Acknowledgements

This thesis was carried out at the Department of Scandinavian Languages at Stockholm University. It was supported by the Hanna Ahlström and Ellen Terserus Memorial Fund, the Bank of Sweden Tercentenary Foundation, the Elisabeth and Herman Rhodin Memorial Foundation, and the Swedish Foundation for International Cooperation in Research and Higher Education (STINT).

A number of people have been of great help in various ways in the process of completing this book. Thank you to all of you! But without the enthusiastic participation of 50 children this thesis would never have come into being. A tremendous “thank you” to you and your teachers!

Apart from those who have been more or less directly involved in the completion of the thesis, a number of other people have meant a great deal to me during these years. Without my dear family and friends around me this process would have been far more difficult. My friend Kerstin has always been there when I needed her, and so have my parents, Stig and Ann Lovis, who have supported me in all possible ways during these years. But last, and definitely not least, my children Elin, Olof, and Lisa have been fantastic coaches. Without the three of you I don’t know what I would have done!
List of papers

This thesis is based on the following papers.


Contents

1 Introduction ................................................................................................ 5
2 The reading process.................................................................................... 7
  2.1 Models of written word recognition....................................................... 7
  2.1.1 Dual-route models................................................................................ 8
  2.1.2 Connectionist models.......................................................................... 13
  2.2 Models of reading.................................................................................. 15
  2.2.1 Just and Carpenter’s interactive model of reading............................ 16
  2.2.2 Gough’s modular reading model......................................................... 18
  2.2.3 Some methodological remarks........................................................... 19
  2.3 The role of different linguistic levels in reading research.................... 20
    2.3.1 Phonological awareness ................................................................. 21
    2.3.2 Spelling: structures and regularity.................................................... 23
    2.3.3 Orthographic depth......................................................................... 26
    2.3.4 Higher linguistic levels .................................................................... 29
    2.3.5 Familiarity ....................................................................................... 34
3 Reading development............................................................................... 36
4 The investigation ...................................................................................... 45
  4.1 Aims and hypotheses........................................................................... 45
  4.2 Methods................................................................................................. 46
    4.2.1 The texts .......................................................................................... 47
    4.2.2 Subjects .......................................................................................... 48
    4.2.3 Procedures ...................................................................................... 49
      4.2.3.1 The database.............................................................................. 50
      4.2.3.2 Classifications ........................................................................ 52
    4.2.4 Methods used in the four studies.................................................... 54
  4.3 Results ................................................................................................... 57
    4.3.1 Study 1........................................................................................... 58
    4.3.2 Study 2........................................................................................... 59
    4.3.3 Study 3........................................................................................... 59
    4.3.4 Study 4........................................................................................... 60
    4.3.5 Summary of results ....................................................................... 61
5 General discussion.................................................................................... 63
  5.1 The sub-lexical level .......................................................................... 64
  5.2 The lexical level .................................................................................. 65
  5.3 Higher linguistic levels ....................................................................... 66
  5.4 Reading development ....................................................................... 67
1 Introduction

The present thesis consists of four papers (see p. 2), presenting the results of four separate studies using data collected in an investigation, in which 50 Swedish beginning readers were video recorded twice a year during their first two years in primary school, reading running texts orally. All four studies were based on more or less the same data, but analysed from different perspectives in each study. In the following chapters, the overall aims of the investigation, as well as various theories associated with these aims are presented. The methods used in the investigation are presented, and the results of each study briefly summarised.

The overall aims of the investigation were to examine the utilisation of various linguistic levels in the oral reading of running texts among Swedish beginning readers, and specifically to question the supposedly predominant role of lower linguistic levels (see 2.3.1, 2.3.2) by examining possible evidence of the utilisation of information at the syntactic or semantic levels, as well as textual context. In contrast to most previous research, based on experimental studies mainly using single words, I decided to use a more naturalistic approach, with a corpus constructed from the oral reading of running texts (see 4.2).

A great deal of reading research in recent decades has pointed out the importance of lower linguistic levels. Therefore we should expect the graphemic and perhaps also the word level to affect error frequencies (and possibly correction tendencies as well). However, other linguistic levels could also be expected to be utilised by the readers when they are faced with running texts.

Specifically methodological/pedagogical, and sociolinguistic aspects of reading are generally ignored in the following. However, the present investigation might serve as a basis for methodological considerations of analysing children’s reading in school as well as a basis for methodological considerations in the teaching of reading.

The following presentation is divided into four chapters apart from this introduction. Chapter 2 deals with the reading process. In that chapter models of written word recognition as well as models of the reading of running text are presented. The ways in which various linguistic levels have been connected to the reading process are also discussed. Chapter 3 presents a number of well-known models of reading development. Chapter 4 is a

---

1 Some of the children were in their last year of preschool and some were in their first year of primary school when the investigation started.

2 It is worth mentioning that non-alphabetic scripts are also ignored, though a great deal of interesting research has been carried out on logographic scripts, for instance.
presentation of the investigation, with the aims, hypotheses, and methods as well as a summary of results of the various studies. Chapter 5, the final chapter, consists of a general discussion of the results obtained in the investigation. The articles presenting the results of the four studies on which this thesis is based then follow.
2 The reading process

The investigation aims to analyse the extent to which readers tend to decode words in a letter-by-letter fashion, as well as the extent to which other linguistic levels (e.g. word, syntax, and semantics) might affect reading. Naturally, such analyses clearly can be connected to models of the reading process. These models can be divided into two main groups, namely models that only consider decoding of individual words, i.e. models of word recognition, and models that aim to describe reading of running texts as well (henceforth ‘models of reading’). Models of reading put particular emphasis on the extent to which higher linguistic levels are presumed to affect decoding (as do word recognition models, but to a lesser extent).

Both models of word recognition and models of reading generally describe skilled reading, and thus beginning reading or poor reading is described as a deviation from certain aspects presumed by the respective model. Most models are usually based on experimental findings, often using single-word reading.

Below, some well-known models are described, as well as a number of factors that have been considered to affect word recognition, such as word familiarity (as measured, for example, by frequency) and cross-orthographic differences. Swedish orthography is discussed in connection with the section on cross-orthographic differences. The final section is specifically devoted to the presumed role of different linguistic levels in models of the reading process (both models for word recognition and models of reading), since this is a key aspect of the present investigation.

2.1 Models of written word recognition

In reading research it is often assumed that the recognition of single words is more or less identical with the reading of running texts, or at least that

---

3 In literature on reading, the terms ‘decoding’ and ‘recoding’ are often used without clear distinctions. The term ‘recoding’ is a more specific term that signifies the process of forming connections between letters and sounds, typically in a letter-by-letter fashion, while the term ‘decoding’ refers to reading in a more general sense, and could involve letter-by-letter recoding, as well as more direct whole-word decoding. In the literature on reading the term ‘decoding’ is quite often used synonymously with the more specific term ‘recoding’. In the following, in the general discussion of reading, the term ‘recoding’ is used in the specific sense, and the term ‘decoding’ is used in the more general sense. When discussing specific models of reading, the terminology adopted in the respective model is generally used.
word recognition is the most important single factor for reading ability:⁴

/…/ word recognition is a basic process on which all other reading processes are predicated. (Bjaalid et al. 1997:73)

We assume that the same basic processes operate when we see single words as when we see a whole page of words. (Harley 1995:68)

To argue that recognition of single words is identical with the reading of running texts is, however, to overstate the case. When the reader faces a real text, other sources of information are present, and these are likely to affect the reading process at least to some extent. However, a significant amount of evidence supports the assumption that word recognition is crucial for reading (for overviews, see e.g. Harley 2001, Stanovich 1991) and in the following, two types of word recognition models are presented, viz. dual-route models and connectionist models.⁵

2.1.1 Dual-route models

In recent decades, dual-route models of word recognition have gained a lot of support (e.g. Bjaalid et al. 1997, Coltheart [1980] 1987).⁶ Dual-route models are related to Morton’s logogen model for visual and spoken word recognition (e.g. Morton 1980, 1989, Morton & Patterson [1980] 1987), which can be regarded as one kind of dual-route model. In the logogen model, two separate routes for visual word recognition are possible, viz. one route with a direct link to a visual logogen system, and one route involving grapheme–phoneme conversions.

One general characteristic of dual-route models is that they presuppose that words are recognised in one of two possible ways, viz. either by a direct route (or visual–orthographic/lexical) or by an indirect route (or phonological/sub-lexical). The direct route refers to a process in which the reader is presumed to recognise words by making direct connections between visual word-forms and their representations in a presumed mental

---

⁴ Some models of word recognition distinguish between ‘word recognition’ (i.e. the point at which the cognitive system picks out a candidate) and ‘lexical access’ (i.e. the point at which all information about the chosen candidate is available, including phonological, syntactic, and semantic information), and consider them to be separate phases of the word recognition process. Other models presume that word recognition and lexical access occur simultaneously. (For an overview, see e.g. Harley 2001.)

⁵ Still, although no one would argue that good comprehenders can be poor at word identification (see Stanovich 1991), there is evidence showing that skilled word recognition is not sufficient for reading comprehension. In the literature we find cases of ‘hyperlexia’ (see Snowling & Frith 1986), as well as studies revealing group differences in comprehension skill, even when word recognition speed and automaticity have been matched (for an overview, see Oakhill 1996).

⁶ See, for example, Harley (2001), Rayner & Pollatsek (1989), and Stanovich (1991) for overviews.
lexicon (i.e. the long term memory for words, which is thought, for example, to contain pronunciation, semantics, and spelling of words).\textsuperscript{7, 8} Thus, a prerequisite for the direct route to be activated is that the reader has built up a mental lexicon for visual word forms. This is thought to happen when the reader has decoded the same word a number of times. The indirect route, on the other hand, refers to a process in which graphemes are sequentially translated into phonemes by applications of grapheme–phoneme conversion rules (‘phonological recoding’).\textsuperscript{9} When this process has acted, a connection between the phonological word form and its representation in the mental lexicon is thought to be made. Thus, a prerequisite for the indirect route to be activated is that the reader has learnt basic grapheme–phoneme mappings (similar to the ‘alphabetic’ phase in models of reading development, Ch. 3). The direct route contains no such translation between graphemes and phonemes and is thus presumed to be a quicker process.

Early versions of dual-route models presupposed that the two routes acted independently of one another. They also presupposed that opaque words, such as \emph{yacht} or \emph{pint}, could only be processed by the direct route, while regularly spelled words, such as \emph{cat} or \emph{made}, could be processed by either of the two routes, and finally that nonwords or novel words could only be processed by the indirect route.

Later versions of the model assume that the two routes are partly interdependent regarding, for example, knowledge structures and processes, although a distinction between two possible ways of decoding is still maintained. In Høien & Lundberg’s model (e.g. 2000), for instance, interaction between the two routes is possible, in the sense that the lexicon can give feedback during phonological recoding. Recent dual-route models presume a “race” between the two routes, i.e., when the reader fixates a word, both routes begin to process it. However, Balota (1994) points out that evidence from cross-orthographic studies regarding frequency-effects (see 2.3.5) indicate that the two routes for word recognition are more likely to be relevant for readers of languages with relatively deep orthographies than for readers of shallower orthographies (see 2.3.3).

