to mark a long consonant sound in a stressed syllable. Yet, to read words with double consonants will probably not cause a problem even for a dyslexic reader if he or she is the least experienced. In many transparent languages (Frith, Wimmer & Landerl, 1998; Grigorenko, 2001; Paulesu et al. 2001; Sprenger-Charolles et al., 2000) latency is more critical for poor readers than accuracy. This is also the case in Swedish. Therefore, the regression analyses included a phonological choice task and an orthographic choice task, which means that both spelling and latency were taken into account. In the latent profile analysis, conducted in Study IV, several measures of phonological and orthographic tasks were included with the intention to make it possible to explore if there were any dyslexic students who were generally poor on one kind of task but not the other.

7 Educational consequences and implications

Teaching reading is rocket science.

Louisa Cook Moates

A very common assumption is that the best way to achieve good reading skills is extensive reading. It may seem logical. Yet, there is not much empirical evidence to support this view. The National Reading Panel (2000) was charged by the US Congress with assessing the status of the research-based knowledge about reading as well as various approaches to teach reading. The panel conducted statistical meta-analyses of peer-reviewed research concerning alphabetics, fluency, comprehension, teacher education, and computer technology. Their analyses indicated, among other things, that independent silent reading in classroom settings could not prove to be effective for developing fluency or any other reading skills, especially not for children who have not yet developed critical alphabetic and word reading skills. What the panel did find was that guided oral reading had a positive influence on word recognition, fluency and comprehension for students both in special education and ordinary classroom settings. The National Reading Panel noted, though, that hundreds of correlational studies have shown that good readers read more than poor readers, and that there is a need for more well-designed studies concerning the causation of these observations.

General ability and print exposure

Comprehension ability and exposure to print are commonly assumed to be in a reciprocal relationship to one another (Stanovich, 1986). In a longitudinal study Stanovich, Cunningham and West (1998) demonstrated that exposure to reading had a significant impact on vocabulary and general knowledge, even after general cognitive ability was accounted for. They also found that if children had a fast start in reading they would be more likely to engage in reading as adults. Thus, the common recommendation by researchers and practitioners that children should be encouraged to read more (e.g. Adams, 1990; Lundberg, 1984; Pressley, 1998; Shaywitz, 2003; Snow et al., 1998), and thereby gain knowledge which will lead to more reading and so forth, seems to be plausible. However, it appears as if poor readers as well as beginner readers need more explicit instruction.

Is what is good for one always good for all?

Another common assumption is that what is good for (for example) a dyslexic child is good for all children. This is probably a partial truth. Many dyslexic children benefit from receiving information orally, and are often capable of paying attention to an interesting story for a long time. This would presumably be hard for, and we cannot expect it from, a child with ADHD. Notwithstanding some differences between children's needs, there are some general instructional procedures which seem to be beneficial for all beginner readers, like guided reading, phonemic awareness training, and instruction in fluency and comprehension strategies (The National Reading Panel, 2000).

Some teachers claim they teach all children individually, and therefore do not want to pay attention to whether the children are, for example, dyslexic or second language learners. Just as it would be a big mistake to give the same educational treatment to all poor readers, just as big would the mistake be to ignore some general knowledge about different kinds of poor reading. Teachers' capacity to generalize is the base for accumulative knowledge and understanding, and the capacity to individualize is the base for proficiency.

The following text concerning educational aspects of poor reading is based on the results of the empirical studies of this thesis. The theoretically predicted subgroups of poor readers were identified, and are here linked to research related to the specific characteristics of varying reading problems. The tentative labels (see p. 47) indicate the nature of the reading problems (e.g. decoding, comprehension) and which family background variables they are related to (e.g. socioeconomic, language at home).

Experiential-social causes of poor reading

Many children from families of lower socioeconomic status enter school with significantly delayed prereading skills (Foorman & Torgesen, 2001; Hecht, Burgess, Torgesen, Wagner & Rashotte, 2000). An abundance of research has demonstrated a strong relation between SES home background and reading (Coleman, 1975; Coleman et al., 1966; Molfese, Modglin & Molfese, 2003; Olson, Forsberg & Wise, 1994; Samuelsson & Lundberg, 2003; Snow et al., 1998). However, primarily comprehension is affected (Olson et al., 1994), as opposed to phonological skills (Samuelsson & Lundberg; Stanovich & Siegel, 1994) and word recognition in early years (Chall, 1996).

Research also indicates that parents from low SES-homes speak less with their children than parents with high SES (Hart & Risley, 1995), and there is evidence that early vocabulary growth is associated with social class (Hart &

Risley, 1995; Snow et al., 1998). Vocabulary seems to reflect how much parents talk to their children (Hart & Risley, 1995; Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991; Snow, 1999), rather than hereditary factors (Biemiller, 2000; Huttenlocher et al., 1991). However, individuals with genetically deficient phonological skills may have particular obstacles in vocabulary acquisition, and poor vocabulary is a significant impedement in reading comprehension (Stahl, 1999). It is not likely that a text appears meaningful to a child if less than 95 per cent (Biemiller, 2000), or as also suggested 80 per cent (Lundberg, 2002b), of the words are understood. It is even less likely that it would be possible for the child to infer meaning to unknown words in such text.

Hayes and Ahrens (1988) demonstrated that adults adapted their word choice towards more common words when they spoke to children. However, adults' simplifications of their vocabulary were not age-dependent. Additionally, their choice of words did not differ very much from adult-to-adult speech in comparison to the vocabulary in newspapers. The adult-to-child speech was closely matched to the pattern of adult-to-adult speech, and so was the children's choice of words. One explanation of the similarities may be that the content of adult conversations is focused on everyday topics, such as household, school and work matters, which are discussed informally. Hayes and Ahrens claim that because of this, to develop vocabulary outside the 5,000 most common words, extensive reading across a broad range of subjects is required.

Altogether, environmental factors seem to be very important in acquiring good vocabulary knowledge, which in turn is an important precursor to linguistic comprehension. According to the Simple View of Reading (Hoover & Gough, 1990), linguistic comprehension is one of two important factors in reading, the other one being decoding (see p. 19). Children who are poor readers because of environmental factors may be average decoders; their shortcomings are more likely to derive from comprehension problems caused by poor vocabulary. These problems seem to be persistant. Cunningham and Stanovich (1997) reported that vocabulary assessed in grade 1 could predict more than 30 per cent of reading comprehension in grade 11.

A common saying is that in the early grades children *learn to read*, and in later grades they *read to learn*. In the struggle to break the alphabetic code not much vocabulary is required, and in general little is done in early grades to encourage vocabulary development (Biemiller, 2000). It is often when students more explicitly start to read to learn, which is roughly in the fourth grade in Sweden, that teachers discover that some students have a very poor vocabulary, and therefore do not understand expository texts. This often leads to

more intensive efforts than previously to teach new words, as the problem is now more apparent. According to Biemiller that is too late. The vicious circle of poor comprehension leading to less reading is hard to break (Lundberg, 2002a), and the gap in reading development between children will widen after some years at school (Chall, 1996; Chall, Jacobs & Baldwin, 1990; Jacobson & Lundberg, 1995; Stanovich, 1986). If we want education to compensate for disadvantaged home background, it is necessary that explicit vocabulary instruction is implemented in earlier grades (Biemiller, 2000), and even in pre-school.

In planned, contextualized introductions of vocabulary most children have the ability to acquire two to three words per day (Biemiller, 2000; Stahl, 1999). A great educational challenge is obviously the fact that children with poor vocabulary have to increase their vocabulary at a speed which is above-average in order to reach grade-level. The earlier the instruction starts, the easier the gap will be closed.

An overwhelmingly large amount of words has to be learned by the child. To know a word, means more than to know the word's definition (Stahl, 1991). It also means to understand what the word means in different contexts- its meaning potential. Thus, to just leave students with a dictionary to look up the meaning of words is not a good idea. One reason for that is that students may not be familiar with the words used in the explanation, another reason is that words preferably are explained in context (Biemiller, 2000; Stahl, 1999). This does not imply that various words should be taught by chance. On the contrary, well-planned and teacher-centered instruction is necessary to structure the sea of words that has to be learned. Explicit teaching includes making students aware of which words they know and which words they do not know.

As in most instructional situations it is important to enhance students' meta-cognitive skills. There is evidence that poor readers are less aware of when they understand and when they do not understand a text compared to skilled readers (Lundberg, 1984). Teachers have to show students how to explore new words by using context, ask themselves questions about the context, use dictionaries, ask someone for help with the meaning etc. In guided reading these things can easily be discussed, and students can explicitly decide their level of knowing a word or expression. To participate actively in group discussions and meet words in many shifting contexts (Stahl, 1999) may be a good help for students to learn new vocabulary. However, some students will need more vocabulary instructions than others. As Biemiller (2000, p.29)

concluded: "Some kids may have to work harder to add vocabulary. Educators may have to work harder with some kids."

In order to make vocabulary instruction more efficient, words could be treated not like unique units, but rather focus on prefixes, suffixes and root words. Students can in a playful way create new words by combining a prefix to a root word, a root word to another root word etc. Swedish has many compound words, and it is perfectly acceptable to invent new such words. Another example is to switch the word order of a compound word. What happens with the meaning of the word? Why? Mind mapping is useful with unfamiliar words, or to play with homonyms, antonyms and synonyms. Let students examine words, perhaps by using a scheme with different headings: What is (for example) a burglar like? What is a burglar not like? What are the differences between a burglar and a thief? What are the similarities? Considering the fact that new words do not simply add up to the vocabulary, but also alter already acquired words and refine the relationship between them (Snow et al., 1998), it seems logical to teach words in many different ways and not only with the traditional use of a dictionary as the only source.

