Development of speed in reading

Background and research goals

Reading research has provided considerable insight into the *quantitative* relationships between children's language and reading development (Bowey, 2005; Elbro & Scarborough, 2004). Centre for Reading Research at the University of Copenhagen has contributed to this insight through longitudinal and experimental studies. For example, researchers at the centre have contributed to theory and empirical findings concerning the importance of well specified phonological representations of lexical items as a foundation for children's acquisition of written word decoding (e.g., Elbro, Borstrøm & Petersen, 1998; Elbro & Petersen, 2004).

However, both nationally and internationally, there is little knowledge of the *qualitative* relationships between children's linguistic abilities and the development of separate component processes of reading. This is even the case for the development of *speed of word decoding* and general fluency of reading. This development ought to be of particular Danish interest. Danish 9-year-olds are among the very slowest readers in international comparisons (Elley, 1992; Allerup *et al.*, 2001). On average, they read even more slowly than students in countries, such as Venezuela and Indonesia, which we do *not* normally compare to Denmark. Conversely, Danish students perform near the international average in reading accuracy.

An overarching goal of the proposed project is thus to contribute to the understanding of the bases of development of speed in word decoding and general fluency in reading – both in general and in areas which may distinguish Danish from most other languages in terms of orthography. A better understanding of what may be particular to Danish orthography will provide better possibilities for adapting general knowledge of reading development to Danish conditions, while a better understanding of individual differences will provide better possibilities for individual support.

The development of speed in reading has generally been explained in two ways. One is in terms of word decoding automaticity. The idea is that already existing associations between letters and sounds become automatised and thereby function more efficiently (Manis, Seidenberg & Doi, 1999). The other explanation points to an increasing vocabulary of "sight words", that is, words which have separate orthographic representations in the reader's mental lexicon. Reading speed increases as a higher proportion of the printed words are recognised as "sight words" and as the orthographic representations become consolidated and more fully associated with each of the phonemes of their spoken forms (Ehri, 2005).

None of these explanations are well suited to account for *individual differences* in the development of reading speed. The automaticity explanation points to differences

in the amount of successful reading experiences as the main and perhaps only source of differences in the development of reading speed. The "sight words" explanation points in the same direction; students need to practice words a number of times in order to acquire orthographic representations of them. Neither of the explanations are well suited to explain *why* some students need far more practice than others in order to increase reading speed. Why do some students fail to learn some printed words even though they have seen them many times (e.g., Wimmer & Mayringer, 2002)? In addition, Ehri's more elaborate explanation points to the same phonological precursors as are well known precursors of accuracy in reading. Yet, Ehri's explanation does not account for the fact that some students continue to read slowly despite marked gains in reading accuracy (Olson m.fl. 1997).

Generally speaking, current theoretical accounts of the development of reading speed do not connect well with basic individual differences in non-reading abilities, such as language abilities. Yet, it is very likely that such individual differences may exist given that a significant proportion of the individual differences in reading speed are of genetic origin (e.g. Gayan & Olson, 2003).

At the same time, there are significant individual differences in processing speed that have not been satisfactorily linked to differences in reading. A prominent example is that of Rapid Automatised Naming (RAN) of figures, colours, digits etc. It is well documented that RAN performance correlates with word decoding in the primary school years (e.g., Catts m.fl. 2002). Individual differences in RAN at pre-school also contribute significant variance to reading later (Wolf & Bowers, 1999; Elbro & Scarborough, 2004). So far, however, it is not clear *how* RAN ties in with the sub-component processes of reading (de Jong & Vrielink, 2004).

Therefore, the general aim of the proposed project is to identify predictors of individual differences in the development of reading speed. These predictors will be searched both among language abilities at the beginning of reading instruction and among other subcomponents of the reading process.

A missing link: from spelling pronunciation to word identification?

When beginning readers encounter a word that they have not seen in writing before, they usually attempt to spell out the word: they assign standard sounds to the individual letters. The result is a string of sounds or some synthesis of them, a re-coded *spelling pronunciation* of the word. No matter how close this spelling pronunciation is to a standard pronunciation of the word, the reader will still need to *recognise* the word, that is, he or she has to activate the phonological identity of the word in his or her mental lexicon. It is easy to observe signs of this identification process – or problems with it – in beginning readers. The reader spells the word out, "l.i.tt..le", and then stops, "litt...le?" Often, the reader identifies the word after a little while "oh, *little*". Sometimes it takes longer, and sometimes the word is not identified from the spelling pronunciation. Anyway, this identification is an important component in word decoding, but largely and strangely overlooked by research. Reading research has focussed on the re-coding phase and more or less taken the identification phase for

granted. The identification process is indeed also largely overlooked by the most cited theoretical models of word decoding, for example, the dual-route model (Coltheart, 2005), and distributed network models (e.g., Plaut 2005). A single exception from the general neglect is a brief account by Byrne (2005, p. 111).