Figure 1 presents Høien & Lundberg’s (1997, 2000) elaborated version of the dual-route model. The two alternative routes are referred to as strategies, indicating that readers can use either route for decoding, although skilled reading presupposes that both routes can be activated. Høien & Lundberg (1997, 2000) suggest four factors that could influence the balance

\textsuperscript{7} For an introduction to theories about a mental lexicon, see e.g. Aitchison (1994).

\textsuperscript{8} In the logogen model (e.g. Morton 1980) the ‘logogens’ themselves do not contain information about phonology, semantics, etc. Instead they are thought to evoke the semantic representation of words in the cognitive system.

\textsuperscript{9} In later variants of dual route models (e.g. Bjaalid et al. 1997, Morton & Patterson [1980 1987], the use of analogies at the rime level, for instance, is also thought to be possible via the indirect route.
Figure 1. Høien & Lundberg’s (e.g. 2000) version of the Dual Route model.
Reprinted with permission from the authors
between the two routes, viz. cognitive learning style, emotional problems, attentional problems, and teaching. In the figure, thin arrows indicate the indirect route and thick arrows the direct route.

The starting point for both routes is when the reader fixates a printed word (VA). The letters are recognised (LR), and parsed (P) into segments of various sizes (letters, syllables, morphemes, or words). These three processes are considered to act in both the direct and the indirect routes.

If there is a representation of the written word in the mental lexicon, the direct route can be activated. After parsing, a direct connection is made with the lexicon, involving word recognition (OR1), semantic activation (SA) and phonological retrieval (PhR2). Word recognition (OR1) activates both the semantic (SA) and phonological retrieval (PhR2) of the word in parallel. The phonological knowledge is the basis for the articulation of the word (AP).

If there is no representation of the written word in the mental lexicon, the indirect route will be activated. After the first three steps (VA, LR, and P) the phonological recoding process (PhR) will be activated. During this process segments of the printed word (letters, syllables, etc.) are recoded sequentially into phonological equivalents, using grapheme–phoneme conversion rules. This information is stored in the verbal short-term memory (V-STM) and the segments are synthesised (PhS) into a phonological representation, which is the basis for phonological word recognition (PhR1). The synthesis into phonological representations (PhS) is thought to act more or less in parallel with the phonological recoding process (PhR), which in its turn leads to semantic activation (SA). After the phonological synthesis has acted, the word can also be articulated (AP) without a connection to lexicon (which applies to novel words or nonwords). Lexicon is permitted to interact with all processes involved in the indirect route, and feedback processes as well as interaction are also permitted between the three sub-processes (phonological recoding, storage in short term memory, and phonological synthesis).

Visual analysis (VA), letter identification (LR), and parsing (P) act in both routes, as well as semantic activation (SA) and the articulatory process (AP). Therefore a deficiency in any of these processes results in difficulties in the acquisition of both strategies. It is pointed out that deficiencies in processes that only act in the indirect route can result in difficulties in the development of the direct strategy as well, presumably since the orthographic representations in the mental lexicon is thought to be built up.

---

It should be noted that parsing in this sense refers to a process in which the input is segmented into orthographic constituents of various sizes, and should not be mixed up with parsing referring to syntactic processing (e.g. Rayner & Pollatsek 1989). The model does not account for syntactic or other higher-order processes.
through recurring recoding of words.\textsuperscript{11}

Dual-route models aim to explain empirical observations in reading research. The direct route, it is claimed, explains, for instance, frequency effects in naming or word recognition and how exception words (i.e. irregularly spelled words, 2.3.2) can be decoded. The indirect route, it is claimed, explains how words that have no entry in the mental dictionary (i.e. nonwords or novel words) can be decoded. Empirical findings revealing specific impairments regarding the ability to decode nonwords (‘phonological dyslexia’) or exception words (‘visual dyslexia’) are also used as evidence of there being two separate routes.\textsuperscript{12}

However, dual-route models take into account neither evidence revealing lexical effects on nonwords (e.g. Baron 1979, Glushko 1979, 1981),\textsuperscript{13} or evidence of regularity effects for real words. In consequence, dual-route models have been criticised for insisting on the distinction between the two separate routes. The critics assert that there are other means of identifying printed words than by the two hypothesised routes, for instance by making analogies between spelling patterns of known sight words and novel words (e.g. Baron 1979, Glushko 1979, 1981, Goswami 1986, 1993).

Ehri’s (1992) model is a partly modified dual-route model with an alternative concept of the direct route. In it, the direct route also involves letter–sound connections. Sight word reading in Ehri’s model is based on word-specific visual–phonological connections, while the direct route in traditional dual-route models is based on arbitrary visual cues (Bjaalid et al. 1997). The prominence given to phonology is also a distinguishing feature in Ehri’s model of reading development (see Ch. 3).

Bjaalid et al. (1997) propose a modified model that is an amalgamation of dual-route models (e.g. Høien & Lundberg 1997, 2000) and connectionist models (e.g. Seidenberg & McClelland 1989). A major distinction from traditional dual-route models is that the model allows lexical (the ‘direct route’) and sub-lexical (the ‘indirect route’) processes to interact. Thus the model take evidence of the involvement of larger sub-lexical units than letters in nonword reading into account (e.g. Baron 1979, Glushko 1979, Goswami 1986) as well as evidence that the lexical route is dependent on phonology to some extent (Stanovich 1991, Ehri 1992). The model also involves a route from the visual processor to the phonological processor by way of semantics (similar to ‘logographic reading’, Ch. 3). Another modification is an indirect lexical route from the orthographic processor to phonology, by way of semantics. A major distinction from connectionist

\textsuperscript{11} See also Høien & Lundberg’s model for reading development (e.g. 1997, 2000), which presupposes that an alphabetic–phonological stage precedes the development of the orthographic–morphemic stage (see Ch. 3).
\textsuperscript{12} For an overview and discussion of dyslexia and its definitions, see, for example, Tønnessen (1995).
\textsuperscript{13} The notion of lexical effects on nonwords implies, for example, that readers generally find it difficult to reject nonwords when these resemble real words.
models is the assumption of different – but highly interrelated – routes for word recognition instead of one interconnected system (see 2.1.2). The modified model is also designed to be compatible with both skilled reading and emerging reading acquisition according, for instance, to Frith’s (1985) model for reading development.

Another modified version of dual-route models is the more complex three-route model proposed by Morton and Patterson ([1980] 1987, Patterson & Morton 1985). In their model, the non-lexical route consists of two sub-systems, viz. a grapheme–phoneme conversion mechanism and a ‘body’ system that makes use of correspondences at the rime level (which is compatible with evidence of lexical effects on nonword pronunciation). The direct route is split into two routes: a semantic route and a non-semantic route. It is assumed that the latter does not contact the semantic system (the non-semantic route is compatible with evidence of non-semantic reading).

2.1.2 Connectionist models

One major difference between dual-route models and connectionist models is that the latter do not generally operate with two distinctly different processing mechanisms (i.e. the two routes). Instead, they emphasise one single procedure for computing phonological representations from orthographic representations.

Connectionist models of word recognition (e.g. Harm & Seidenberg 1999, Seidenberg & McClelland 1989) are computer-based simulations designed to mimic human performance in skilled and impaired word reading and (in some cases) learning to read words. For that purpose, a computer model is developed, in which a number of simple processing units act; these units are connected into a network. The models aim to be compatible with variations in lexical decision and naming tasks, such as frequency effects, regularity effects based on orthography, etc. (see also 2.3), as well as different types of reading impairments. To mimic impairments, various aspects of the models are changed. For example, the network of connections can be ‘lesioned’ to produce a damaged network. In models aiming to mimic the process of learning to read, the system is self-trained in the sense that it sets up interim rules by comparing input data with feedback given the system. Other models do not include such a learning mechanism (e.g. ‘interactive activations and competition’ (IAC) models). Connectionist models of word recognition are either interactive or autonomous, that is the various sub-processes in word recognition are either allowed to interact

---

14 For an introduction to connectionist models in general, see, for example, Schneider & Graham (1992); for an overview of connectionist models of word recognition, see, for example, Harley (2001).
with one another, or they are thought to act autonomously with no connection between levels. (For an overview, see Harley 2001.)

An influential connectionist model of word recognition is briefly presented below, namely Seidenberg & McClelland’s (1989) interactive activation model.

The Seidenberg & McClelland framework assumes that at least three codes are computed in reading, viz. the orthographic, phonological, and meaning code, and in the model interaction is allowed between the three codes. There is one route from orthography to phonology by way of semantics (see also the revised dual-route model, Bjaalid et al. 1997), and another route from orthography to phonology. However, as opposed to dual-route models, this route does not involve pronunciation rules (cf. the indirect, or phonological, route); nor does the model involve a lexicon with entries corresponding to individual words. Instead it contains a learning mechanism (‘back-propagation’) that learns correspondences between orthographic and phonological patterns through experience with the spelling–sound correspondences implicit in the set of words with which the model is fed.

Seidenberg & McClelland also assume that “word processing can be influenced by contextual factors arising from syntactic, semantic, and pragmatic constraints” (1989:526), though they point out that “the scope and locus of these effects is a matter of current debate” (ibid). Also, they assume that these aspects are more important in comprehension processes than in word recognition. In addition to the processing units, the model includes ‘hidden units’, which act as mediators between the processing units. The reason for including hidden units is that processing capacity is thought to be too limited when it is dependent on direct connections between the main units. However, one thing that is not explicitly accounted for is how these hidden units are thought to act.

In the 1989 article, a simplified model of the overall framework is implemented in a computer simulation. In short, the implementation does not contain the semantic and contextual levels. Instead, only the orthographic (input) level, the phonological (output) level, and the interlevel of hidden units between the two, are preserved. Another simplification is that the model implemented does not involve feedback from phonological units to hidden units. Consequently, the phonological level cannot influence the construction of representation at the orthographic level. However, feedback is allowed between the hidden units and the orthographic level.

Each of the two levels, orthography and phonology, involves a large number of separate units, which are initially set at random weights.15 The learning mechanism changes the weights of these units along with the process in which the model learns to associate orthographic input with the phonological units. The implementation aims to mimic oral reading, making

---

15 In earlier computer simulations, weights were set by hand.
the output of the model a phonological representation. To measure the correctness of the response, the model measures the degree of activation for different phonemes. For example, if the input string is <hot>, a correct output would be /hɔt/. Activation of units in which these three phonemes are all present is considered a correct response. However the model does not permit activity to be entirely on (1) or off (0); instead activation is somewhere in between these extremes. Thus, all output units are activated to some extent. In order to evaluate correctness, a number of presumed false responses (in the example, all combinations that differ from /hɔt/ by exactly one phoneme) are compared with the activity of the correct phoneme sequence. A response is regarded as incorrect if the correct target is beaten by any of these competing targets regarding activity of the output units.16

Seidenberg & McClelland claim that their model is applicable to both normal and impaired reading, and that the procedure for computing phonological representations from orthographic representations is applicable to both regular and irregular words, and to nonwords or novel words. However, Coltheart et al. (1993) refute five out of six important aspects of reading that the Seidenberg & McClelland model has been claimed to be compatible with. Instead, Coltheart et al. advocate a dual-route cascaded model.

Connectionist models have been criticised for ignoring the fact that at the beginning of reading acquisition children normally have a considerable amount of phonological knowledge (see Bjaalid et al. 1997 for a discussion). Instead, the models assume that the phonological store is unstructured beyond the phoneme level. This must of course also be a weakness in a model that claims to be applicable to skilled reading.