Linguistic habits and interest

Of course, comprehension is not only a question of vocabulary. Children are socialized into literacy long before real reading takes place. Parents, and important others, show that reading is a valued and also a pleasurable skill. Children will meet various texts with reference to different purposes. Not least, parents read story books aloud to their children. Apart from new vocabulary (Ninio, 1983) children learn how stories are structured, so-called story grammar (Graesser, Golding, & Long, 1991; Lundberg, 1984). Reading aloud to children may enhance children's syntactic competence, and perhaps, the benefit above all is that it may help to develop a life-long interest for reading.

Some children grow up under more or less chaotic circumstances. They never have the advantage to be cautiously guided to the new world of fantasy, joy and knowledge literacy may involve. These students may not feel comfortable, and may not be familiar, with long texts. This may imply that they might manage short information and texts (like document tasks) better than expository and narrative texts (see Study I). Important educational efforts for these students are guided oral reading, discussions about interesting texts and the opportunity to be guided by experienced and competent educators to books that

may interest them. Thus, the important aim here is to encourage the students to read more and to experience the enjoyment and the usefulness of reading.

Students with dyslexia

In contrast to the previous group of students, students with dyslexia have difficulties decoding words. There is an almost complete consensus view in the research community that this is the core manifestation of dyslexia (Høien & Lundberg, 2000), and the underlying cause is of phonological nature (Høien & Lundberg; Pennington et al., 1990; Ramus, 2001; Snowling, 2000; Stanovich & Siegel, 1994). Dyslexic students do not primarily have comprehension difficulties, but of course problems with reading comprehension may occur as a secondary problem. Very slow and effortful word decoding and dysfluent reading may involve too high a load on working memory resulting in poor reading comprehension. The vicious circle of avoidance of reading leading to poor vocabulary, which in turn leads to further avoidance etc., could happen to dyslexic students too.

Another important risk with early failure in reading is that it may cause low self-esteem (Taube, 1987). In an interview study including 40 adult dyslexic students (Wolff, 2002), a majority of them were not (to their knowledge) recognized as dyslexic in the early years of school. Their experience was that they were considered lazy, stupid and/or careless. Many of them still regarded themselves as careless concerning reading and writing, even though they obviously were not careless by nature in any other domain. Thus, both for educational and personal reasons it is critical to prevent and identify reading difficulties as early as possible. Even though individuals with dyslexia may be successfully compensated, dyslexia seems to be a life-long condition (Frith, 1985; Grigorenko, 2003; Vogel & Reder, 1998) with persisting phonological problems (Bruck, 1992; Svensson & Jacobson, in press), and educational remediation may come into question far up into adulthood. Both compensatory and instructional interventions for children and adults will be addressed below.

Instructional prevention

It has repeatedly been demonstrated that lack of phonological awareness is related to failure in reading acquisition (for a review see Høien & Lundberg, 2000; Snowling, 2000). When children learn to read they have to shift from using phonemes implicitly (in talking) to using them explicitly (Lundberg, 2002b). Lundberg, Olofsson and Wall (1980) conducted a study where preschool children were given a test battery of both linguistic and non-

linguistic (more general cognitive) tasks. Children's deficiency in phonological awareness showed to be linguistic in nature, and not a deficiency in general cognitive analytic ability. The best predictors for later reading performance were tasks requiring phonological awareness, especially those tasks concerning manipulation of phonemes in words. Phonological awareness was thus developed before reading, which allows for a causal interpretation, that is phonological awareness seems to be an important prerequisite for acquiring good literacy skills. A study conducted by Scarborough (1990) was consistent with these results. She studied 32 children of dyslexic parents and 20 control children from the age of 2.5 years to the age of 8 years. Subsequently 20 students became reading disabled. They showed deficient object-naming, phonemic awareness and letter-sound knowledge at the age of five, but already at the age of 2.5 years they were deficient in syntactic complexity and pronunciation accuracy. The findings of various deficiencies, sometimes called "precursors" of dyslexia, are consistent with the view of dyslexia as a syndrome (Frith, 1999). Poor reading is then one of many symptoms (Scarborough, 1990), only more striking and critical than other symptoms to an individual's life.

As phonological skills have been identified as critical for learning to read, it is of great educational interest to see if they are possible to improve. In a large training study Lundberg et al. (1988) designed a programme of metalinguistic games including rhymes and phonemes. The daily training sessions lasted over a time of eight months with 235 children participating. A control group consisted of 155 children. The trained children gained in general higher reading and spelling skills in school. Also, a majority of children in a high-risk zone for later reading failure reached a normal level of reading three years later (Lundberg, 1994). This study has been replicated by Kjeldsen, Niemi and Olofsson (2003) and Schneider, Küspert, Roth, Visé and Marx (1997). Borström and Elbro (1997) conducted a study where children with dyslexic parents received intense phonological stimulation in kindergarten. These children were considered "at-risk" because of the strong inheritance of dyslexia. Later 17 per cent of these children developed dyslexia symptoms, whereas 40 per cent of children with dyslexic parents in an untrained control group developed dyslexia symptoms. Phoneme awareness training in kindergarten has shown positive long term effects on reading comprehension in grade 7 (Elbro & Petersen, 2004). The phonological training has to be explicit and structured (Cunningham, 1990: Lundberg et al., 1988), and it seems to be even more efficient if combined with training of phoneme-grapheme correspondences (Adams, 1990; Bradley & Bryant, 1983; Snowling, 2000).

Instructional intervention

Naturally, the optimal course of events is that in which children never failed to learn to read. Literacy activities in pre-school are thus of critical importance, as there is no reason to wait for a child to fail. However, a substantial number of children will fail to learn to read, and even up into adulthood some individuals will suffer from reading and writing difficulties. Therefore, schools have to be willing to offer remedial instruction, as well as continuously well accomplished reading instruction throughout the years in classroom settings.

There is almost a total consensus view that phonemic awareness instruction improves students' phonemic awareness, reading and spelling, and that it is most effective when an explicit linkage is made to alphabetic letters (for reviews see e.g. Adams, 1990; Høien & Lundberg, 2000; Rack, 2004; Snowling, 2000). Reading Recovery is a structured reading intervention programme in New Zealand (Clay, 1985), which is conducted by highly trained tutors. Strategies to use the context are emphasized, and it has generally been regarded as a successful programme. However, studies have shown that in modified versions of Reading Recovery, including explicit linking of phonology and reading, children made more progress in reading than in the original Reading Recovery programme (Chapman & Tunmer, 1991; Hatcher, Hulme & Ellis, 1994; Tunmer, 1994).

To be efficient, intervention and prevention should focus on the same components of reading instruction (Foorman & Torgesen, 2001). In the meta-analyses conducted by the National Reading Panel (2000), explicit instruction in phonemic awareness, phonemic decoding skills, fluency, construction of meaning, vocabulary, and guided reading were found to signify effective reading instruction. However, a significant number of children will require instructional interventions beyond the capacity of the regular classroom teacher (Torgesen, 2000; Torgesen, Alexander, Wagner, Rashotte, Voeller & Conway, 2001). The same components of instruction are needed, but have to be even more intensive, more explicit, more comprehensible, and carried out in small groups or in one-to-one tutoring (Foorman & Torgesen, 2001; Torgesen, 2000). It is far more efficient with intense intervention, even if it is over a shorter period of time, compared to a few hours of special education a week (Torgesen, 2002). Typically, children placed in special education do not fall farther behind, but neither do they close the gap in reading at the same level as their peers. Torgesen, Alexander et al. (2001) conducted an intervention study including 60 children between eight and ten years, who had not acquired

adequate word reading skills through instruction in general and special education. They received two 50-minute sessions per day for eight weeks (67.5 hours) carried out with two different methods, both involving phonemic awareness, phonemic decoding and sight word recognition skills. The students showed powerful improvements in generalized reading skills during the intervention period compared to pre-intervention with regular resource room intervention. Even in the follow-up period two years after intervention the students made progress and closed the gap. They were then as a group in the lower end of the normal range of ability in word reading accuracy and reading comprehension. About 40 per cent of the students performed average within one year and were no longer in need of special education. This may imply not only individual but also economic advantages in implementing increased quality and intensity of instruction for students with reading disabilities.

Adult and adolescence dyslexia

As noted earlier, dyslexia is a life-long condition. However, the manifest reading problems may attenuate or even more or less disappear. Several studies have demonstrated that although some adults are so-called compensated dyslexics with rather normal word decoding ability, they remain phonologically impaired (Bruck, 1992; Paulesu et al, 1996; Svensson & Jacobson, in press). The persisting phonological deficit could be interpreted as a result of low exposure to print. A reading level matched control group could facilitate an interpretation. In a study by Wolff (2005) ten triplets of students were matched on word reading. Each triplet consisted of one dyslexic university student, one academic level control student and one reading level control student. The adult dyslexic students performed significantly worse than both control groups on all phonological measures. Thus, phonological problems seem to be persistent in dyslexic students.

In Study II in this thesis a group screening battery for dyslexia is presented, which is based on phonological tasks, which makes it possible to identify even compensated dyslexic students. It may seem puzzling that one should identify compensated dyslexic students at all. One reason is that dyslexic students' writing problems often are persistent, and they may need compensatory technical support, in for example, report writing. Another reason is that their word reading may be rather unstable. Children with dyslexia seem to be affected by letter change in the beginning and in the end of words, but not in the middle of words as compared to younger beginning readers (Ehri & Saltmarsh, 1995). One could then conceive of a higher dependence on context

(Høien & Lundberg, 2000), and somewhat blurred word representations also in older dyslexic individuals. In stressful situations (e.g. exams) students may regress in their literacy skills, especially under time restrictions. Denckla and Cutting (1999) suggest that sophisticated assessments of successfully compensated dyslexic adults, yet residually slow readers, can legitimate lifelong extended-time accommodations at exams.