(1) The point is that there may be important individual differences in the speed with which words are identified from spelling pronunciations. Anyone who observes beginning readers will notice that some readers recognise such not-quite-right pronunciations faster than others. And, obviously, reading speed is no faster than the recognition speed. So, the question is where these differences come from, and what their impact is on the development of reading speed, if any.

At this point it should be pointed out that word identification based on spelling pronunciations may certainly not be the only component process in reading worth considering. And the proposed project will take a closer look at other candidates. However, identification speed has some exemplary features which makes it a good example of a component processes worth studying. It is a component of the reading process, which links well with other, better described components. At the same time, it may be studied outside the context of reading, even before the onset of reading instruction (see the methods section).

One possibility is that the quality of existing phonological representations are important for the recognition of spelling pronunciations and other slightly deviant pronunciations (e.g., Elbro, 1996). Perhaps, well specified phonological representations are good attractors ("magnets") in the recognition of deviant pronunciations. There is evidence that differences in the distinctness of words, i.e., how many other words that sound almost like them, influence how easily words are produced (Harley & Bown, 1998). This effect may generalise to individual differences in terms of the distinctness with which the sounds of words are stored in their mental lexicon. Such differences may be studied *before* the onset of reading instruction, and their value as predictors of reading development assessed in a prospective longitudinal study.

(2) A second point is that it may be studied separately how the relationships between word identification from more or less deviant pronunciations correlates with other, more well-studied phonological abilities – and with RAN, which currently lacks theoretical links to processes in reading. It is a hypothesis to be studied that RAN is a measure of the efficiency with which lexical items are activated – and hence related to the speed of activation of words when deviant phonological input is provided.

(3) A third point is that identification of spelling pronunciations is stressed by orthographically irregular words (such as *bear, plait, have*). A spelling pronunciation of these words is further removed from the standard pronunciation. Consequently, it is important to control words to be read for the degree of orthographical regularity – and to study the possible links between individual regularity effects in reading and recognition of spelling pronunciations.

Orthographical irregularity interacts with frequency in word recognition: orthographic irregularity is an impediment for low frequency words only. However, results from earlier studies with beginning readers suggest that orthographic

irregularity is a global obstacle even in orthographies with relatively few irregularities such as the German (Elbro, 2005). Fortunately, the proposed project will be able to profit from an ongoing, empirical study of the degrees of orthographic irregularity of Danish words (Juul, inspired by Kessler & Treiman, 2001, and funded by the Danish Research Council). By means of a metric for orthographic irregularity, the project may approach the question of possible interactions between orthographic irregularity and the recognition of spelling pronunciations.

Separation of accuracy and speed in the development of word decoding

The proposed project aims at a comparison of the *development* of speed in decoding, not only at a comparison of the reading speed at a certain time point. Such a comparison requires control over other components of reading, in particular decoding accuracy. It is well known – also from Danish studies – that the development of reading speed usually "takes off" when accuracy reaches about 95 % correctly read words (Nielsen *et al.*, 1992). Consequently, a study of precursors of the development of reading speed should attempt to define the individual time points when decoding accuracy reaches a level that is sufficient for a marked increase in reading speed (Juul *et al.*, 2007). Such a definition will allow for an assessment of the individual progress in reading speed and a prediction of individual differences.

Hence, the study will aim at a separation of the initial reading development into two phases, one through which the student acquires basic decoding accuracy, and one through which decoding speed increases markedly. Previous studies have rarely worked with such phases (except in theory, e.g., Frith, 1985). This have made it impossible to tell which precursors are important for which phases in the initial reading development.

It is a hypothesis in the proposed project that some precursors are important for the development of decoding accuracy while others are primarily important for the development of reading speed (cf. Elbro, 1997).

Summary of research aims

The proposed project aims at gaining insights into the foundations of component processes in reading – particularly the development of decoding speed. The precursors in focus are pre-school language abilities with a long track record, e.g. RAN and confrontation naming speed, quality of pronunciation – and new, experimental measures such as identification of spelling pronunciations. It is a further aim to look into possible interactions between these precursors and orthographic regularity on word reading. The project also aims at defining a separation point between an initial phase in reading during which decoding accuracy improves greatly, and a later phase when reading speed is acquired. By this definition development in speed may be studied relatively independently of other component processes in reading. Finally, the project aims at developing dynamic measures of central language and reading components (se the Methods section below). Such measures could provide very useable

short cuts to insights into development which normally require costly longitudinal studies to obtain.

Method

The research questions are to be answered in a prospective longitudinal study. A cross sectional study would not suffice because it cannot rule out inverse causality, i.e., the influence of reading abilities on the precursors. In the present case, it is obvious that students meet and possibly learn spelling pronunciations during initial reading instruction. Consequently, the proposed study aims to follow children from just *before* the onset of formal reading instruction – until stable differences in the developmental trends in reading speed can be detected, towards the end of the 2nd grade.