However, as opposed to the original dual-route models, connectionist models are compatible with empirical results revealing that nonword reading involves sub-lexical processes including larger units than letters or graphemes. They are also compatible with evidence of phonological processing in sight word reading. (The modified variants of dual-route models proposed by Bjaalid et al. 1997 and Morton & Patterson [1980] 1987 are also compatible with these aspects, see p. 12 f.)

2.2 Models of reading

Two main types of models of the reading of running texts can be discerned. On the one hand there are interactive models, in which the various sub-processes in reading are assumed to interact. In these models the different processing levels act simultaneously. Examples of interactive models are

16 However, as Coltheart et al. (1993) point out, if using this criterion, responses that differ in length could get higher levels of activation, without being detected as errors.
Just & Carpenter (1980) and Perfetti & Roth (1981). On the other hand there are autonomous processing models (e.g. Gough 1972), in which the sub-processes are assumed to act through independent processing modules (see Fodor 1983).

Below, two influential models are presented, namely Just & Carpenter’s (1980) interactive model and Gough’s (1972) modular model. Both models are based on results from experimental studies, but they make completely different claims about the nature of the reading process. Furthermore, the ways in which the two models are constructed differ greatly. The outline of Just & Carpenter’s model is based on an experiment in which the aim was to create a reading situation that was as realistic as possible. (However, that experimental study in its turn was constructed to test evidence from previous experimental studies, for example, on word recognition.) They used real, running texts, since they presupposed that the various sub-processes involved in reading interact. Gough, in contrast, used an abstract model that was assumed to be compatible with various experimental data on single-word reading and visual processing. This approach is in line with the presupposition that the reading process is a serial, bottom-up process, with no interaction between sub-processes, and that the reading of running texts is more or less equivalent to single word reading (with the only difference being that a number of words must be processed simultaneously).

2.2.1 Just and Carpenter’s interactive model of reading

According to interactive models, higher linguistic levels affect lower linguistic levels and vice versa. That is, expectations based, for example, on syntax or semantics are thought to affect the processing of words or graphemes in decoding, and signals from lower levels (e.g. graphemes) are thought to affect decisions at higher levels.

Just & Carpenter (1980) describe their interactive model as an attempt to relate to the whole on-line reading process, as opposed to models based on single word decoding (e.g. Rumelhart 1977) or models that only take more general aspects of reading into account, and thus ignore lower levels (e.g. Kintsch & van Dijk 1978). Just & Carpenter’s model is based on an eye movement study, in which college students read scientific texts, with the explicit instruction to read for understanding, and to be able to retell the contents of the texts.

The model is based on a number of assumptions about what might influence the reading process, such as text-specific factors, for example, text-grammar (Kintsch & van Dijk 1978), syntax, word frequency, and word length, as well as factors that are not text-specific, such as the reader’s reading goals. Most of their assumptions derive from evidence from previous experimental findings on eye fixation times, depending on various textual conditions.
The foundations of the model are two main assumptions, namely the ‘immediacy assumption’ and the ‘eye–mind assumption’. The ‘immediacy assumption’ presumes that the reader concurrently interprets each content word at a number of linguistic levels, i.e. word decoding, lexical meaning, assigning the word to its referent, and assigning the status of the word at the discourse level. The ‘eye–mind assumption’ presumes that the word is fixated for the amount of time these processes require to be completed. The choice of an eye movement experiment relies heavily on this second assumption, and consequently, the validity of the results also relies on the validity of the ‘eye–mind assumption’.

In the model, the reading process is described in five main steps, viz. ‘get next input’, ‘encoding and lexical access’, ‘case role assignment’, ‘inter-clause integration’, and ‘sentence wrap up’. All of these aspects are presumed to affect processing time, and, according to the ‘eye–mind assumption’, they will be reflected in the fixation times of the various words or sectors in a text.¹⁷

One crucial part of the reading process as described in the model is not fully compatible with the notion of interactivity, namely word encoding and lexical access. The model assumes that lexical access acts after the distinctive features have been recognised by the cognitive system and have been transited to working memory. Such an assumption is more in line with bottom-up models. (This divergence from a fully interactive perspective is not discussed by Just & Carpenter.)

To connect to models of written word recognition (see 2.1), at the word level, the syllable is thought to be the natural unit for decoding, but under certain conditions, phonological recoding or direct access are possible alternatives (however, what these certain conditions might be is not clearly accounted for in the description of the model).

Concerning lexical access, Just & Carpenter claim that three major factors can activate the meaning of a word, namely (1) ‘perceptual encoding’, i.e. that the encoded representation of a word activates its meaning, (2) ‘spreading activation’, i.e. that a previously decoded word has activated other closely related concepts, and (3) ‘serial production’, which means that if a concept has been activated above a threshold level, there will still be a pointer to this concept in the working memory for some time. This will make it easier to activate that particular concept if a subsequent process reactivates it.¹⁸ Regarding ambiguous words, the most common interpretation is assumed to have a higher level of activation, provided, for instance, that spreading activation has not eliminated activation or that the interpretation at other linguistic levels does not bias the interpretation of the word in another direction. This is in line with the commonly held view of the

¹⁷ A ‘sector’ refers to a unit consisting of one or a number of words judged to be a single meaningful piece of information.
¹⁸ This assumption is in line with Morton’s logogen model (e.g. 1980).
working memory as having a limited capacity, as well as with experiments giving evidence that multiple meanings of ambiguous words are initially activated, but that the ‘wrong’ senses decrease very rapidly in activation (for an overview, see e.g. Harley 2001).

For novel words, the model assumes that when the reader comes across a new word, a perceptual representation is built up (phonological and orthographic) and this representation is then associated with the syntactic and semantic properties implied by the context, after which a new entry in the mental lexicon is created.

On the one hand, Just & Carpenter claim that there is no single reading process, but that it is a function of who is reading (the individual’s reading ability and knowledge of the world), what is being read (different text types), and why the text is being read (reading goals and the reading situation). On the other hand, they aim to present a model of reading that is valid for describing the reading process as such, not only the reading process in certain specific circumstances.

2.2.2 Gough’s modular reading model

Gough’s model (e.g. 1972) assumes that processes at different levels act independently of one another in a modular fashion (Fodor 1983). The model works in a strictly serial bottom-up fashion. Modules processing lower levels are thought to ‘pass on’ information to modules processing higher levels, and eventually the information obtained at the different levels is amalgamated into a meaningful entirety. According to the model, word decoding is always non-lexical, and letter-by-letter decoding is assumed (similar to the ‘indirect route’ in dual-route models).

Gough constructed an abstract model based on evidence obtained in experimental studies on word recognition (single words) or visual processing in general, as well as on experiments regarding the capacity of the short-term memory. Gough assumes that the reading of running texts is more or less equivalent to word reading (see also p. 7 f.), the only difference being that in reading running text, more than one word is processed at the same time, and therefore several processes must act simultaneously, but with no interaction between the sub-processes. As an argument for the hypothesis that words are processed without interaction between levels, Gough refers to experimental studies on ambiguity that have shown that processing time for phonemes is longer when they follow an ambiguous word, and that all

---

19 The assumption that a number of words are processed at the same time is based on two facts. Firstly, previous studies on eye movement revealed an average of 250 milliseconds for fixations of words in running texts. Secondly, in a tachistoscopic study it took around one second for Gough to pronounce the first word of the sentence in running texts.
interpretations of ambiguous words are activated (compare, however, Just & Carpenter 1980).

According to the model, the reading process begins with the eye fixating a word in a text, which leads to an activation of an iconic representation of the word. This representation is only available for a brief moment, and is thought to be an exact visual image of the stimuli. During the fixation, a feature analysis is made, and the visual input is recognised as a string of letters. The assumption that words are processed letter-by-letter is based on word recognition studies revealing length effects at letter level. Gough claims that word effects revealed in other experiments are actually due to later processes.20

After the iconic image has been recognised as a string of letters, an abstract phonemic representation of the word form is created. Evidence for this assumption is found in the fact that subjects find it difficult to reject nonwords when these are homophonous with an existing word. Gough argues that if a connection to a visual entry was made, these effects would not be found.21 Furthermore, he claims that a lexicon with each word being represented as a visual unit would be too capacity-demanding.

Since words are thought to be processed one at a time, they are assumed to be stored in primary memory until all words in the sentence have been decoded and can be organised into a whole. Gough assumes that when a number of words have been processed into sentences, the structure can be moved from the primary memory to a place with a better capacity, denoted ‘the Place Where Sentences Go When They Are Understood’ (PWSGWTAU), which is assumed to be located in secondary memory.22 Gough does not account for how the process in PWSGWTAU acts; instead he describes it as a magic process performed by a ‘Merlin’.

2.2.3 Some methodological remarks

It is quite clear that hypotheses about the reading process to a large extent affect the choice of experimental methods chosen for trying out the model of reading. The main experiment on which the Just & Carpenter model is based is the one that is closest to a normal reading situation. This enables them to investigate a number of parameters at the same time. However, one problem with this kind of experimental approach is that it is difficult to control. What seems to be manifested when analysing one level may be a

---

20 The notion of ‘word effects’ refers to the fact that a string of letters that forms a word – or is pronounceable – is recognised faster than a string of letters that cannot be pronounced.

21 In a way this claim presupposes readers always being proficient spellers. These ‘homophone effects’ could also be due to a vague notion of the spelling of particular words, i.e. that the visual representation in the mental dictionary is not always exact.

22 The basic higher unit in Gough’s model is the sentence level.
result of factors at another level. Just & Carpenter made regression analyses in order to eliminate these effects, which of course makes their results more reliable. However, in all experimental studies factors not in focus might affect the results. One example in Just & Carpenter’s study is that orthographic complexity is only measured in terms of word length (number of syllables). In their discussion about the processing of unusual words it is obvious that other factors than the degree of unusualness can affect fixation times, since words like *staphylococci* and *thermoluminescence*, which are given as examples of unusual words, also contain complex orthographic structures foreign to English orthography.

Gough does not, however, use a specific experimental study (apart from the tachistoscopic study mentioned in note 19, p. 18). Instead, evidence from various experimental studies of single word reading is used. One advantage of such studies is that they are easier to control. However, as mentioned above, factors that have not been controlled for might affect the data. Moreover, we cannot be sure that we can draw conclusions about reading in a normal reading situation from data deriving only from single word reading in an experimental condition.

The point of departure for the present investigation was to analyse the utilisation of various linguistic levels in reading (see 4.1), and I have assumed that the choice of running texts (similar to Just & Carpenter 1980) would make it possible to discern various strategies among the readers (see 4.2).

### 2.3 The role of different linguistic levels in reading research

The present investigation analyses the utilisation of a number of linguistic levels in beginners’ reading of running texts, with the overall aim of examining the extent to which levels higher than the graphemic level were utilised (see 4.1). In previous research, different linguistic levels have been given different prominence, and the aim of this section is to present some of the evidence that has been obtained regarding these matters.