Many dyslexic adults have never been offered adequate testing, and therefore never been identified or received adequate educational intervention. Consequently, they have not reached an acceptable level of reading and writing. A well designed self report questionnaire of dyslexia problems may also invite to further discussions of strengths and weaknesses. Some students can experience a feeling of relief just because it is presupposed that students in gymnasium (Am. senior high school), or even adults, can experience serious reading problems, for example not being able to read the subtitles on TV. When collecting data for Study II, several times students came up to the test leader and wanted to talk about his or her reading problems. In some cases the students had a dyslexia diagnosis, which the school was not aware of. The students had believed that it was not expected of a senior high school student to have such problems, or at least no teacher had seemed to be interested. A screening has more far reaching implications than remediation. It may lead to development of self-understanding and understanding of dyslexia, and development of compensatory strategies (Vogel, 1998). In spite of many benefits from assessments, they have to be conducted with great care and thoughtfulness. Many schools may find the assessment procedure very expensive and time-consuming. The most cost-effective solution is probably to undertake initially a group screening for identifying students at risk (Study II gives an example) and then, after consulting the student in question, go on to a more detailed individual assessment (Fawcett & Nicolson, 1998).

The instructional intervention for older students could be based on the same components as for children (see e.g. Rhode-Wallström, 2000; Wilson, 1998; Witting, 1985), which is also true for Swedish dyslexic students learning English as an additional language (Holmberg, 2004). Naturally, it has to be accomplished in an "adult manner", but with recognition of the resemblance with dyslexic children's problems, even though systematic phonics seems to be most efficient in early grades (National Reading Panel, 2000). Yet, the same as for children is true; extensive reading is not enough to acquire stable reading or spelling skills, nor just to repeat the spelling rules. Adult dyslexic individuals need carefully designed and well-structured remediation programmes to become

fluent in reading and to acquire sufficient spelling skills. These programmes have, of course, to be adjusted to each individual in the way they are conducted.

Subtypes of dyslexia

Among teachers in Sweden it is sometimes suggested that students should be assessed if they have auditory (cf. phonological dyslexia) or visual (cf. surface dyslexia) dyslexia (Gjessing, 1977). Consequently, intervention should be different and adjusted according to that. The existence of a surface dyslexia subtype was not supported in this thesis (Study IV). There is no evidence for intervention based on the assumption that dyslexia is either a visual or an auditory deficiency. However, the fact that no surface dyslexia subgroup was identified here does not necessarily mean there is none. This issue certainly merits further research.

Compensatory strategies

It is not unusual among dyslexic adults that they do not want instructional intervention; they rather want to learn how to use compensatory strategies and to be entitled to various compensatory measures. Irrespective of whether they take instructional courses or not, compensatory strategies are critical to function in a literate society. These strategies, when applicable, should of course be offered to children too. This is important as dyslexic children tend to read less. Because of this they have fewer opportunities to acquire new words and new information (Rack, 1997).

There are two kinds of compensatory strategies, internal and external (Jacobson, 2005). Internal strategies refer to an individual's coping with the difficulties, by, for example, admitting the difficulties and asking a friend for help, or by adopting useful techniques of studying. Teachers play an important role in making students realize the existence, and potential, of students' putative internal strategies. At least in a subgroup of dyslexics, there seems to be a possibility of enhanced creative visual skills. It is important that teachers recognize and appreciate these skills. It may be fruitful to build upon them in mnemonics strategies.

The external strategies are of a more technical nature. The main idea is that students should, in spite of reading and writing difficulties, be able to utilize and produce information; to gain access to education. Many adults with dyslexia tell they failed in several areas at school (Wolff, 2002), even though their weaknesses actually were related to reading and writing only. They claim that if they had only received sufficient accommodations at school they would

not have experienced to be labelled as stupid and thereby stigmatized. The vicious circle, sometimes referred to as the Matthew effect (Stanovich, 1986), could have been inhibited.

Accommodations have to be provided on an individual basis according to type and severity of problems (Vogel & Reder, appendix 1998), and above all, according to students' requirements. Generally suggested accommodations include the following:

- Allow extra time on exams
- Allow oral exams
- Provide tape-recorded exam
- Provide tape-recorder for oral answers on exams
- Allow separate (i.e. silent) room for exam
- Allow, and provide, adaptive technology such as spell checker and word processor
- For additional languages provide "translation pencils"
- Provide notes for lessons in advance
- Provide literature on tape or cd

University students with dyslexia are entitled to have an economically compensated peer student taking notes on their behalf, and exams should be adopted to their needs. Dyslexic students are also allowed extended time on the Swedish higher education aptitude test.

Environmental accommodations for dyslexic students are often easily provided. Sometimes these measures are related to costs, but more often to knowledge and awareness among educators. Dyslexic students must be allowed to omit the (for most people uncomplicated) part of decoding in order to deal with more complicated tasks beyond that. Also, to use a spell checker, for example, or to listen to a text and simultaneously read it, may increase literacy skills on various levels (Lundberg, 1995; Lundberg & Olofsson, 1993; Olson & Wise, 1992). Compensatory interventions may reduce future costs, both in terms of money, inhibited capacities and human suffering.

Fluency

For dyslexic individuals, the primary bottleneck to good reading is poor reading on a word-level (Lyon, 1995). These difficulties are caused by a low ability in decoding unfamiliar words (phonological coding), which in turn is caused by poor phoneme awareness (Pennington & Lefly, 2001). In accordance with this, whole word reading is not an optimal method for acquiring word

representations (Levy, 2001). Many reading intervention studies including segmentation methods and phoneme awareness training have been successful concerning accuracy of word decoding. However, reading rate (fluency) seems to be harder to improve (Torgesen, Alexander et al., 2001). It also seems as if reading fluency problems are easier to prevent than to remediate (Torgesen, Rashotte & Alexander, 2001).

Lack of fluency particularly has an impact on older students as they are expected to read and understand more (Shaywitz, 2003). One problem is they may have to spend an unreasonable amount of time on reading, and yet, it may not be enough. Thus, poor reading fluency may slow students down in gaining knowledge in all areas, and require compensatory measures such as additional time on exams and homework assignments. Another aspect of fluency problems is that there is a relationship between comprehension and fluency (Shaywitz, 2003), slow and effortful reading without appropriate prosodic features could lead to deficient comprehension. Improved word recognition speed improves text reading fluency (Levy, 2001; Shaywitz, 2003; Torgesen, Alexander et al., 2001), which may (in absence of linguistic comprehension problems) improve reading comprehension (Levy, 2001). It is probably a reciprocal relationship between fluency and comprehension.

In recent years, fluency in relation to reading difficulties has become more in focus (e.g. Levy, 2001; Torgesen, Rashotte et al., 2001; Wolf et al., 2002; Wood, Flowers & Grigorenko, 2001). The most frequently suggested intervention for fluency problems seems to be to increase accuracy of word decoding (Levy, 2001; Shaywitz, 2003; Torgesen, Rashotte et al., 2001) and as a next step to increase sight vocabulary (Torgesen, Rashotte et al., 2001). As sometimes suggested, it is not sufficient to simply provide opportunities for extended reading to increase sight vocabulary, especially as in higher grades, the words they try to recognise occur infrequently (Adams, 1990). *Guided oral reading* (National Reading Panel, 2000) and *repeated reading* (Adams, 1990; Høien & Lundberg, 2000; Lundberg, 1984; National Reading Panel, 2000; Shaywitz, 2003) are found to markedly improve word recognition, fluency and reading comprehension skills.

There are of course many variants of repeated reading, and the benefits vary among students. The idea of reading the same text over and over again may sound boring. However, both student and teacher have to be aware of the purpose of this exercise, that is to achieve fluency, enhance word recognition and/or reading comprehension skills. Also, the pleasure of almost instantly

recognising positive results may make it worthwhile (Høien & Lundberg, 2000; Lundberg, 1984; Shaywitz, 2003).

Moving from accuracy to fluency requires different approaches, such as to follow the text when a teacher reads (or a tape or CD), peer reading under the supervision of a tutor, chorus reading (Høien & Lundberg, 2000), and to urge the reader to attend to the next step. The level of the next step is dependent on stage of development (Wood et al., 2001). It could be what is next in this word, sentence or text.

Students reading in an additional language

In 2003, around 14 per cent of all students in the last grade of compulsory school in Sweden had immigrant background (Skolverket, 2004). In a few decades Sweden has moved from being almost a monolingual country to a multilingual one. Bilingual, or multilingual, children could be expected to have comprehension problems. A very obvious obstacle in second language learners' reading comprehension may be lack of vocabulary. This may imply that bilingual students perform proportionally well on tasks such as documents (see Study I), which do not in general involve much vocabulary or lengthy texts. This is consistent with findings on arithmetic tasks (Lesaux & Siegel, 2003). Bilingual students are not expected to have phonological problems or to be deficient in word decoding. On the contrary, bilingualism can sometimes lead to superior skills in pseudoword reading and spelling (Abu-Rabia & Siegel, 2002; DaFontura & Siegel, 1995; Lesaux & Siegel) and in word reading (Abu-Rabia & Siegel, 2003; Yelland, Pollard & Mercuri, 1993).

The script-dependent hypothesis (Ryan & Meara, 1991) and the linguistic interdependence hypothesis (Cummins, 1979; Da Fontoura & Siegel, 1995; Lundberg, 2002c; Muter & Diethelm, 2001) are two competing hypotheses concerning second language learners' language acquisition. In the former hypothesis it is supposed that performance varies depending on the orthography; whether it is opaque or transparent for example (Wimmer, 1993), and in the latter it is supposed that performance is related to the individual rather than to language. Geva and Siegel (2000) found that if both positions are taken into account it will result in a more comprehensive picture of bilingual students' reading performance.