Insights into causal mechanisms require experimental methods. However, the main precursors under study are rather un-researched so far, so it would seem prematurely to develop and test training programs.

On the other hand, the project will develop dynamic tests of both independent and dependent variables. In dynamic testing, the potentials for development are measured, rather than the actual level of proficiency (Grigorenko & Sternberg, 1998). A dynamic test of vocabulary, for example, is not a test of how many words a person knows, but a test of how easily a person acquires new vocabulary items. Correspondingly, it is an aim to develop dynamic tests of the acquisition of spelling pronunciations and maximally distinct phonological representations of lexical items (see a preliminary attempt in Elbro & Jensen, 2005). As for the dependent variables, an attempt will be made at dynamic testing of the acquisition of reading speed by means of repeated reading of the same segments of texts.

Participants

Unfortunately, it is not possible to select a high-risk group for the study because the specific precursors of reading speed are largely unknown. The study will be based on intact school classes from the greater Copenhagen area. The aim is to follow approximately 150 children individually, a group size required to conduct the planned multivariate analyses (and structural equation modelling) with controls for decoding accuracy, vocabulary etc.

Measures

Each ability will be assessed with at least two independent measures. This will allow for insights into the validity of the experimental measures. Two or more independent measures will also allow for the construction of "error free" latent variables rather than just simple measures.

Kindergarten grade measures

One possible way of testing identification of spelling pronunciations, is to ask participants to listen to (other) beginning readers. These other readers attempt to read

words and do an accurate re-coding of the letters into speech sounds, but they fail to recognise the words. The task of the participants is simply to guess as quickly as possible what the words are. A pilot study of this technique suggests that this may be feasible.

Tests of the strength of phonological representations of lexical items comprise (1) speed and accuracy of the identification of words that are pronounced slightly wrongly, (2) speed and accuracy in error detection with spoken words.

Phonological representations will also be studied by means of dynamic tests (cf. Elbro & Jensen, 2005). The new phonological representations to be acquired will be both spelling pronunciations, maximally distinct pronunciations of words, and sound segments that correspond to frequent, irregular spelling patterns.

In addition, well known predictors of reading development in the first school years will be studied, including

letter knowledge (naming of letters)
phoneme awareness (identification of specific sounds in words)
vocabulary (and vocabulary acquisition)
picture naming (speed and accuracy)
RAN (figures and colours)
Morphological/grammatical awareness

Grade 1 measures

Towards the end of grade 1 and during the beginning of grade 2, the reading accuracy and speed of the participants will be monitored closely so as to define possible individual transition points between acquisition of accuracy and development of speed of word decoding. There are several reading tests available some of which are regularly employed by schools.

One experimental measure at this point is a dynamic test of the acquisition of speed in decoding. This test will be based on repeated reading of the same section of a text. The measure taken may be the number of repetitions required to increase reading speed by a set amount of words per minute.

Grade 2 measures

During grade 2, the reading speed of the participants will be measured regularly in order to enable individual developmental trajectories to be estimated. Both single word and connected text measures will be employed. Among the words in the materials will be some of *the same words* which were part of the measures at the end of the kindergarten grade. This will allow for a better understanding of the mechanisms underlying possible correlations between grade 2 and kindergarten grade measures.

Time plan

The proposed project is planned to take four years.

During the first year, development and testing of the experimental measures will take place. Contacts with schools and teachers will be made and parents' consents will be obtained.

During year two and three, the participants will be followed and data collected (from the end of the kindergarten grade till the end of the second grade).

During year four, data analysis and reporting will take place.

Quality indicators

The applicants have much experience with longitudinal and experimental studies of reading development (see the CV's). Previous studies have been well received and are frequently cited.

As stated in the introduction, studies of precursors of specific components of reading abilities are scarce, and the specific ideas are new about the role of recognition of words given spelling pronunciations. Hence, the project has potential for internationally important results.

Previous longitudinal projects on reading development have had immediate and significant impact on all levels of teaching – from elementary teaching, through undergraduate to post graduate education. They have also inspired local and national educational policies. Provided that the proposed project leads to reliable, new insights, there is every reason to believe that it will have a similar impact. One position for a PhD student will be part of the proposed project.

The proposed project will, just like previous projects, be presented at national and international conferences, and it will be discussed in detail with colleagues world wide. Collaboration will also be sought with researchers from The Danish Educational University.

Results will be published in international, refereed journals, as well as at conferences for researchers and for teachers, in newspapers and TV.

Further funding (for PhD grants) will be sought from the research council, and from the Ministry of Education.

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Holger Juul, postdoc
Carsten Elbro, professor
(primary investigator)

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