The first part of the section deals with various aspects that can be associated with lower linguistic levels, such as phonological awareness, spelling structure, and orthographic regularity. These aspects have received a great deal of attention in recent decades. In connection with orthographic regularity, some comments on Swedish orthography are made. The second part of the section deals with the role of higher linguistic levels, such as syntax and textual context.
2.3.1 Phonological awareness

In recent decades, a great deal of research has focused on the role of phonological awareness for successful reading development (e.g. Blachman 1994, 1997, Brady 1997, Goswami 1986, Høien et al. 1995, Torgesen et al. 1994, Treiman & Zukowski 1996, Tunmer 1991, Vandervelden & Siegel 1995). The underlying argument is that for alphabetic scripts, the sounds in the language are systematically related to the symbols in the script, and the child who is able to objectify language and especially, who has realised that words are built up of a number of constituents without meaning (syllables, rhymes, phonemes), will more easily discover the systematic relationship between sounds and symbols in the orthography. Most scholars agree that phonological awareness and success in reading acquisition are interrelated at least to some extent. The term ‘phonological awareness’ is, however, relatively vague, and has been used to cover various aspects of metalinguistic abilities. Firstly, a number of linguistic levels at the sub-lexical level have been in focus (such as syllables, rhymes and phonemes). Secondly, the ways in which phonological awareness has been measured vary greatly in terms of cognitive demands (see Treiman & Zukowski 1996, Yopp 1988). It is also striking that the notion of the phoneme is seldom discussed in depth, although there are good reasons for doing so, especially in relation to aspects such as coarticulation, assimilation, etc. (e.g. Liberman & Shankweiler 1991, Lindblom 1983, Vihman 1996).

It has generally been found that children manage to master metalinguistic tasks involving larger linguistic units, such as rhymes, earlier in development than they manage to master tasks involving smaller linguistic units, such as phonemes. A correlation has been found between the more specific phonemic awareness and reading success (e.g. Høien et al. 1995). Although many scholars agree that phonological awareness (especially phonemic awareness) and successful reading are interrelated, there are different views about to what extent phonological awareness is a prerequisite for (e.g. Høien et al. 1995, Lundberg 1991), or a result of mastering the alphabetic code (e.g. Morais 1991, Muter et al. 1997).

---

23 A great deal of research has been performed related to non-alphabetic scripts as well, and it has been claimed that reading ability and phonological awareness are also interrelated for readers, for example, of logographic scripts (e.g. Ho & Bryant 1997).

24 In Swedish publications, the even less specific term ‘linguistic awareness’ is often used.

25 For a thorough discussion of metalinguistic abilities, see Gombert (1992), who also discusses the fact that this term has been used to cover unconscious, ‘epilinguistic’, abilities as well as more conscious, ‘metalinguistic’, abilities.

26 See, for example, Treiman & Zukowski (1996) for a discussion of unit size vs. linguistic level.

27 See, for example, Seymour et al. (1999) for an opposite view, and Szcerbinski (2001) for contrasting evidence from Polish, a language in which rhyming words are infrequent.
Liberg (1990) and Söderbergh (e.g. 1986) both claim that phonological awareness is not a prerequisite for reading development. Söderbergh (1986) claims that phonological awareness may follow as a consequence of learning to read, while Liberg (1990) argues that when phonological awareness is tested by questions such as (1), the child is involved in a kind of activity that is common in traditional teaching of reading.

(1) Which/How many sounds are there in the word ‘sun’?
Which sound comes after/before /i:/ in ‘police’?

Liberg argues that phonological awareness measured using tasks like the questions in (1) and success in reading cannot be interrelated since they are actually the same, only performed in different media (spoken and written). Regardless of whether or not we agree with Liberg’s view, it is not surprising that a correlation is found between success in answering the kind of questions above (or manipulation tasks, like phoneme deletions or spoonerisms) and success in reading. The child who can master tasks like (1) is aware of the phonemic level, and has also grasped the sequential order of the units. To convert these insights regarding the auditory medium into the visual medium is probably not a very complex task.

The importance of the rime-level has also received attention in recent decades (e.g. Goswami 1986, Goswami & Bryant 1990, Treiman 1992, Treiman & Zukowski 1996). In this research children’s ability to make analogies is in focus, and it is claimed that beginning readers make use of analogies at the rime-level in decoding (see p. 12). Opponents of this view claim that the rime-level is of little importance; instead the phonemic level is considered to be the key level (e.g. Ehri & Robbins 1992, Høien et al. 1995, Seymour et al. 1999). It is worth noting that evidence used as a basis for claiming the importance of the rime-level has, as a rule, been based on monosyllabic words, and furthermore on findings in the reading of English. It is a well-known fact that in English orthography there is a complex relationship between graphemes and phonemes, especially concerning vowels (e.g. Venezky 1970), while the relationship between written and spoken vowels is less complex when considering whole rimes, especially in word-final position. Texts adapted for beginners often consist of monosyllabic

---

28 That is, when the teaching of reading and writing is carried out in a traditional programme, using the “static language sign” (Liberg 1990:156).
29 Each syllable can generally be divided into two main parts, ‘onset’ and ‘rime’. The onset consists of the first consonant(s) (if any) in the syllable, while the rime consists of the following vowel plus the following consonant(s) (if any). For example, the word *cat* consists of the onset *c-* plus the rime -*at*. Thus, in monosyllabic words the rime unit coincides with the more general concept ‘rhyme’ (*h-at* – *c-at*), while this is not the case in polysyllabic words (cf. the first syllable in *vowel*, which consists of the onset *v-* plus the rime -*o*).
words and consequently the rime unit in these words corresponds to rhyme (see note 29, p. 22).

2.3.2 Spelling: structures and regularity

Two studies (studies 3 and 4) in the present investigation investigated reading errors associated with different aspects of spelling. It was assumed that the spelling could affect the extent to which words resulted in reading errors (see 4.2).

One aspect of spelling concerns the graphemic (and phonological) structure of the words. In reading research, word length effects have been found in studies on word recognition. For example, longer words (measured by numbers of syllables or letters) have been found to produce longer fixation times and to take longer to identify and name. Some conflicting evidence has been obtained regarding lexical decision tasks, though these results might be biased by other measures (for an overview, see Balota 1994). Studies on reading and writing among beginners have suggested that complex spelling patterns, such as consonant clusters, contribute to children’s difficulties (e.g. Bruck & Treiman 1990, Treiman 1993; see Wimmer & Landerl 1997 for deviating results on German speaking spellers).

Another important factor associated with reading is spelling-to-sound regularity in words (Stanovich 1991). This refers to the consistency of mappings between the letters in the word and the sounds in its pronunciation. It is often assumed that there are two main classes of words, namely regular words (e.g. made, cat), in which the pronunciation reflects common spelling–sound correspondences, and irregular words (e.g. isle, colonel, yacht), in which the pronunciation reflects atypical spelling–sound correspondences. In models of the reading process, such as dual-route models, it is sometimes assumed that regular and irregular words are decoded in different fashions (see 2.1.1). However, the extent to which words are regular or irregular is not a matter of either/or; instead, regularity is a continuous variable (Stanovich 1991). The concept of regularity is also related to ‘transparency’ and ‘consistency’. Szczersinski (2001) gives an overview of the use of these terms and how they relate to one another (see also Patterson & Morton 1985). In the following, a brief account of these three somewhat overlapping concepts is given.

Transparency

Transparency refers to the relationship between graphemes and phonemes in the orthography (see also ‘orthographic depth’, 2.3.3). In a fully transparent alphabetic system there would be a one-to-one relationship between the sounds and their graphic symbols. That is, each grapheme (single letter or letter cluster) would represent exactly one phoneme, and each phoneme would be represented by exactly one grapheme, regardless of its position in the word. Below, a one-way perspective is used, since in reading only the
way in which the graphemes represent phonemes is relevant, while the reverse holds true for writing. No existing orthography can be regarded as fully transparent, although the phonetic script (IPA) can serve as an example of such a system. Finnish is an example of an existing orthography with high correspondences between graphemes and phonemes.

Regardless of the extent to which an orthography is transparent, individual words in a particular orthography may be more or less transparent (if applying a more lenient definition of transparency, i.e. one that does not presuppose a complete one-to-one grapheme–phoneme relationship). A word could be considered transparent when its pronunciation can be worked out by using knowledge of the most typical sound values of the graphemes in the spelling, or by using letter names (Szczerbinski 2001). Some English examples are *cat, not, chap,* and some Swedish examples are *katt ‘cat’, tro ‘believe’, lång ‘long’.* The definition is, however, quite vague. For instance, how do we define “most typical sound values”? Swedish vowels generally differ in both quality and quantity depending on stress, length, the phonemes that follow, etc. (see also p. 27 ff.). Should all these variants be considered “most typical sound values”? In Study 4 in the present investigation a division into three sub-levels of transparency was applied (p. 56 f.).

**Regularity**

Regularity refers to the extent to which the relationship between graphemes and phonemes can be described in a systematic way and is thus subject to ‘orthographic rules’. In English one such rule concerns the ‘silent e’ (e.g. the systematic difference in the spelling and pronunciation of word pairs like *hat–hate;* by applying the ‘silent e’ rule we can work out the pronunciation of e.g. the nonword *fit*). To decide to what extent a spelling is regular, both the position of the grapheme and the graphemic/phonological context must be considered. In Swedish, for example, the pronunciation of an initial <c> generally depends on the vowel following (which is also the case with initial <c> in English). Thus, transparent words are always regular, but the reverse does not follow. Some regular words are transparent, while others are not.

**Consistency**

Szczerbinski (2001) describes the notion of consistency in relation to transparency and regularity in the following terms:

> The notions of transparency and regularity are used primarily to describe individual grapheme–phoneme correspondences extracted from contextual and positional effects as far as possible. Consistency, on the other hand, deals with correspondences in a specific ‘environment’ (certain preceding and following letters, given position within a string) and can be applied to the analysis of

---

30 However, there might be exceptions (or irregular cases) to the rule, cf. *pint* and *come,* which both break the ‘silent e’ rule.
Clearly, there is a great deal of overlap between the concepts of regularity and consistency. For example, given the above definition, the pronunciation of the initial letter <c> in different contexts could be described in terms of both regularity and consistency. However, while irregular words have to be inconsistent, the reverse does not follow. It is possible therefore to identify a number of orthographic rules that are not fully consistent. The extent to which spelling (or pronunciation) is consistent is determined by computing the relative frequencies of alternative pronunciations (or spellings) of identical spellings (pronunciations) in the same position within words, i.e. in the word’s ‘neighbourhood’ (in this case, the pool of words sharing the target graphemes or phonemes in the same position in a word). An example of regular but inconsistent spelling in English is the rime -ove, for example in stove. The word stove obeys standard grapheme–phoneme conversion rules (e.g. the ‘silent e’ rule), but has several ‘enemies’ (e.g. love, dove, move). Other spellings are more consistent, but still have the odd enemy in the word neighbourhood, for example, mint (hint, tint, lint, etc., but pint). Words generally tend to show a higher level of consistency when larger units than the letter-level are considered (this also applies to regularity) (see e.g. Jared 2002). In English, the rime-level has received particular attention (e.g. Glushko 1979, Goswami 1986, Treiman 1993).

As Coltheart et al. (1993) have pointed out, there may be a conflict concerning the regularity/consistency between graphemes vs. ‘word bodies’ (e.g. the rime-level). For example, the most common pronunciation of the grapheme <i> in English is [ɪ], while the most common pronunciation of the word body -ind in final position is [aɪnd]. Words like mind are thus regular at the rime level, but irregular in terms of grapheme–phoneme conversion rules. Jared (2002) found that spelling-to-sound consistency rather than spelling-to-sound regularity could explain naming difficulties in her studies on skilled readers.