According to Snow (1999) a middle-class monolingual child typically acquires between 12 to 15 new words a day between the age of three and six, and a bilingual child acquires even more words. The type of talk families engage in at mealtimes, for example, is critical for contextual support

for sophisticated vocabulary (Snow, 1999). Naturally, immigrant children do not generally encounter these situations, where they can extend their Swedish vocabulary at home. Obviously, preschool and school have to work most deliberately and explicitly with immigrant children's vocabulary acquisition. The vocabulary which has to be attended is of course wider than for Swedish children. They are also in part different, both concerning some common words frequently used in most Swedish homes as well as more abstract words. Typical examples are what Vail (1999) called "shifters", that is words like *unless*, *but*, *until* and *whenever*. Also idiomatic phrases and anaphoric references often imply difficulties (as for some Swedish children). Intervention in this area should be explicit, intense and contextual, as described above.

Adult talk improves language acquisition for grammar to the same extent as vocabulary (for an overview and discussion see Snow, 1999). Thus, immigrant children are likely to need extra support and attention from school. A modified version of repeated reading with fewer repetitions could be a possible way to automatize and enhance syntactic competence. Guided oral reading could explicitly focus both comprehension and grammar. The same cognitive processes as for children reading in their first language are required for children reading in an additional language, that is phonological processing, syntactic awareness and working memory (Lesaux & Siegel, 2003).

However, it is important to note that bilingual students often are underrepresented in special education (Cline & Reason, 1993; Cline & Shamsi, 2000). An immigrant child may, for example, also be dyslexic, but teachers seem likely too often to consider students' problems as consequences of being second language learners of the majority language.

Poor reading performance could also be due to cultural factors. Families immigrating from illiterate societies, or societies where written language is not as important as in the new country, may not value books as much, or may not be familiar in how to socialize a child into literacy.

Students with poor comprehension

Around ten per cent of all children are estimated to have generally poor comprehension (Nation & Snowling, 1997). In a Swedish study eight per cent were identified as poor comprehenders (Samuelsson, 2002). They are expected to have normal or close to normal word decoding skills, as IQ and word reading are not strongly related (Høien & Lundberg, 2000). In a study on children in grade one to five, Geva and Siegel (2000) demonstrated that when verbal memory was taken into account, non-verbal intelligence did not explain

any of the differences in word recognition and pseudoword reading. However, children with poor comprehension may have difficulties in understanding texts of all types. Perhaps their performance on document tasks (see Study I) will be particularly poor, as these texts may be more cognitively demanding at least in comparison to narrative texts.

This group of children is sometimes referred to as hyperlexic (Catts et al., 2003), even though this term traditionally is used for very extreme cases. A troublesome issue concerning students with this performance profile is that it is hard to apply any compensatory technical support. They will not be helped by listening to a text instead of reading, for example (Samuelsson, 2002). Rather we have to change the text itself. For older students there are newspapers intended for individuals with poor comprehension, for example the Swedish newspaper 8 SIDOR (8 pages). These papers have less demanding language, with uncomplicated vocabulary and wording. There are also books comparable to Start-to-Finish Books (e.g. LL-böcker), which are available for younger students too.

Students with comprehension problems benefit from the same kind of intervention concerning vocabulary and guided oral reading, only at a much slower pace and embracing a smaller amount of new information. It is an educational challenge to find appropriate tasks and reading material, and not least to encourage reading and improve vocabulary (Samuelsson, 2002).

Concluding remarks

This thesis concerns the issue of varieties in reading and the issue that poor reading manifests in different ways depending on the origin of the reading problems. For a teacher, it is a rather simple task to delineate a group of poor readers. However, the characteristics of the poor reading may need to be more in focus. Reading problems with different characteristics, including strengths and deficits, require different approaches. Different problems have to be attended to, and different strengths to be built upon. Hopefully, this thesis will contribute to the understanding of the nature of varying reading problems and give guidance into educational intervention for poor readers with different reading performance profiles.

8 References

Aaron, P.G. (1997). The impending demise of the discrepancy formula. *Review of Educational Research, 67,* 461-502.

Aaron, P. & Guillemarde, J.-C. (1993). Artistic as dyslexics. In D. Willows, R. Kruk, & E. Corcos (Eds.), *Visual processes in reading and reading disabilities (*pp. 393-415). Hillsdale, NJ: Lawrence Erlbaum Associates.

Aaron, P.G., Joshi, M. & Williams, K.A. (1999). Not all reading disabilities are alike. *Journal of Learning Disabilities, 32,* 120-137.

Aaron, P.G., Phillips, S. & Larsen, S. (1988). Specific reading disabilities in historically famous persons. *Journal of Learning Disabilities, 21,* 521-584.

Abu-Rabia, S. & Siegel, L. (2002). Reading, syntactic, orthographic, and working memory skills of bilingual Arabic-English speaking Canadian children. *Journal of Psycholinguistic Research, 31,* 661-678.

Abu-Rabia, S. & Siegel, L. (2003). Reading skills in three orthographies: The case of trilingual Arabic-Hebrew-English-speaking Arab children. *Reading and Writing: An Interdisciplinary journal, 16*, 611-634.

Adams, M. J. (1990). *Beginning to read.* Boston, Mass.: MIT Press.

Argulewicz, E.N., Mealor, D.J. & Richmond, B.O. (1979). Creative abilities of learning disabled children. *Journal of Learning Disabilities, 12*, 21-24.

Baddeley, A. D. (1986). *Working memory.* Oxford: Oxford University Press.

Baddeley , A.D. (2000). Short-term and working memory. In E. Tulving & F.I.M. Craik (Eds.), *The Oxford Handbook of Memory* (pp. 77-92). New York: Oxford University Press.

Baddeley, A.D., Gathercole, S.E. & Papagno, C. (1998). The phonological loop as a language device. *Psychological Review, 105,* 158-173.

Biemiller, A. (2000). Vocabulary: The missing link between phonics and comprehension. *Perspectives. The International Dyslexia Association, 26,* 26-30.

Boder, E. (1971). Developmental dyslexia: Prevailing diagnostic concepts and a new diagnostic approach. In H. Myklebust (Ed.), *Progress in learning disabilities* (pp. 293-321). New York: Grune & Stratton.

Boder, E. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. *Developmental Medicine and Child Neurology, 15,* 663-687.

Borström, I. & Elbro, C. (1997). Prevention of dyslexia in kindergarten: Effects of phoneme awareness training with children of dyslexic parents. In C. Hulme and M. Snowling (Eds.), *Dyslexia. Biology, cognition and intervention* (pp. 235-253). Whurr: London.

Bouchard, T. J. Jr. (1997). Experience producing drive theory: How genes drive experience and shape personality. *Acta Paediatrica, 86,* 65-68.

Bradley, L. & Bryant, P. (1983). Categorising sounds and learning to read- a causal connection. *Nature, 301,* 419-421.

Bruck, M. (1990). Word-recognition skills of adults with childhood diagnoses of dyslexia. *Development Psychology, 26,* 439-454.

Bruck, M. (1992). Persistence of dyslexics' phonological awareness deficits. *Development Psychology, 26,* 874-886.

Cain, K., Oakhill, J. & Bryant, P. (2000). Phonological skills and comprehension failure: A test of the phonological processing deficit hypothesis. *Reading and Writing: An Interdisciplinary Journal, 13,* 31-56.

Castles, A. & Coltheart, M. (1993). Varieties of developmental dyslexia. *Cognition, 47,* 149-180.

Catts, H.W., Hogan, T.P., Adlof, S.M. & Barth, A.E. (June, 2003). *The simple view of reading: Changes over time.* Poster presented at the tenth annual meeting of the Society for the Scientific Study of Reading, Boulder, 2003.

Catts, H.W., Hogan, T.P. & Fey, M. (2003). Subgrouping poor readers on the basis of reading related abilities. *Journal of Learning Disabilities, 36,* 151-164.

Chall, J.S. (1996). *Stages of reading development, 2nd* edn. Orlando, FL: Harcourt Brace College Publishers.

Chall, J.S., Jacobs, V.A. & Baldwin, L.E. (1990). *The reading crisis. Why poor children fall behind.* Cambridge, MA: Harvard University Press.

Chapman, J.W. & W.E. Tunmer (1991). Recovering Reading Recovery. *Australia and New Zealand Journal of Developmental Disabilities, 17,* 59-71.

Chiappe, P., Stringer, R., Siegel, L. S. & Stanovich, K. E. (2002). Why the timing deficit hypothesis does not explain reading disability in adults. *Reading and Writing: An Interdisciplinary Journal, 15,* 73-107.

Clay, M. M. (1985). *The early detection of reading difficulties.* Portsmouth, NH: Heinemann.

Cline, T. & Reason, R. (1993). Specific learning difficulties (dyslexia): Equal opportunities issues. *British Journal of Special Education, 20,* 30-34.

Cline, T. & Shamsi, T. (2000). *Language needs or special needs? The assessment of learning difficulties in literacy among children learning English as an additional language: A literature review.* Department for Education and Employment, Great Britain. Research report 184, 2000.

Cole, G.S. (1989). Excerpts from the learning mystique: A critical look at "learning disabilities". *Journal of Learning Disabilities, 22,* 267-277.

Coleman, J.S. (1975). Methods and results of the IEA studies of effects of school and learning. *Review of Educational Research, 45,* 355-386.

Coleman, J., Campbell, E., Hobson, C., McPartland, J., Mood, A., Weinfield, F. et al. (1966). *Equality of educational opportunity.* Washington, DC: U.S. Government Printing Office.

Critchley, M. (1970). *The dyslexic child.* London: Heinemann Medical Books.

Croll, P. (1986). *Systematic classroom observation.* London: The Falmer Press.

Cummins, J. (1979). Linguistic interdependence and the educational development of bilingual children. *Review of Educational Research, 49,* 222-251.