---

31 Consistency in neighbourhoods can be computed in two ways. A type count compares the number of ‘friends’ (i.e. words sharing a particular pronunciation, e.g. head, dead, lead [noun]) with the number of ‘enemies’ (i.e. words with alternative pronunciations, e.g. bead, lead [verb]). A token count involves the same comparison, but is weighted by the frequency of each word (see Szczersinska 2001). See also Harley (2001) for an overview of the neighbourhood concept.

32 Although it is difficult to find these kinds of systematic differences regarding graphemes vs. word bodies in Swedish, one example is the pronunciation of the grapheme <s>. The most common pronunciation of this grapheme is [s], while the pronunciation of -sion is always [ʃuːn].
2.3.3 Orthographic depth

A great deal of research in reading has been biased towards the Anglosaxon perspective. Due to the fact that orthographies vary, for instance regarding correspondences between graphemes and phonemes, the orthography as such might affect readers’ inclinations to use different strategies. For example, a sounding-out strategy might be more beneficial in an orthography in which the relationship between graphemes and phonemes is uncomplicated (e.g. Finnish) than in an orthography with a more complex relationship between graphemes and phonemes (e.g. English). In the present investigation, I assume that aspects of the Swedish orthography might influence the results. In the following, a brief overview of the concept of ‘orthographic depth’ is given, and some of the major aspects regarding the Swedish orthography are dealt with. For a more thorough discussion, see Study 4, in which word transparency was in focus.

In recent decades, numerous studies have found systematic differences across languages in the reading process of beginning or dyslexic readers of alphabetic scripts (e.g. Goswami et al. 1998, Landerl et al. 1997, Miller Guron & Lundberg in press, Öney & Goldman 1984). These differences have often been explained by differences in the complexity of the relationship between graphemes and phonemes in the orthographies in question, i.e. in their ‘orthographic depth’ (Frost & Katz 1992).

According to the ‘orthographic depth hypothesis’ (e.g. Katz & Frost 1992), differences in orthographic depth should lead to processing differences in lexical naming and (visual) word recognition in the sense that shallow orthographies are thought to more easily support word recognition processes that are (partly) based upon phonology, even for proficient readers. Beginning readers generally find it easier to learn to read in shallow orthographies than in deep orthographies (e.g. Cossu 1999, Cossu et al. 1995, Ellis & Hooper 2001, Thorstad 1991, Öney & Goldman 1984).33, 34

Alphabetic scripts can be placed along a continuum regarding their presumed orthographic depth. Finnish, Italian and Serbo-Croatian are examples of shallow orthographies (e.g. Cossu 1999, Cossu et al. 1995, Ognejovic et al. 1983), while English qualifies as an example of a typical deep orthography (e.g. Sampson 1985, Shankweiler & Lundquist 1992). Swedish orthography, the focus of the present study, may be placed somewhere in the middle of this continuum. A shallow orthography must be more or less phonological and is, by definition, transparent. That is, the orthographic system renders the surface sound form of words, using an alphabetic or

---

33 See Szczcerbinski (2001) for an extensive overview of cross-orthographic studies regarding this matter.
34 However, it is not only the way in which sounds map to letters in an orthography that adds to potential difficulties in reading and spelling in a specific language. Other factors, such as assimilation and coarticulation, could also be highly relevant, as well as complex graphemic/phonological structures, etc. (see Lundberg 1999, Olofsson 2003).
syllabic principle. In cases when the phonological form of a morpheme is changed due, for example, to assimilation processes, the spelling of the morpheme in a typically shallow orthography varies. This is always the case in Serbo-Croatian, for instance. In Swedish there are examples of such variants of the spelling. One example is the regular morphemes marking past tense, for example, spill-de vs. åk-te, where the spelling of the morpheme mirrors the pronunciation (i.e. voiced [d] or unvoiced [t], depending on the preceding consonant). Deep orthographies, on the other hand, involve the morphological principle. In such orthographies, orthography represents the underlying morphological structure of words (for example the spellings of the regular morphemes marking past tense in English, walk-ed vs. mov-ed, where the last phoneme is unvoiced in the former verb, but voiced in the latter, but in both cases spelled with a <d>). In Swedish there are also examples of the morphological principle governing spelling. This can be illustrated by hög [ho:ɡ] ‘high’ vs. högt [hœkt] ‘highly’, where the latter is spelled in accordance with the morphology of the word, preserving the spelling of the word-stem hög even though assimilation processes lead to a pronunciation with an unvoiced [t].

Hence, transparency and orthographic depth are closely interrelated concepts. As was discussed above (2.3.2), transparency is a fairly broad concept, though, and aspects such as regularity and/or consistency of spellings could also be expected to affect the reading process (Jared 2002). A deep orthography always implies non-transparency, but not necessarily irregularity and inconsistency. That is, even when the spellings in a language do not consist of one-to-one relations between letters and sounds, the spelling can be more or less consistent when larger units than the letter-level are concerned (see p. 25).

In most orthographies that are not fully transparent, we can find individual words with various degrees of transparency. For example, in English we find both transparent and opaque spellings of words; the spelling of cat is considered transparent, since there is only one possible pronunciation of that combination of graphemes in English (as long as it is not a sub-part of another word, of course), while the spelling of bead is considered opaque, since the rime -ead has more than one possible pronunciation (e.g. lead [verb] and head). It is possible that individual words with various degrees of transparency in any alphabetic script differ in terms of their difficulty to decode, especially for beginners. Study 4 in the present investigation focuses on this aspect.

Swedish orthography
Below, some comments on Swedish orthography are made. For a more thorough description, see Study 4.\(^{35}\)

\[^{35}\] See also Olofsson (2003) for an overview.
In many alphabetic scripts, including Swedish, grapheme-to-phoneme mapping (i.e. reading) is on the whole less complicated than phoneme-to-grapheme mapping (i.e. spelling) (e.g. Bosman & van Orden 1997, Wimmer & Landerl 1997). In Swedish, there are usually only one or two possible pronunciations of a grapheme, while there could be a number of alternative ways of spelling a phoneme in Swedish, especially for some consonantal phonemes, depending on factors such as the etymology of the word in combination with which vowel sound follows the consonant.

One general feature of Swedish orthography is that the relationship between written and spoken vowels is less complicated as a rule than the relationship between written and spoken consonants (e.g. Hellberg 1974, Hultman 1969). In Swedish, digraphs (e.g. <ng, tj, kj>) or triplets (e.g. <sch, stj>) can only consist of consonantal graphemes, and some consonantal graphemes, such as <k> and <g>, have different pronunciations depending on factors such as the vowel following.

All Swedish vowels have a long and a short allophone, and to a certain extent these allophones differ in quality as well as in quantity. Yet, in general, the same grapheme is used for both allophones, for example, the grapheme <a>, which is used both for the long [a:] and the short [a]. In some cases one grapheme can denote different phonemes, for example, <o> (pronounced [u:] in the alphabet). This grapheme is used not only for the phoneme /u/, which may be long, [u:], or short, [ʊ], but also for the phoneme /o/, which may be long, [o:], or short, [o]. The two latter sounds can also be spelled with the grapheme <å> (pronounced [o:] in the alphabet). Conversely, the phoneme /e/ can be spelled with two different graphemes, namely <e> or <ä>, but only for the short vowel; long [e:] is practically always spelled <ä>.

All stressed syllables are heavy, and exhibit complementary distribution of quantity between vowels and consonants. Each stressed syllable has exactly one long sound. Thus, if the vowel is long, the consonant following is short, and if the consonant is long, the preceding vowel is short.

In the orthography, quantity is never marked on vowels, but in some contexts it is marked on consonants, and in yet other contexts it is predictable from other factors. This is in contrast to some other languages, such as Finnish, in which quantity for both vowels and consonants is marked directly on the phoneme in both stressed and unstressed syllables. The general rule for Swedish is that in stressed syllables consonant length is marked by gemination of the long consonant, unless one or more different consonants follow the long consonant (up to the next morpheme boundary). Some short, frequent words ending with nasals are governed by a minor spelling rule stating that these nasals should not be geminated. Thus, in reading Swedish, it is not until the reader has recoded the following consonant (and connected the spelling of that consonant to the spelling rules

---

36 In English orthography, for instance, it is the other way around (Venezky 1970).
concerning quantity, and has also as decided whether the syllable should be stressed or not) that the reader knows whether a vowel should be pronounced with the long or the short allophone.

Quantity is a well-known problem in Swedish spelling (see Lundberg 1999, Nauclér 1989, Olofsson 2003), both for beginners and impaired spellers. Even quite proficient spellers have difficulties regarding this aspect. As was mentioned above, quantity in stressed syllables is complementarily distributed between vowels and consonants. An interesting associated aspect is that generally, when talking about quantity in Swedish, we focus on vowel quantity, and people are generally unaware of the fact that consonants also differ in quantity. When children are explicitly taught gemination rules for consonants, this is generally done by focusing on the quantity of the preceding vowel, although consonantal quantity could just as well have been in focus, given the complementary distribution of quantity in stressed syllables. However, since there is generally also a shift in quality between long and short vowels, the difference between them is probably more salient than the difference between long and short consonants.

The beginning reader who is in the process of learning to read Swedish faces an orthography with words of varying degrees of transparency. Some words exhibit fully transparent spellings, with one-to-one relationships between phonemes and graphemes, for example, **ben** ‘leg’ and **bli** ‘become’. Other words are transparent given the graphemic and/or phonological context, for example, **huset** ‘the house’, in which the ending -et (definite form) must be pronounced with a short vowel sound, since it is unstressed (the first syllable is stressed). Still others are opaque even when given the graphemic and/or phonological context, i.e. there could be several possible ways of pronouncing words like **bakom** ‘behind’, **syskon** ‘brothers and sisters’, and **sen** ‘then’.

### 2.3.4 Higher linguistic levels

The role of higher linguistic levels in reading has received less attention in recent decades, when the focus instead has mainly been on the role of especially the phonemic level (e.g. orthographic depth, phonemic awareness, etc.). However, although many scholars regard the reading process as mainly a bottom-up process, driven by the print on the page, the role of higher linguistic levels is still being discussed (see e.g. Hjälme 1999, Chall 1996). In the following, a review of the role of higher linguistic levels in reading research in recent decades is given.

Some decades ago, Goodman formulated his conception of reading as a ‘psycholinguistic guessing game’:

Furthermore, when the spelling system is explained to children, the explanation often neglects the fact that quantity can only be marked in spelling in stressed syllables.
Reading is a selective process. It involves partial use of available minimal language cues selected from perceptual input on the basis of the reader’s expectation. As this partial information is processed, tentative decisions are made to be confirmed, rejected, or refined as reading progresses.

More simply stated, reading is a psycholinguistic guessing game. (Goodman 1970:260)

Goodman describes reading as a top-down process, in which the reader makes use of higher linguistic levels to avoid grapheme-to-phoneme recoding. He studied beginning readers in primary school and their performance on reading lists of words compared to reading words in running texts, and found that the readers made fewer errors when reading the texts than when reading the lists of words ([1965] 1982). Third grade readers also benefited more from reading running text than did first and second grade readers. This latter fact made Goodman conclude that the use of higher levels is the more advanced readers’ strategy, while less skilled readers tend to rely on phonological recoding.