Cunningham, A. (1990). Explicit versus implicit instruction in phonemic awareness. *Journal of Experimental Child Psychology, 50,* 429-444.

Cunningham, A. E. & Stanovich, K.E. (1997). Early reading acquisition and its relation to reading experience and ability ten years later. *Developmental Psychology 33,* 934-945.

Da Fontoura, H.A. & Siegel, L.S. (1995). Reading, syntactic, and working memory skills of bilingual Portuguese-English Canadian children. *Reading and Writing: An Interdisciplinary Journal, 7,* 139-153.

Decker, S., Vogler, G. & DeFries, J.C. (1989). Validity of self-reported reading disability by parents of reading-disabled and control children. *Reading and Writing: An Interdisciplinary Journal, 1,* 327-331.

Denckla, M.B. & Cutting, L.E. (1999). History and significance of rapid automatized naming. *Annals of Dyslexia, 49,* 29-42.

Eden, G. F., Jones, K.M., Cappell, K., Gareau, L., Wood, F.B., Zeffiro, T.A., et al. (2004). Neural changes following remediation in adult developmental dyslexia, *Neuron, 44,* 411-422.

Edfeldt, Å. (1959). *Silent speech and silent reading.* Acta Universitatis Stockholmiensis, Stockholm Studies in Educational Psychology.

Ehri, L.C. & Saltmarsh, J. (1995). Beginning readers outperform older disabled readers in learning to read words by sight. *Reading and Writing: An interdisciplinary Journal, 7,* 295-326.

Eisen, M.L. (1989). Assessing differences in children with learning disabilities and normally achieving students with a new measure of creativity. *Journal of Learning Disabilities, 7,* 462-464, 451.

Elbro, C. (1996). Early linguistic abilities and reading development: A review and a hypothesis. *Reading and Writing: An Interdisciplinary Journal, 8* 453-485.

Elbro, C., Nielsen, I., & Petersen, D.K. (1994). Dyslexia in adults: Evidence for deficits in nonword reading and in the phonological representation of lexical items. *Annals of Dyslexia, 44,* 205-226.

Elbro, C., & Petersen, D.K. (2004). Long-term effects of phoneme awareness and letter sound training: An intervention study with children at risk for dyslexia. *Journal of Educational Psychology, 96,* 660-670.

Elley, W.B. (1992). *How in the world do students read?* The Hague, the Netherlands: The International Association for the Evaluation of Educational Achievement.

Elley, W.B. (1994). *The IEA study of Reading Literacy: Achievement and instruction in thirty-two school systems.* Exeter, Great Britain: Pergamon.

Everatt, J. , Steffert, B. and Smythe, I. (1999). An eye for the unusual: Creative thinking in dyslexics. *Dyslexia, 5,* 28-46.

Fawcett, A.J. & Nicolson, R.I. (1998). Screening and diagnosis of dyslexia in adults in the United Kingdom. In S.A. Vogel & S. Reder (Eds.), *Learning*

disabilities, literacy, and adult education (pp. 155-178). Baltimore, MD: Paul H. Brookes.

Fawcett, A. & Nicolson, R. (2001). Dyslexia: the role of the cerebellum. In A. Fawcett (Ed.), *Dyslexia. Theory & good practice* (pp 89-105). London: Whurr Publishers.

Fletcher, J.M., Shaywitz, S.E., Shankweiler, D.P., Katz, L, Liberman, I.Y., Stuebing, K.-K. et al., (1994). Cognitive profiles of reading disability: Comparisons of discrepancy and low achievement definitions. *Journal of Educational Psychology, 86,* 6-23.

Foorman, B.R. & Torgesen, J. (2001). Critical elements of classroom and small-group instruction promote reading success in all children. *Learning Disabilities Research & Practice, 16,* 203-212.

Frederickson, N. & Frith, U. (1998). Identifying dyslexia in bilingual children: A phonological approach with inner London Sylheti speakers. *Dyslexia, 4,* 119-131.

Fredriksson, U. (2002). *Reading skills among students of immigrant origin in Stockholm.* Stockholm: Institute of International Education.

Fries, C. (1963). *Linguistics and reading.* New York: Harper & Row.

Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. Patterson, J. Marshall & M. Coltheart (Eds.), *Surface dyslexia* (pp. 301-330). London: Lawrence Erlbaum Associates.

Frith, U. (1986). A developmental framework for developmental dyslexia. *Annals of Dyslexia, 36,* 69-81.

Frith, U. (1997). Brain, mind and behaviour in dyslexia. In C. Hulme & M. Snowling (Eds.), *Dyslexia. Biology, cognition and intervention* (pp 1-19). London: Whurr Publishers.

Frith, U. (1999). Paradoxes in the definition of dyslexia. *Dyslexia, 5,* 192-214.

Frith, U., Wimmer, H. & Landerl, K. (1998). Differences in phonological recoding in German and English speaking children. *Scientific Studies of Reading, 2,* 31-54.

Galaburda, A., Rosen, G. & Sherman, G. (1989). The neural origin of developmental dyslexia: Implications for medicine, neurology and cognition. In A. Galaburda (Ed.), *From reading to neurons* (pp. 377-388). Cambridge, MA: MIT Press.

Gathercole, S.E. & Baddeley, A.D. (1986). *Working memory and language.* Hove: Lawrence Erlbaum Associates, Publishers.

Geschwind, N. & Galaburda, A.M. (1987). *Cerebral lateralization: Biological mechanisms, associations, and pathology.* Cambridge, MA: MIT Press.

Geva. E. (2000). Issues in the assessment of reading disabilities in L2 children-beliefs and research evidence. *Dyslexia, 6,* 13-28.

Geva. E. & Siegel, L.S. (2000). Orthographic and cognitive factors in the concurrent development of basic reading skills in two languages. *Reading and Writing: An Interdisciplinary Journal, 12,* 1-30.

Gjessing, H.-J. (1977). *Dysleksi* (Dyslexia). Oslo: Universitetsforlaget.

Goodman, K.S. (1985). Unity in reading. In H. Singer & R. Ruddell (Eds.), *Theoretical models and processes of reading* (3rd ed., pp. 813-840). Newark, DE: International Reading Association.

Gough, P. & Tunmer, W. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7,* 6-10.

Goulandris, N., Snowling, M. & Walker, I. (2000). Is dyslexia a form of specific language impairment? A comparison of dyslexic and language impaired children as adolescents. *Annals of dyslexia, 50,* 103-120.

Graesser, A. C., Golding, J. M., & Long, D. L. (1991). Narrative representation and comprehension. In R. Barr, M. L. Kamil, P. Mosenthal, & P. D. Pearson (Eds.), *Handbook of Reading Research* (pp. 171-205). London: Longman.

Grigorenko, E. (2001). Developmental dyslexia: An update on genes, brains, and environments. *Journal of Child Psychology and Psychiatry, 42,* 91-125.

Grigorenko, E. (2003). The first candidate gene for dyslexia: Turning the page of a new chapter of research. *Proceedings of the National Academy of Sciences of the United States of America, 100,* 11190-11192.

Grigorenko, E.L., Wood, F.B., Meyer, M.S., Hart, L.A., Speed, W.C., Shuster, A., et al. (1997). Susceptibility loci for distinct components of developmental dyslexia on chomosomes 6 and 15. *American Journal of Human Genetics, 60,* 27–39.

Gustafson, S. (2001). Cognitive abilities and print exposure in surface and phonological types of reading disability. *Scientific Studies of Reading, 5,* 351-375.

Gustafsson, J-E. (1995, April). *Alternative hierarchical models of reading achievement.* Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco.

Gustafsson, J.-E. & Rosén, M. (2005). *Förändringar i läskompetens 1991-2001. En jämförelse over tid och länder* (Changes in level of reading competence 1991-2001. A comparison over time and countries). Stockholm: Myndigheten för Skolutveckling.

Gustafsson, J.-E. & Stahl, P.-A. (2001). *STREAMS User's guide, Version 2.5 for Windows95/98/NT.* Mölndal, Sweden: Multivariate Ware.

Habib, M. (2000). The neurological basis of developmental dyslexia: An overview and working hypothesis. *Brain, 123,* 2373-2399.

Hagtvet, B.E. (2004). *Språkstimulering: Tal och skrift i förskoleåldern* (Language stimulation: Speech and written language in preschool age). Stockholm: Natur och Kultur.

Hagtvet, B.E. & Pálsdóttir, H. (1992). *Lek med språket!* (Play with the language!). Oslo: Universitetsforlaget.

Hart, B. & Risley, T.R. (1995). *Meaningful differences in the everyday experience of young American children.* Baltimore: Paul H Brookes.

Hatcher, P.J. (2000). Sound links in reading and spelling with discrepancy-defined dyslexics and children with moderate learning difficulties. *Reading and Writing: An Interdisciplinary Journal, 13,* 257-272.

Hatcher, P.J., Hulme,C. & Ellis, A.W. (1994) Ameliorating early reading failure by integrating the teaching of reading and phonological skills: The phonological linkage hypothesis. *Child Development, 65,* 41-57.

Hayes, D.P. & Ahrens, M.G. (1988). Vocabulary simplification for children: A special case of "motherese"? *Journal of Child Language, 15,* 395-410.

Hecht, S.A., Burgess, S.R., Torgesen, J.K., Wagner, R.K. & Rashotte, C.A. (2000). Explaining social class differences in growth of reading skills from beginning kindergarten through fourth-grade: The role of phonological awareness, rate of access, and print knowledge. *Reading and Writing: An Interdisciplinary Journal, 12,* 99-127.

Holmberg, M. (2004). *HELP- for dyslexics* (Holmberg English Learning Program). Göteborg: Specialpedagogiska institutet.

Hoover, W. & Gough, P. (1990). The simple view of reading. *Reading and Writing: An Interdisciplinary Journal, 2,* 127-160.

Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M. & Lyons, T. (1991). Early vocabulary growth: Relation to language input and gender. *Developmental Psychology, 27,* 236-248.

Høien, T. (1999). Theories of deficits in dyslexia. In I Lundberg, F.E. Tønnesen & I. Austad (Eds.), *Dyslexia: Advances in theory and practice* (pp. 31-43). London: Kluwer Academic Publishers.

Høien, T. & Lundberg, I. (1988). Stages of word recognition in early reading development. *Scandinavian Journal of Educational Research, 32,* 163-182.

Høien, T. & Lundberg, I. (1991). *Dysleksi* (Dyslexia). Oslo: Gyldendal.

Høien, T & Lundberg, I. (2000). *Dyslexia. From theory to intervention.* Dordrecht NL: Kluwer Academic Publishers.

Jacobson, C. (1993). *Manual till Ordkedjor.* (Manual for Wordchains). Stockholm: Psykologiförlaget.

Jacobson, C. (2005). *Compensatory measures for people with reading and writing disabilities.* Manuscript in preparation.

Jacobson, C. & Lundberg, I. (1995). *Läsutveckling och dyslexi. Frågor, erfarenheter och resultat* (Reading development and dyslexia. Questions, experiences and results). Stockholm: Liber Utbildning.

Jarrold, C., Baddeley, A. D., Hewes, A. K., Leeke, T. & Phillips, C. (2004). What links verbal short-term memory performance and vocabulary level? Evidence of changing relationships among individuals with learning disability. *Journal of Memory and Language, 50,* 134-148.

Juel, C. & Minden-Cupp, C. (2000). Learning to read words: Linguistic units and instructional strategies. *Reading Research Quarterly, 35,* 458-492.

Kjeldsen, A-C., Niemi, P. & Olofsson, Å. (2003). Training phonological awareness in kindergarten level children: Consistency is more important than quantity. *Learning and Instruction, 13,* 349-365.

Kronbichler, M., Hutzler, F. & Wimmer, H. (2002). Dyslexia: Verbal impairments in the absence of magnocellular impairments. *Neuroreport, 13,* 617-620.

Kuhl, P. K. (2000). A new view of language acquisition. *Proceedings of the National Academy of Science, 97,* 11850-11857.

Kuhl, P. K., Tsap. F.-M. & Liu, H.-M. (2003). Foreign-language experience in infancy: Effects of short-term exposure and social interaction on phonetic learning. *Proceedings of the National Academy of Sciences, 100,* 9096-9101.

Landerl, K. (2001). Word recognition deficits in German: More evidence from a representative sample. *Dyslexia, 7,* 183-196.

Larsen, J.P, Høien, T., Lundberg, I. & Odegaard (1990). MRI evaluation of the size and symmetry of the planum temporale in adolescents with developmental dyslexia. *Brain and Language, 39,* 289-301

Lefly, D.L. & Pennington, B.F. (2000). Reliability and validity of the adult reading history questionnaire. *Journal of Learning Disabilities, 33,* 286-296.

Lesaux, K.N. & Siegel, L.S. (2003). The development of reading in children who speak English as a second language. *Developmental Psychology, 39,* 1005-1019.

Levy, B.A. (2001). Moving to the bottom: Improving reading fluency. In M. Wolf (Ed.), *Dyslexia, fluency, and the brain* (pp. 358-379). Timonium, MD: York Press.

Lindell, E. (1972). *Läs- och skrivmetodikens psykologi* (The reading and writing method's psychology). Lund: Gleerups bokförlag.

Lundberg, I. (1984). *Språk och läsning* (Language and reading). Malmö, Sweden: Gleerup.

Lundberg, I. (1985). Longitudinal studies of reading and writing difficulties in Sweden. In G. E. McKinnon & T. G. Waller (Eds.), *Reading research: Advances in theory and practice* (pp. 65-105). New York: Academic Press.

Lundberg, I. (1994). Reading difficulties can be predicted and prevented: A Scandinavian perspective on phonological awareness and reading. In C. Hulme & M.J. Snowling (Eds.), *Reading development and dyslexia* (pp. 180-199). London: Whurr.

Lundberg, I. (1995).The computer as a tool of remediation in the education of students with reading disabilities: A theory-based approach. *Learning Disability Quarterly, 18,* 89-99.

Lundberg, I. (1999a). *Bilingualism: Psychological perspectives*. Hong Kong: Monograph 3, School of language in education. Hong Kong Institute of Education.

Lundberg, I. (1999b). Towards a sharper definition of dyslexia. In I. Lundberg, F.E. Tonnessen, & I. Austad (Eds.), *Dyslexia. Advances in theory and practice* (pp. 9-29). Dordrecht, NL: Kluwer Academic Publishers.

Lundberg, I. (2002a). The child's route into reading and what can go wrong. *Dyslexia 8*, 1-13.

Lundberg, I. (2002b). Twenty-five years of reading research as a basis for prediction of future development. In E. Hjelmquist & C. von Euler (Eds.), *Dyslexia and literacy* (pp. 206-219). London: Whurr Publishers.

Lundberg, I. (2002c). Second language learning and reading with the additional load of dyslexia. *Annals of Dyslexia, 53,* 165-187.

Lundberg, I., Frost, J. & Petersen, O. (1988). Effects on an extensive program for stimulating phonological awareness in pre-school children. *Reading Reaearch Quarterly, 23*, 263-284.

Lundberg, I. & Høien, T. (2001). Dyslexia and phonology. In A. Fawcett (Ed.), *Dyslexia. Theory & good practice* (pp 89-105). London: Whurr Publishers.

Lundberg I, & Olofsson Å. (1993). Can computer speech support reading comprehension? *Computers in Human Behavior, 9*, 283-293.

Lundberg, I., Olofsson, Å. & Wall, S. (1980). Reading and spelling skills in the first school years predicted from phonemic awareness skills in kindergarten. *Scandinavian Journal of Education, 21*, 159-173.

Lundberg, I. & Wolff, U. (2003). *DUVAN, Dyslexiscreening för ungdomar och vuxna*. (Dyslexia screening for adolescents and adults). Stockholm: Psykologiförlaget.

Lyon, G.R. (1995). Towards a definition of dyslexia. *Annals of Dyslexia, 45,* 3-27.

Lyon, G.R., Shaywitz, S.E. & Shaywitz, B.A. (2003). Defining dyslexia, comorbidity, teachers' knowledge of language and reading. *Annals of Dyslexia, 53,* 1-14.

Malmquist, E. (1958). *Factors related to reading disabilities in the first grade of the elementary school.* Stockholm: Almqvist & Wiksell.

Manis, F., Seidenberg, M., Doi, L., McBride-Chang, C. & Petersen, A. (1996). On the bases of two subtypes of developmental dyslexia. *Cognition, 58,* 157-195.

McGuiness, D. (1998). *Why children can't read.* Harmondsworth, Middlesex: Penguin Books.

Metha, P.D., Foorman, B.R., Branum-Martin, L. & Taylor, W.P. (2005). Literacy as a unidimensional multilevel construct: validation, sources of influence, and implications in a longitudinal study in grades 1 to 4. *Scientific Studies of Reading, 9,* 85-116.

Miller Guron, L. & Lundberg, I. (2003). Identifying dyslexia in multilingual students: Can phonological awareness be identified in the majority language? *Journal of Research in Reading, 26,* 69-82.

Molfese, V.J., Modglin, A. & Molfese, D.L. (2003). The role of environment in the development of reading skills: A longitudinal study of preschool and school-age measures. *Journal of Learning Disabilities, 36,* 59-67.

Morris, R.D., Stuebing, K.K., Fletcher, J.M., Shaywitz, S.E., Lyon, G.R., Shankweiler, D.P. et al. (1998). Subtypes of reading disability: Variability around a phonological core. *Journal of Educational Psychology, 90,* 347-373.

Morton, J. (1979). Word recognition. In J. Morton & J. Marshall (Eds.), *Psycholinguistics 2: Structures and processes* (pp. 107-156). Cambridge: Mass: MIT Press.

Muter, V. & Diethelm, K. (2001). The contribution of phonological skills and letter knowledge to early reading development in a multilingual population. *Language learning, 51,* 187-219.

Muthén, L.K. & Muthén, B.O. (2004). *Mplus: The comprehensive modeling program for applied researchers. User's guide* (3rd ed.). Los Angeles: Muthén & Muthén.

Myklebust, H.R. & Johnson, D.J. (1962). Dyslexia in children. *Exceptional Children, 29,* 14-25.

Myrberg, M. (2000). *The foundation for lifelong learning.* Stockholm: Liber.

Nation, K. & Snowling, M. (1997). Assessing reading difficulties: The validity and utility of current measures of reading skill. *British Journal of Educational psychology, 67,* 359-370.

National Reading Panel. (2000). *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction.* Washington DC: National Institutes of Child Health and Human Development.

Ninio, A. (1983). Joint book reading as a multiple vocabulary acquisition device. *Developmental Psychology, 19,* 445–451.

Olson, R.K. (1999). Research on reading disabilities in the Colorado learning disability research center. In I. Lundberg, F.E. Tonnessen, & I. Austad (Eds.), *Dyslexia. Advances in theory and practice* (pp. 141-150). Dordrecht, NL: Kluwer Academic Publishers.

Olson, R., Forsberg, H., & Wise, B. (1994). Genes, environment, and the development of orthographic skills. In V.W. Berninger (Ed.), *The varieties of orthographic knowledge I: Theoretical and developmental issues* (pp. 27-71). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Olson, R., Forsberg, H., Wise, B. & Rack, J. (1994). Measurement of word recognition, orthographic, and phonological skills. In G.R. Lyon (Ed.), *Frames of reference for the assessment of learning disabilities. New views on measurement issues* (pp. 243-277). Baltimore, MD: Paul H. Brookes.