Goodman’s claims, as well as the study they were based on, have subsequently been severely criticised (Nicholson 1993, Nicholson et al. 1988, Stanovich 1980, 1986). One obvious drawback of Goodman’s study was the fact that the list of words consisted of the same words as the running text and was read before the text. Therefore a practice effect cannot be ruled out (e.g. Nicholson 1993, Nicholson et al. 1988). Gough et al. (1992) point out that there is a great deal of evidence revealing that words cannot be effectively predicted from context, and especially not content words, which are often long and have complex spelling patterns. They state that “context will fail children exactly where they most need help” (Gough et al. 1992:38). Yet, at least in Swedish, function words are often opaque, and therefore the use of syntactical context might be a profitable strategy for the beginner when decoding these words in Swedish texts.

Goodman’s view of skilled readers’ use of higher linguistic levels can be contrasted with Stanovich’s (e.g. 1980, 1986) position. Contrary to Goodman, Stanovich claims that the use of higher levels should be regarded as a compensatory strategy for insufficient decoding skills among poor readers (see also Nicholson 1993, Nicholson et al. 1988, Tunmer & Hoover 1992). Høien & Lundberg’s model for reading development is in line with this view (1997, 2000). In their model, context is presumed to work compensatorily (see Ch. 3). Stanovich bases his position on several studies that have shown that poor readers seem to rely on context, while skilled readers do not (see e.g. Stanovich 1986 or 1991 for overviews). Among other things, Stanovich (1991) refers to eye movement studies that have revealed that skilled readers fixate words even when these could be predicted from context in combination with information obtained in parafovea (i.e. the length of following words, etc.).

However, Stanovich et al. (1984) found some contradicting evidence in their longitudinal study of first grade readers. In that study, more skilled
readers at first really benefited more from context than did less skilled readers, but less skilled readers showed the same beneficial context effect at a later time when they had reached the same level of context free word recognition as the more skilled readers. These results led Stanovich et al. to redefine their position, stating that the reader needs a certain level of decoding proficiency to be able to use context as a facilitating source, if they only have the text to depend on. Thus, if decoding proficiency is too poor, the reader will be unable to grasp the context at all. This is not equivalent to being unable to use context as a source of facilitation, as previously indicated by Goodman. Also, as Stanovich points out, reading is a very quick process once it is automated. Guessing from contextual cues, etc., would be too time-consuming for such a quick process to be beneficial. Stanovich also points out that most models of the reading process presume that expectancy based processing is generally restricted to the post-lexical level (1991).38

Another aspect of the possible use of higher linguistic levels is the notion of processing capacity. When the act of decoding is too cumbersome, there might not be enough processing capacity for the reader to make use of context at all.39 In the discussion about reading problems, difficulty in reading comprehension is often perceived as a secondary problem, resulting from poor decoding (e.g. Høien & Lundberg 1997, 2000). This position is in line with a two-component view of reading, involving two sub-processes, viz. decoding and comprehension (e.g. Gough & Tunmer 1986; for an overview, see e.g. Hoover & Tunmer 1993). Although a two component view of reading might be too simplistic (see e.g. Stothard 1994), we can assume that higher linguistic levels can only be used when decoding proficiency has reached a certain level. This notion is in line with evidence from a number of studies (e.g. Stanovich et al. 1984, Biemiller 1970, Magnusson & Nauclér 1991), some of which is discussed below.

Biemiller (1970) and Weber (1970) carried out a longitudinal study in which American beginners were followed during their first year at school. Notes were taken on their oral reading during their reading lessons. Biemiller found that first grade readers who performed best in a reading test at the end of the study had made a transition into a phase in which many non-responses occurred, after an initial phase of whole-word guessing. These non-responses were considered to reflect a transition from contextual to graphic constraints (similar to many models of reading development, Ch.3). The period of non-responses was assumed to reflect a phase in which the readers realised that they could not “read” the words (i.e. they could not decode words by using grapheme–phoneme mappings). The readers who performed best concentrated on the graphemic level during one phase of

---

38 That is, when a candidate has been chosen from the mental lexicon, see note 4, p. 8.
39 See evidence of a limited capacity working memory system, briefly overviewed, for example, in Stothard (1994).
reading development, after which they became able to make use of context, rather than being dependent on contextual cues – as was the case before the non-response period (see also Perfetti & Roth 1981). Weber (1970) analysed linguistic consequences of the reading errors among these beginning readers, and found that their errors were largely syntactically and semantically appropriate, regardless of reading ability of the readers. The responses of the better readers were also more graphically similar to the target words than those of the less skilled readers.

Evidence of the use of higher levels than the grapheme level among skilled readers has been obtained, for example, in studies of Swedish readers (Magnusson & Nauclér 1990, 1991, Nauclér & Magnusson 1985) and English speaking readers (Garner 1981, 1987). In their longitudinal study, Magnusson and Nauclér analysed what linguistic units were involved in reading errors among Swedish poor and proficient readers. Although there were similarities between the groups, they found that poor readers tended to concentrate on meaningless units (i.e. phonemes), while proficient readers concentrated on meaningful units (i.e. morphemes and words). Garner (1981, 1987) investigated the extent to which poor and skilled comprehenders detected inconsistencies in texts. She found that poor comprehenders had difficulties detecting inconsistencies between sentences, while skilled comprehenders on the whole detected inconsistencies more easily, even between sentences. Her conclusion was that poor comprehenders rely on piecemeal processing, while skilled comprehenders have a larger attention span. These conclusions are similar to Walczyk’s (1995), below. Oakhill (1996) also claims that lower linguistic levels (for example, the word level) make fewer demands on the readers’ processing capacity than, for instance, syntax and semantics. Therefore, less skilled readers have difficulties with building mental models when reading texts. We could consequently expect poor readers to be more sensitive to lower linguistic levels than to higher ones.

Walczyk (1995), who advocates a compensatory-encoding model, suggests that what characterises the efficient reader is the ability to benefit from various strategies, using both high and low levels in the reading process, while poor readers might rely on only one strategy. Walczyk claims that “compensatory mechanism use is the rule, not the exception” (1995:400). Examples of compensatory behaviour in his model are slowing down the reading rate, rereading passages, and reallocating attention from higher level processes to lower level processes (thus higher level processing is thought to be natural in skilled reading). The use of higher linguistic levels as the normal strategy for the skilled reader is also described by Ehri (1992), who claims that expectations about upcoming words in the text is coordinated with graphemic information in written word processing.
Expectations are thought to be based on the reader’s world knowledge in combination with syntactic and semantic information.\textsuperscript{40}

Contrary to traditional models of reading development, Share (1995) argues that readers, from the very first steps in reading development, are item sensitive rather than stage dependent. That is, even early in reading development, the reader will use a whole-word decoding strategy with minimal phonological processing for words that have been decoded frequently. For novel or less familiar words the reader will more often use grapheme-to-phoneme recoding. This view is in line with Seymour’s (1994) ‘dual foundation’ model, which presumes that distinct logographic and alphabetic processes should be discernable even in early reading (similar to dual-route models for skilled reading, 2.1.1).\textsuperscript{41} That is, readers are expected to use a combination of strategies involving alphabetic recoding as well as decoding of larger linguistic units, such as syllables, rimes and whole words. This is thought to be the case even among beginning readers. In Share’s model, it is assumed that context can be used by the reader to resolve decoding ambiguity, while Seymour’s model makes no predictions about the use of higher linguistic levels than the word level.

In conclusion, there is little evidence today that better readers use context to facilitate word recognition, although there is some evidence that “better readers are better able to use contextual information to facilitate their comprehension processes” (Stanovich 1991:431). It is important, however, not to confuse sensitivity to higher linguistic levels with dependency on higher levels (Perfetti 1999, Perfetti & Roth 1981). Dependency on higher levels can indicate that the reader has major problems with decoding and uses context compensatorily (Stanovich 1980), while overall linguistic sensitivity could instead reveal more efficient reading strategies, in which the use of context is one strategy among others (e.g. Ehri 1992, Walczyk 1995).

However, it is also important to distinguish between processes involved in skilled reading and processes involved in becoming a skilled reader (e.g. Tunmer & Hoover 1992). On the one hand, it could well be the case that the beginning readers who concentrate mainly on the graphemic level are those who will later become skilled readers, since the bottleneck of skilled reading appears to be automatic decoding ability.\textsuperscript{42} On the other hand it might be the case that readers who are able to utilise information from more than one source from the very beginning are those who will eventually become skilled readers since, at least according to some scholars, this is the way the reading process works for proficient readers (e.g. Ehri 1992, Perfetti 1999, Walczyk 1995).

---

\textsuperscript{40} However, it should be pointed out that in Ehri’s model of reading development, alphabetic mappings are of major importance (see Ch. 3).

\textsuperscript{41} Seymour (1994) bases his model mainly on findings from dyslexic readers, but the model is presumed to be relevant for the reading process as such.

\textsuperscript{42} However, for an alternative view, see, for example, Liberg (1990).
2.3.5 Familiarity

At the word level, a number of factors that could all be associated with some kind of familiarity concept have been found to influence word recognition. One such factor is frequency. Another factor closely related to frequency is age of acquisition (AoA). These aspects will be discussed below.43

The literature contains ample evidence of word frequency effects. This is shown, for example, in lexical decision tasks and word naming (for overviews, see e.g. Balota 1994, Harley 2001, Lively et al. 1994, Massaro 1994).44 Frequency effects have also been studied in relation, for example, to spelling regularity, and it has been found that when irregular words are familiar enough they are recognised just as accurately and with the same speed as regular words (Gough et al. 1992, Stanovich 1991). This may also be related to the dual-route models described above. A word that has been decoded a number of times is likely to become part of the reader’s sight-word vocabulary (i.e. there is a representation of the written form of the word in the mental lexicon), and can be decoded with direct access (but see Zevin & Seidenberg 2002, for an alternative view). Frequency effects have also been studied in relation to orthographic depth (see 2.3.3), revealing that word frequency effects are much greater in languages with typically deep orthographies than in languages with typically shallow orthographies (for overviews, see Balota 1994, Katz & Frost 1992). Frequency must be regarded as a relative concept, though. As is pointed out by Gernsbacher (1984), corpora of printed words can only be approximations of experienced familiarity. Some words, such as function words, are likely to have high frequencies regardless, for example, of text type. However, words with lower absolute frequencies can have relatively high frequencies in certain types of texts, or can be highly familiar to certain groups of readers or for individuals. Another aspect concerns the differences between spoken and printed frequencies. Moreover, a number of words associated with everyday life might be highly familiar, even though they have low frequencies in both spoken and written language (e.g. *toothbrush*). Furthermore, words that have been brought to the fore recently might also “behave” like high-frequency words.

At the sub-lexical level, the notion of orthographic neighbourhoods is relevant (for the notion of ‘neighbourhood’, see p. 25). There is evidence that the characteristics of a given word’s neighbourhood influence the impact of the consistency of spelling-to-sound correspondences in words (for overviews, see Balota 1994, Lively et al. 1994). Examples of factors presumed to affect word recognition are neighbourhood size, frequencies of the respective words in a neighbourhood, and number of ‘enemies’ or

---

43 For a more extensive overview, see, for example, Harley (2001).
44 However, it is important to note that frequency and a number of other variables correlate. For example, frequent words tend to be shorter than infrequent words.
‘friends’ (combined with frequencies of these) in a neighbourhood (Balota 1994, Jared 2002).