Olson, R.K. & Wise, B.W. (1992). Reading on the computer with orthographic and speech feedback. *Reading and Writing: An Interdisciplinary Journal, 4,* 107-144.

Paulesu, E., Démonet, J., Fazio, F., McCrory, E., Chanoine, V., Brunswick, N. et al. (2001). Dyslexia: Cultural Diversity and Biological Unity. *Science, 291,* 2165-2167.

Paulesu, E., Frith, U., Snowling, M., Gallagher, A., Morton, J., Frackowiak, R.S.J et al. (1996). Is developmental dyslexia a disconnection syndrome? Evidence from PET scanning. *Brain, 119,* 143-157.

Pennington, B.F. & Lefly. D.L. (2001). Early reading development in children at family risk for dyslexia. *Child Development, 72,* 816-833.

Pennington, B., van Orden, G., Smith, S., Green, P. & Haith, M. (1990). Phonological processing skills and deficits in adult dyslexics. *Child Development, 61,* 1753-1778.

Perfetti, C.A. (2003). The universal grammar of reading. *Scientific Studies of Reading, 7,* 3-24.

PISA (2001). *PISA 2000. Svenska femtonåringars läsförmåga och kunnande i matematik och naturvetenskap i ett internationellt perspektiv* (Swedish 15-year olds' reading ability and knowledge in mathematics and science in an international perspective). Skolverket. Rapport 209, 2001.

Pressley, M. (1998). *Reading instruction that works. The case for balanced teaching.* New York: The Guilford Press.

Pugh, K. R., Mencl, E.W., Jenner, A.R., Lee, J.R., Katz, L., Frost, S.J. et al. (2001). Neuroimaging studies of reading development and reading disability. *Learning Disabilities Research & Practice, 16,* 240-249.

Pugh, K. R., Mencl, E.W., Shaywitz, B.A., Shaywitz, S.E., Fulbright, R.K., Constable, P.R. et al. (2000). The angular gyrus in developmental dyslexia: Task-specific differences in functional connectivity within posterior cortex. *Psychological Science, 11,* 51-56.

Rack, J. (1997). Issues in the assessment of development dyslexia in adults: Theoretical and applied perspectives. *Journal of Research in Reading, 20,* 66-76.

Rack, J.P. (2004). Review of research on effective intervention. In M. Turner & J. Rack (Eds.), *The study of dyslexia.* New York: Kluver Academic Publishers.

Ramus, F. (2001). Outstanding questions about phonological processing in dyslexia. *Dyslexia, 7,* 197-216.

Ramus, F. (2004). The neural basis of reading acquisition. In M. S. Gazzaniga (Ed.), *The Cognitive Neurosciences* (3rd ed., pp. 815-824), Cambridge, MA: MIT Press.

Ramus, F. (in press). A neurological model of dyslexia and other domain-specific developmental disorders with an associated sensorimotor syndrome. In G. D. Rosen (Ed.), *Developing New Pathways in the Study of the Dyslexic Brain.* Baltimore: York Press.

Ramus, F., Rosen, S., Dakin, S., Day, B., Castellote, J. White, S. et al. (2003). Theories of developmental dyslexia: insights from a multiple case study of dyslexic adults. *Brain, 126*, 841-865.

Rapkin, B.D. & Luke, D.A. (1993). Cluster analysis in community research: Epistemology and practice. *American Journal of Community Psychology, 21*, 247-277.

Rayner, K., Foorman, B.R., Perfetti C.A., Pestsky, D. & Seidenberg, M.S. (2001). How psychological science informs the teaching of reading. *Psychological Science in the Public Interest, 2,* 31-74.

Rodhe-Wallström, C. (2000). *Svenska steg för steg.* (Swedish step by step). Flen, Sweden: Alfamax.

Ryan, A. & Meara, P. (1991). The case of the invisible vowels: Arabic speakers reading English words. *Reading in a Foreign Language,7,* 531-539.

Samuelsson, S. (2002). Läs- och skrivsvårigheter: Inte bara dyslexi (Reading and writing problems: Not only dyslexia). *Dyslexi- aktuellt om läs- och skrivsvårigheter, 3,* 17-20.

Samuelsson, S. & Lundberg, I. (2003). The impact of environmental factors on components of reading and dyslexia. *Annals of Dyslexia, 53,* 201-217.

Satz, P. & Morris, R. (1981). Learning disability subtypes: A review. In F.J. Pirozzolo & M.C. Wittrock (Eds.), *Neoropsychological and cognitive processes in reading* (pp. 109-141). New York: Academic Press.

Scarborough, H. (1990). Very early language deficits in dyslexic children. *Child Development, 61,* 1728-1743.

Schneider, W., Küspert, P., Roth, E, Visé, M. & Marx, H. (1997). Short- and long term effects of training phonological awareness in kindergarten: Evidence from two German studies. *Journal of Experimental Child Psychology, 66,* 311-340.

Shankweiler, D., Crain, S., Katz, L., Fowler, A.E., Liberman, A.M., Brady, S.A. et al. (1995). Cognitive profiles of reading-disabled children: Comparisons of language skills in phonology, morphology, and syntax. *Psychological Science, 6,* 149-156.

Share, D. (1995). Phonological recoding and self-teaching: sine qua non of reading acquisition. *Cognition, 55,* 151-218.

Share, D. L. & Silva, P. A. (1986). The stability and classification of specific reading retardation: A longitudinal study from age 7 to 11. *British Journal of Educational Psychology, 56*, 32-39.

Shaywitz, S. (2003). *Overcoming dyslexia. A new and complete science-based program for reading problems at any level.* New York: Alfred A. Knopf.

Siegel, L.S. (1988) Agatha Christie's learning disability. *Canadian Psychology, 2*, 213-216.

Siegel, L.S. (1989). IQ is irrelevant to the definition of learning disabilities. *Journal of Learning Disabilities, 22,* 469-478.

Siegel, L.S. & Himel, N. (1998). Socioeconomic status, age and the classification of dyslexics and poor readers: the dangers of using IQ scores in the definition of reading disability. *Dyslexia, 4,* 90-104.

Skolverket (2004) *Elever med utländsk bakgrund* (Students with immigrant background). Stockholm: Liber.

Skolverket (2005). *Nationell utvärdering av grundskolan 2003* (National evaluation of the compulsory school 2003). Stockholm: Liber.

Snow, C. (1999). Social perspectives on the emergence of language. In B. MacWhinney (Ed.), *The Emergence of Language* (pp. 257-276). London: Lawrence Erlbaum.

Snow, C., Burns, S. & Griffin, P. (1998). *Preventing reading difficulties in young children.* Washington, D.C.: National Academy Press.

Snowling, M. (2000). *Dyslexia.* Oxford: Blackwell Publishers Ltd.

Snowling, M. (2001). From language to reading and dyslexia. *Dyslexia, 7,* 37-46.

Snowling, M. & Frith, U. (1986). Comprehension in "hyperlexic" readers. *Journal of Experimental Child Psychology, 42*, 392-415.

Snowling, M. & Nation, K. (1997). Language, phonology, and learning to read. In C. Hulme & M. Snowling (Eds.), *Dyslexia: Biology, cognition, and intervention* (pp. 153-166). London: Whurr Publishers.

Sprenger-Charolles, L., Colé, P., Lacert, P. & Serniclaes, W. (2000). On subtypes of developmental dyslexia: Evidence from processing time and accuracy scores. *Canadian Journal of Experimental psychology, 54*, 87-103.

Stahl, S. A. (1991). Beyond the instrumental hypothesis: Some relationships between word meanings and comprehension. In P J. Schwanenflugel (Ed.), *The psychology of word meanings* (pp. 157-185). Hillsdale, NJ: Erlbaum.

Stahl, S. (1999). *Vocabulary Development.* Cambridge, Mass.: Brookline Press.

Stanovich, K.E. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. *Reading Research Quarterly, 15,* 10-29.

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly, 21*, 360-407.

Stanovich, K. E. (1988a). The right and wrong places to look for the cognitive locus of reading disability. *Annals of Dyslexia, 38*, 154-177.

Stanovich, K. E. (1988b). Explaining the differences between the dyslexic and the garden-variety poor reader: The phonological-core variable-difference model. *Journal of Learning Disabilities, 21,* 590-612.

Stanovich, K. E. (1989). Has the learning disabilities field lost its intelligence? *Journal of Learning Disabilities, 22,* 487-492.

Stanovich, K.E. (2000). *Progress in understanding reading.* New York: The Guilford Press.

Stanovich, K.E., Cunningham, A.E. & West, R.F. (1998). Literacy experiences and the shaping of cognition. In S. Paris & H. Wellman (Eds.), *Global prospects for education: Development, culture, and schooling* (pp. 253-288). Washington, DC: American Psychological Association.

Stanovich, K.E. & Siegel, L.S. (1994). Phenotypic performance profile of children with reading disabilities: A regression-based test of the phonological-core variable-difference model. *Journal of Educational Psychology, 86,* 24-53.

Stanovich, K.E. & Siegel, L. (2000). The phonological performance profile of reading disabled children. In K.E. Stanovich (Ed.), *Progress in understanding reading* (pp. 119-145). New York: The Guilford Press.

Stanovich, K.E., Siegel, L. & Gottardo, A. (1997). Converging evidence for phonological and surface subtypes of reading disability. *Journal of Educational Psychology, 89*, 114-127.

Stein, J. (2001). The magnocellular theory of developmental dyslexia. *Dyslexia, 7,* 12-36.

Stein, J.F., Talcott, J. & Witton, C. (2001). The sensorimotor basis of developmental dyslexia. In A. Fawcett (Ed.), *Dyslexia. Theory & good practice* (pp 65-88). London: Whurr Publishers.