Age of acquisition (AoA) is also closely related to familiarity, and has received a great deal of attention in recent years. It is assumed that the age at which a word was first learned affects the performance of skilled readers in the sense that words learned early in life are named more quickly and more accurately than words learned later in life (for overviews, see Harley 2001, Morrison & Ellis 2000, Zevin & Seidenberg 2002). Of course AoA and frequency interact, in the sense that high-frequency words are generally learned earlier in life than low-frequency words. Morrison & Ellis (1995) claim that previously observed frequency effects were, in fact, AoA effects. However, in a later article (Morrison & Ellis 2000) they suggest that both frequency and AoA might have independent effects on word processing. In a computer simulation, Zevin & Seidenberg (2002) reanalysed materials used in their previous research, and claim that “the evidence for an effect of AoA on skilled reading is weak at best” (2002:2). Zevin & Seidenberg argue that other effects can explain results that have been used as evidence of AoA effects, since both frequency and AoA correlate with other measures, such as word length and characteristics of orthographic neighbourhoods. Zevin & Seidenberg interpreted the results in terms of structural familiarity (i.e. characteristics of the orthographic neighbourhood). Jared (2002) came to similar conclusions in her empirical study on spelling-sound consistency versus regularity in word naming.

In running texts we can, of course, expect to find words with high and low frequencies, and both familiar and unfamiliar words. Study 3 in the present investigation analyses, among other things, to what extent error frequencies could be related to expected familiarity of the words in four of the texts that were used in the investigation.

---

45 It is, of course, not easy to know at what ages people have learned particular words. AoA studies instead use collected subjective ratings. One such frequently used collection for English is Gilhooly & Logie (1980).
3 Reading development

The present investigation was carried out over a two year period (see Methods, below), and naturally, models of reading development are highly relevant. Although my aim was never to evaluate models of reading development, some of the results obtained in the present investigation can be related to such models.

Reading development is often described in stages or phases, on the presupposition that all readers pass through qualitatively different steps in a similar way (but not necessarily at the same pace). Most of these models include at least three stages, namely one stage in which words are read as wholes, followed by a stage in which grapheme–phoneme mapping is used (in other words, the reader has ‘cracked’ the alphabetic code), and finally a stage at which orthographic regularities are used. One could argue that when reading in an alphabetic script, unanalysed whole-word reading is not ‘real’ reading (see note 47), but a kind of pre-reading, i.e. a stage in which the emergent reader has realised, for example, that the marks on the paper convey meanings. Most likely, however, this activity facilitates the initiation of reading development.

Table 1 gives a schematic picture of the way in which some of the models described below can be related to the three above-mentioned stages. The figure also indicates to what extent the models contain stages/phases beyond the ‘orthographic’ (or equivalent) stage. Some scholars (e.g. Frith 1985, Høien & Lundberg 1997, 2000) explicitly emphasise that reading is a skill that has to be taught at least to some extent, as opposed to the development of spoken (or signed) language. Frith states that the transition into the phase in which grapheme-to-phoneme mapping is used (the ‘alphabetic phase’) requires explicit teaching. Høien & Lundberg also

46 In the literature on reading, the terms ‘stage’ and ‘phase’ are used more or less interchangeably (this issue is discussed in e.g. Ehri 1999). In the following, the term ‘stage’ is used when discussing reading models in general. In descriptions of specific models, the terminology employed in the specific model is used.

47 However, it is often claimed that during the first stage, the emergent reader recognises words by means of selective association, i.e. the child might select a cue for recognising the word, rather than recognising it as a whole. An often cited example is that a word like camel could be recognised by the two ‘humps’ in the <m> (e.g. Byrne 1992, Gough et al. 1992).

48 However, Liberg (1990) and Söderbergh (1986) both argue that reading could (and should) be seen as a more natural linguistic activity, similar to the child’s acquisition of spoken language. Both claim that the similarities between the acquisition of spoken and written language are greater than the differences.
claim that this, in combination with individual differences, can affect the way in which reading achievement develops for the individual reader.

### Table 1. Phases/stages in some models of reading development

<table>
<thead>
<tr>
<th>Scholar</th>
<th>Phase/Stage</th>
<th>Pre-alphabetic</th>
<th>Alphabetic</th>
<th>Orthographic</th>
<th>Post-orthographic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chall (1983)</td>
<td>‘Prereading’</td>
<td></td>
<td>‘Initial reading/decoding’</td>
<td>‘Confirmation, fluency, ungluing from print’</td>
<td>x</td>
</tr>
<tr>
<td>Frith (1985)</td>
<td>‘Logographic’</td>
<td>‘Alphabetic’</td>
<td></td>
<td>‘Orthographic’</td>
<td>-</td>
</tr>
<tr>
<td>Marsh et al. (1981)</td>
<td>1. ‘Rote learning’</td>
<td></td>
<td>‘Sequential decoding’</td>
<td>‘Hierarchical decoding’</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2. ‘Visual cues’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. ‘Logographic’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ehri (1992, 1999)</td>
<td>1. ‘Pre-alphabetic’</td>
<td></td>
<td>‘Full alphabetic’</td>
<td>‘Consolidated alphabetic phase’</td>
<td>x*</td>
</tr>
<tr>
<td></td>
<td>2. ‘Partial alphabetic’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Söderbergh (1986)</td>
<td>1. ‘Whole word’</td>
<td></td>
<td>‘Phonetic’</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2. ‘Morphemic’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liberg** (1990)</td>
<td>‘Pre-phonetic’</td>
<td></td>
<td>‘Phonetic’</td>
<td>‘Elaborated’</td>
<td>-</td>
</tr>
</tbody>
</table>

** Liberg describes various aspects of development, but these aspects connect most easily to models of reading development.

Chall (1983) developed an early stage-model for reading development. Her model is divided into six stages, starting with ‘prereading’ and ending with ‘construction and reconstruction – a world view’. The stages in the model do not describe reading in a technical sense, but instead to some extent the various ways in which reading is used at different stages of reading development. The aim of the model is to describe not only the initial stages of reading development, but also the transition into, and qualities of, mature reading. Chall gives approximate indications of expected ages at different stages, starting at birth and ending at high school age. The first, ‘prereading stage’ (0-6 years), is not really considered a reading stage, but rather a prerequisite for later reading development to commence.

What is thought to happen during the prereading stage is, for example, for the emergent reader to be aware of a number of fundamental aspects of print – such as reading direction, and the fact that print conveys meaning –
as well as to develop what are generally termed ‘metalinguistic’ and ‘phonological’ awareness (see also 2.3.1). Before the reader leaves the prereading stage, it is thought that he or she begins to pretend to read, ‘pseudo-reading’. The next step, ‘initial reading, or decoding, stage’, is the first stage during which Chall considers real reading to take place, and it is the stage at which the child learns to associate letters with the corresponding parts of spoken words. In the following stage, ‘confirmation, fluency, and ungluing from print’, what was learnt during the previous stage is thought to be consolidated. During this stage, reading is performed not to gain new information, but for confirming what is already known to the reader, as well as for gaining fluency and speed. During the next stages, ‘reading for learning the new: a first step’, ‘multiple viewpoints’, and ‘construction and reconstruction – a world view’ the reader is thought to gradually use reading as a tool, for example, for gaining information instead of focusing on the activity as such.

Another classic model is Frith’s (1985), which has a more technical approach to reading than Chall’s more general model. In Frith’s model, reading development is described in three phases identified with three qualitatively different strategies, the ‘logographic’, ‘alphabetic’, and ‘orthographic’ phases. These phases are thought to appear in a strictly sequential order. In the logographic phase, the reader is thought to read words as unanalysed wholes, perhaps with salient graphic features acting as cues (see note 47, p. 36), without being aware of the way in which the letters build up the word. During this phase the child might use a guessing strategy based on contextual or pragmatic cues when faced with unknown words. In the alphabetic phase, the reader is thought to have understood the fact that phonemes in the spoken language correspond to graphemes in the written language, and to use this knowledge systematically, decoding words grapheme by grapheme. It is not until this phase that the reader is thought to be able to decode nonwords and novel words. In the final, orthographic phase, the reader is thought to be able to make an instant analysis of words into orthographic units without phonological conversions. The orthographic patterns are thought to be represented internally in letter-by-letter strings (ideally coinciding with morphemes) that could make up an almost unlimited set of words.

For the logographic phase, Frith makes no difference between fully context-dependent reading – sometimes labelled pseudo-reading (for example, when the child reads McDonald’s when passing a building with the restaurant’s logotype, or reads the names over the clothing pegs at nursery school), and more or less decontextualised whole-word reading (for example, the child who can find the name of the favourite character on a page in a story-book). These two kinds of ‘reading’ are regarded as logographic decoding in the model, although we could consider them to be qualitatively different reading activities. Frith leaves open the various ways in which previously acquired strategies might operate in skilled reading, i.e.
if the reader might “fall back” on earlier strategies or whether previous strategies are less accessible once the orthographic strategy has become established (see ‘dual-route’ models, 2.1.1).

Frith based her model on the work of Marsh and his colleagues (e.g. Marsh et al. 1981), who suggest a four-stage model of reading development based on learning strategies. According to their model, in the first stage the reader uses a rote learning strategy combined with predicting from context. In the second stage, these guesses are also based on visual letter cues as well as linguistic context. Frith’s logographic phase is equivalent to these two stages. In the third stage the reader uses a sequential decoding strategy based on one-to-one correspondences between letters and sounds. Finally, in the fourth stage, which Marsh et al. denote as ‘hierarchical decoding’, the interpretation of each phoneme becomes dependent on its letter context. It is not until this stage that the child can deal with specific spelling rules. Frith’s alphabetic phase is equivalent to the third stage in this model, while the orthographic phase corresponds to the fourth stage. As Frith remarks, the hierarchical strategy as described by Marsh et al. could be interpreted as either orthographic (similar to Frith’s third phase) or an advanced form of the alphabetic strategy (see Ehri’s model, e.g. 1999, below). If we interpret it as an advanced form of alphabetic strategy, this strategy is not quite as qualitatively different from the previous stage as an orthographic strategy would be.

Høien & Lundberg’s (1997, 2000) stage model is an elaboration of Frith’s model. One difference is that Høien & Lundberg distinguish between two separate stages in the initial whole-word reading, namely ‘pseudo reading’ and ‘logographic-visual’ reading (similar to Marsh et al. 1981). By making this division, they distinguish between a fully context dependent ‘pseudo reading’, and an unanalysed but decontextualised ‘logographic’ reading. The following stages, ‘alphabetic-phonemic’ and ‘orthographic-morphemic’, are more or less equivalent to Frith’s ‘alphabetic’ and ‘orthographic’ phases, respectively. One difference is that the model takes contextual factors into account in the sense that the reader is thought to become gradually less context dependent in step with reading development. At the pseudo reading stage, the reader is highly dependent on context, while by the final, orthographic-morphemic stage, the reader shows very little context-dependence. Also, in Frith’s model the different phases are considered to be strictly sequential, with new strategies more or less taking over from former strategies, while in Høien & Lundberg’s model new strategies and new knowledge characterise each stage, although previous strategies remain accessible as back-up strategies.

Ehri’s (1992, 1997, 1999) perspective is somewhat different. Ehri claims that stage models generally imply that each reader goes through the same stages step by step, and that the transition to one stage presupposes that earlier stages have been passed, with no overlapping between strategies used in the different stages. Instead, a phase model is advocated, where
phases may overlap, and mastery of one phase may or may not be a prerequisite for movement into the next.