Sterner, G. & Lundberg, I. (2005). *Word recognition and comprehension in early years*. A manuscript in preparation.

Sundblad, B. (1993). Myten om den ärftliga sjukdomen dyslexi (The myth of the inheritable disease dyslexia). *Ordfront magasin, 2*, 37.

Svensson, I. (2003). *Phonological dyslexia. Cognitive, behavioural and hereditary aspects*. Doctoral dissertation. Göteborg University, Sweden.

Svensson, I. & Jacobson, C. (in press). How persistent are phonological difficulties? A longitudinal study of reading retarded children. *Dyslexia.*

Tallal, P. (1980). Auditory temporal perception, phonics and reading disabilities in children. *Brain & Language, 9,* 182-198.

Tallal, P., Miller, S.L., Jenkins, W.M. & Merzenich, M.M. (1997). The role of temporal processing in developmental language-based learning disorders: Research and clinical implications. In B.A. Blachman (Ed.), *Foundation of reading acquisition and dyslexia: Implications for early intervention* (pp. 49-66). Mahwah, NJ: Lawrence Erlbaum Associates.

Taube, K. (1987). *Läsinlärning och självförtroende* (Reading acquisition and self-confidence). Stockholm: Rabén & Sjögren.

Taube, K. (1996). *Läsförmågan hos 6305 nioåringar i Stockholm* (The reading ability among 6305 9-year olds in Stockholm). Stockholm: Lärarhögskolan i Stockholm, Institutionen för språk och litteratur/Stockholms skolor centralförvaltning.

Taylor, H.G., Satz, P. & Friel, J. (1979). Developmental dyslexia in relation to other childhood reading disorders; significance and utility. *Reading Research Quarterly, 15*, 84-101.

Torgesen, J.K. (2000). Individual differences in response to early intervention in reading: The lingering problem of treatment resisters. *Learning Disabilities Research & Practice, 15,* 55-64.

Torgesen, J.K. (2002, August). *Setting new goals for intervention with older children: Lessons from reasearch.* Paper presented at the Third Nordic Conference on Dyslexia in Stockholm, Sweden.

Torgesen, J.K., Alexander, A.W., Wagner, R.K., Rashotte, C.A., Voeller, K.K.S: & Conway, T. (2001). Intensive remedial instruction for children with severe reading disabilities: Immediate and long-term outcomes from two instructional approaches. *Journal of Learning Disabilities, 34,* 33-58.

Torgesen, J.K., Morgan, S.T. & Davis, C. (1992). Effects of two types of phonological awareness training on word learning in kindergarten children. *Journal of Educational Psychology, 84*, 364-370.

Torgesen, J.K., Rashotte, C.A., & Alexander, A.W. (2001). Principles of fluency instruction in reading: Relationships with established empirical outcomes. In M. Wolf (Ed.), *Dyslexia, fluency, and the brain* (pp. 333-355). Timonium, MD: York Press.

Tunmer, W. (1994). Phonological processing skills and reading remediation. In C. Hulme & M. Snowling (Eds.), *Reading development and dyslexia* (pp. 147-162). London: Whurr Publishers.

Vail, P. (1999, November) *Accommodations vs. Remediation: What is the difference?* Paper presented on the International Dyslexia Association Conference in Chicago.

Vellutino, F.R. & Scanlon, D.M. (2001). Emergent literacy skills, early instruction, and individual differences as determinants of difficulties in learning to read: The case for early intervention. In S.B. Neuman & D.K. Dickinson (Eds.), *Handbook of Early Literacy Research* (pp. 295-321). New York: The Guilford Press.

Vogel, S.A. (1998). Adults with learning disabilities. In S.A. Vogel & S. Reder (Eds.), *Learning disabilities, literacy, and adult education* (pp. 5-28). Baltimore, MD: Paul H. Brookes.

Vogel, S.A. & Reder, S. (1998). Educational attainment of adults with learning disabilities. In S.A. Vogel & S. Reder (Eds.), *Learning disabilities, literacy, and adult education* (pp. 43-68). Baltimore, MD: Paul H. Brookes.

Wagemaker, H., Taube, K., Munck, I., Kontogiannopoulou-Polydorides, G. & Martin, M. (1996). *Are girls better readers? Gender differences in reading literacy in 32 countries.* Amsterdam: The International Association for the Evaluation of Educational Achievement.

Wagner, R. K. & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin, 101*, 192-212.

Wallin, E. (1967). *Spelling. Factorial and experimental studies.* Stockholm: Almqvist & Wiksell.

West, T.G. (1997). *In the mind's eye: Visual thinkers, gifted people with dyslexia and other learning difficulties, computer images, and the ironies of creativity.* Amherst, NY: Prometeus.

White, S., Milne, E., Rosen, S., Hansen, P.C., Swettenham, J., Frith, U. et al. (2005). *The role of sensorimotor processing in dyslexia: A multiple case study of dyslexic children.* Manuscript submitted for publication.

Wilson, A.M. & Lesaux, N.K. (2001). Persistence of phonological processing deficits in college students with dyslexia who have age-appropriate reading skills. *Journal of Learning Disabilities, 34,* 394-400.

Wilson, B.A. (1998). Matching student needs to instruction. In S.A. Vogel & S. Reder (Eds.), *Learning disabilities, literacy, and adult education* (pp. 213-235). Baltimore, MD: Paul H. Brookes.

Wimmer, H. (1993). Characteristics of developmental dyslexia in a regular writing system. *Applied psycholinguistics, 14,* 1-33.

Winner, E., von Károlyi, C. & Malinsky, D. (2000). Dyslexia and visual-spatial talent: No clear link. *Perspectives. The International Dyslexia Association, 26,* 26-30.

Winner, E., von Károlyi, C., Malinsky, D., French, L., Seliger, C., Ross, E. et al. (2001). Dyslexia and visual-spatial talents: Compensation vs deficit model. *Brain and Language 76,* 81-110.

Witting, M. (1985). *Wittingmetoden. Metod för läs- och skrivinlärning.* (The Witting program. A method for reading and writing). Stockholm: Ekelunds förlag.

Wolf, M., Goldberg O'Rourke, A., Gidney, C., Lovett, M., Cirino, P. et al. (2002). The second deficit: An investigation of the independence of phonological and naming-speed deficits in developmental dyslexia. *Reading and Writing: An Interdisciplinary Journal, 15,* 43-72.

Wolff, U. (2002). (Interviews with 40 dyslexic and 40 non-dyslexic university students). Unpublished raw data.

Wolff, U. (2005). *Compensated adults with dyslexia still have phonological problems.* Manuscript in preparation.

Wolff, U. & Lundberg, I. (2001) *Dyslexia and artistic talents- is there a connection?* CD-rom document from British Dyslexia Associations 5th international conference, York 2001.

Wood, F.B., Flowers, L. & Grigorenko, E. (2001). On the functional neuroanatomy of fluency or why walking is just as important to reading as talking is. In M. Wolf (Ed.), *Dyslexia, fluency, and the brain* (pp. 235-244). Timonium, MD: York Press.

Yelland, G.W., Pollard, J. & Mercuri, A. (1993). The metalinguistic benefits of limited contact with a second language. *Applied psycholinguistics, 14*, 423-444.

Zabell, C. & Everatt, J. (2002). Surface and phonological subtypes of adult developmental dyslexia. *Dyslexia, 8,* 160-177.

Zeffiro, T. & Eden, G. (2000). The neural basis of developmental dyslexia. *Annals of Dyslexia, 50*, 3-30.

Appendix

I Wolff, U. (2004). *Subgrouping of readers based on performance measures: A latent profile analysis.* Manuscript submitted for publication.

II Wolff, U. & Lundberg, I. (2003). A technique for group screening of dyslexia among adults. *Annals of Dyslexia, 53,* 324-339.

III Wolff, U. & Lundberg, I. (2002). The prevalence of dyslexia among art students. *Dyslexia, 8,* 34-42.

IV Wolff, U. (2004). *Phonological and surface subtypes among dyslexic university students.* Manuscript submitted for publication.

På grund av upphovsrättsliga skäl kan vissa ingående delarbeten ej publiceras här.
För en fullständig lista av ingående delarbeten, se avhandlingens början.

Due to copyright law limitations, certain papers may not be published here.
For a complete list of papers, see the beginning of the dissertation.

GÖTEBORGS UNIVERSITET

GÖTEBORG STUDIES
IN EDUCATIONAL SCIENCES

ISSN 0436-1121

Characteristics and varieties of poor readers

Reading consists of two components, decoding and comprehension, which both are necessary for skilled reading. This thesis examines and discusses different patterns of reading performance, as well as characteristics and features of different reading performance profiles. The view that reading is a skill with high generality and transferability was supported. However, poor readers exhibit more heterogeneous performance patterns. They may have sufficient decoding skills but poor comprehension, due to general limited comprehension skills or to linguistic background. Some students were generally poor on both comprehension and decoding. One group of students exhibited a typical dyslexia profile with sufficient comprehension but deficient word decoding. The thesis is in strong support of the phonological deficit hypothesis of dyslexia, that is phonological problems are the underlying cause of dyslexia. Furthermore, it was not possible to demonstrate the existence of a subgroup of students with dyslexia who exhibited surface (visual) dyslexia without phonological problems. The heterogeneous performance patterns among poor readers certainly have educational implications. Instructional intervention for various reading problems is suggested and discussed in relation to current research.

Ulrika Wolff practised as a special educator for 13 years in adult education with students with dyslexia. Her research interest is in reading and reading difficulties. Currently, she is affiliated to the Department of Education, Göteborg University.

Subscriptions to the series and orders for single volumes should be addressed to: ACTA UNIVERSITATIS GOTHOBURGENSIS, Box 222, SE-405 30 Göteborg, Sweden.

ISBN 91-7346-537-2

Kompendiet, Göteborg
2005