However, as is evident in comparison with the above description of Frith’s (1985) and Høien & Lundberg’s (e.g. 2000) models, Ehri’s assumption that the use of the term ‘stage’ implies no overlapping between stages, and that the use of the term ‘phase’ implies that earlier strategies can work as backup strategies is a simplification. Frith’s phase model presupposes that each phase is passed in a strict order, and that new and more efficient strategies take over from old strategies. Frith leaves the question open whether strategies in earlier phases can function as backup strategies at later phases. Høien & Lundberg’s stage model, on the other hand, assumes that the reader uses previous strategies as backup strategies at later stages.

In Ehri’s model (e.g. 1999), the role of alphabetic mapping is emphasised more than is the case in most other models. Mapping is thought to act in both early and more advanced phases of reading development. The model includes four phases. The first, ‘pre-alphabetic’ phase corresponds to Høien & Lundberg’s (1997, 2000) ‘pseudo reading’, in the sense that Ehri’s model, too, suggests an initial phase in which the reader is thought to form connections between non-alphabetic visual features and the pronunciations and meaning of the words, and typically cannot recognise words out of context. One difference, though, is that in Ehri’s model this phase implies that some visual cues from the spelling patterns are used, while, for example, in Høien & Lundberg’s model, pure graphic information is not thought to be used. In the second, ‘partial alphabetic’ phase, the reader uses visual cues from letter shapes. This phase is quite similar to the ‘logographic-visual’ stage in Høien & Lundberg’s model and Stage 2 in the model advocated by Marsh et al. A prerequisite for moving into the partial alphabetic phase is basic knowledge of the shapes and names of the letters of the alphabet, as well as sufficient phonological awareness for the reader to be able to segment words into the more salient sounds, recognising, for instance, that *bird* and *bee* begin with the same sound. During this phase, the reader recognises sight-words by using partial alphabetic connections between letter shapes and sounds.49 Unfamiliar words cannot be decoded, since making analogies between similarly spelled words would require a deeper knowledge of the alphabetic system. The third, ‘full alphabetic’, phase is more or less equivalent to the ‘alphabetic stage/phase’ in the models mentioned above, and the fourth, ‘consolidated alphabetic phase’ is similar to the ‘orthographic’ or ‘morpho-orthographic’ stages/phases mentioned above. Ehri & McCormick (1998) also include a fifth, ‘automatic

49 ‘Sight-words’ refer to words that the reader has previously read a number of times and therefore can recognise more or less by direct access, since the words have a representation in the mental lexicon (similar to the direct route in ‘dual-route’ models, 2.1.1).
phase’, which is considered to be a phase of proficient reading, in which a majority of words are present in the reader’s sight-word vocabulary. When readers come across uncommon words, they have several strategies for identifying the words. Though Ehri (e.g. 1992) emphasises the importance of a sight-word vocabulary from which words are decoded more or less by direct access, she claims that the reader in later phases, too, is using phonological information even for words in the sight-word vocabulary, but that this strategy is at work at an unconscious level (e.g. Ehri & McCormick 1998).50

The models for reading development described above are generally based on findings from English speaking readers.51 However, some Swedish studies on reading development are based on Swedish readers’ reading development, for instance Liberg’s (1990) study of Swedish children in preschool and Söderbergh’s (e.g. 1986) case study of her 3-year-old child. Neither of them, however, go into details of language-specific factors.

Söderbergh’s (e.g. 1986) often cited case study of a child’s transition from whole-word reading to graphematic reading gives a detailed description of the way in which one child broke the alphabetic code without explicit teaching. This description fits relatively well into the above-mentioned models. The child developed stepwise, from whole-word reading via morphematic reading to syllabic and finally phonematic reading. Thus, to use the terminology from the models discussed above, what is described is a detailed transition from a logographic stage to an alphabetic stage. In Ehri’s (e.g. 1999) model this transition is also described in detail, although Ehri’s model presupposes a focus on graphemic structures rather than morphematic or syllabic structures.52

Liberg (1990) analysed the interaction between eleven Swedish preschool children and their parents, as well as the children’s manner of using written language (reading, writing or talking about reading, writing and grammatical features). In the study, reports about activities that could be connected to reading or writing were collected from parents. During the study, the children passed through similar phases in their development.53 Liberg describes differences between the children primarily as differences

---

50 According to the ‘dual-route model’ (e.g. Høien & Lundberg 1997, 2000) high frequency words, for instance, are thought to be decoded by direct access, without phonological recoding.
51 Though Høien & Lundberg are Scandinavian scholars, their model is grouped here with the other international models, since it is based on evidence largely obtained in Anglosaxon research. (Also, as they explicitly remark, their model is an elaboration of Frith’s model.)
52 As Söderbergh remarks (1986), in Swedish a number of morphemes such as plural, definiteness, genitive, etc., are marked by final morphemes to a larger extent than is the case, for example, in English. Therefore, these morphemes can be quite salient for a Swedish beginning reader.
53 However, the reports were from periods of varying length (from nine months to three years).
in duration of the different phases, but also as differences regarding the children’s preference for reading, writing or just talking about reading, writing and grammatical features. Their development is described as U-curve trends (which are frequently used in descriptions of children’s language acquisition), in which the children passed, for example, from using complex texts back to simple texts and then to complex texts again, and from solitary and self-reliant work via interactive work to solitary and self-reliant work (1990).\footnote{The use of the U-model might be a way of emphasizing the stance that the acquisition of written language is parallel to the acquisition of spoken language.} The data indicates, for example, that the children used more advanced texts at an early point in their pre-reading acts (e.g. pretending to read a story). In order to break the alphabetic code they used simple texts (mostly single words), and then they returned to more complex texts again. Along with this shift regarding texts, there was a parallel shift regarding to what extent parents and others were involved. Regarding the actual development of decoding ability, we can connect the developmental stages to models of reading development in which the first phase (left stem of the U-curve) corresponds to whole-word reading (‘prephonetic reading’), the second phase (the bottom part of the U-curve) to alphabetic reading (‘phonetic reading’), and the third phase (the right stem of the U-curve) to orthographic decoding (‘elaborated reading’), although this is never explicitly described in the study. A problem when using the U-model is that such models generally imply a first period of unsystematic but correct production (left stem) followed by a period in which the child develops a simplified system of his or her own, frequently showing errors revealing overgeneralisations of rules (bottom line), which in turn leads to a reorganised system encompassing new data. Finally the child’s system coincides with the adult norm (right stem). This type of development is not entirely parallel to the various aspects that Liberg describes in her data. Since Liberg’s data reveals a wave-like development, the use of a U-model can lead us to draw the wrong conclusions. For example, regarding the reading process as such, the concentration on the graphemic level during the bottom part phase could not really be regarded a simplified system compared to the first phase in which the readers were only able to read previously learnt whole words. Instead, the reader who concentrates on the graphemic level is able to decode novel words in a fashion that was not possible before. This cannot be considered even a seeming decline in performance.

A model (or rather, a ‘scheme’) for reading development that has had a great impact in Swedish school system is ‘The Reading Scheme’ (LUS)\footnote{‘Läsutvecklingsschemat’. In the following description of the scheme, I have made approximate translations of the different steps in development.} (Allard et al. 2001, Sundblad et al. 1981).\footnote{The scheme differs slightly between the two versions. In the revised 2001 version of the scheme, the various steps are more elaborated, with suggestions about appropriate literature for each respective step, etc.} The scheme is divided into a
large number of steps. Step 1, ‘Reads (finds) and writes (draws) his/her own
name’, all the way to step 19 ‘Skims’ (in the 1981 model, the final step is
23, ‘Unconsciously adapts the reading process to the nature of the text and
to the overall reading situation’). It claims to give a comprehensive picture
of reading development. However, the various steps often describe activities
rather than strategies or the reading process as such. Furthermore, the steps
tend to be quite vaguely defined, and depend heavily on intuitive previous
knowledge for interpretation. For example, what exactly is ‘fluency’, and
what does ‘gets stuck’ mean in step 13? ‘More fluent reading, but still gets
stuck from time to time’. Also, the natural course of development between
steps is debatable (perhaps also due to the relative vagueness in the descrip-
tion of the steps), step 7, for instance, (in the 1981 version), ‘Can read a
simple text with an appropriate interpretation of contents. Can grasp a
simple, written instruction’, and step 9 (in the 1981 version), ‘Can decode
geminated words and some opaque words by the use of context’. The
scheme could be a useful tool in a school situation, to focus on children’s
reading activities, and as a basis for a discussion about reading development
between teachers and parents, but it is less useful in describing more precise
aspects of reading development.

foundation’ model, both mentioned in 2.3.4 can also be related to models of
reading development. According to Share and Seymour, reading, even in
early stages, involves decoding of whole words as well as mappings be-
tween sub-lexical units of various sizes, such as graphemes, syllables or
rimes. This view is in contrast to the majority of models of reading develop-
ment that instead generally describe reading development as stages in-
volving qualitatively different reading behaviour.

The above-mentioned models generally do not analyze the extent to
which our view of what is natural reading development might be biased by
the orthography as such, or the way in which reading is generally taught in
schools (see Vellutino & Scanlon 1991). However, during recent decades
there has been an increasing interest in cross-orthographic differences (see
2.3.3). It could well be that language-specific factors as well as develop-
mental or instructional factors affect the way in which reading proficiency
develops in the individual (e.g. Goulandris 2003, Høien & Lundberg 1997,
2000, Lundberg 1999).58

57 Liberg does discuss the way in which traditional teaching of reading and writing might
result in reading and writing difficulties. She claims that “grammatical treatment [e.g.
blending or sounding out, author’s comment] does not constitute a pivot factor in
learning to read and write” (Liberg 1990:146).
58 However, Marsh et al. (e.g. 1981), whose model to a large extent resembles, or is
actually the basis for, later models of reading development, developed their scheme
based on Piagetian models of cognitive development, and Piaget’s findings are, of
course, not considered language-specific.
The present study focuses on the utilisation of various linguistic levels in reading. Typically, in traditional models of the reading process higher levels than the word level are only discussed regarding the very first stages of reading development, and when they are, more general contextual aspects are in focus (see, for instance, the logographic phase in Frith 1985, and Stages 1 and 2 in Marsh et al. 1981). One exception is Høien & Lundberg’s model (e.g. 1997, 2000), in which the role of context is explicitly considered in all four stages, but only in a general sense. Other scholars who consider higher linguistic levels in reading development include Goodman (e.g. 1969) and Stanovich (e.g. 1980). They take higher linguistic levels into account, and they connect context to reading development (or reading proficiency), though theirs are not elaborated models of reading development, but instead descriptions of how beginning or poor reading might diverge from proficient reading. Their models of the reading process are described in 2.3.4.
4 The investigation

4.1 Aims and hypotheses

As mentioned in Chapter 1, the overall aims of the present investigation were to examine the utilisation of various linguistic levels in the oral reading of running texts among Swedish beginning readers, and specifically to question the supposed predominant role of lower linguistic levels. I decided to investigate this aspect in a relatively natural reading situation (see Methods, below).

The importance of the graphemic and perhaps also of the lexical levels should not be overlooked. However, in the present investigation it was hypothesised that other linguistic levels would also be utilised by the readers when these were faced with running texts.

The individual studies used different approaches to these overall aims. The purpose of the first study was to examine linguistic consequences of reading errors made in a first video recording, as well as to investigate whether readers corrected their errors with different linguistic consequences. The second study analysed the same aspects, but examined whether readers with fast or slow reading development behaved differently from each other or from readers with average reading development. The third study aimed to examine what kinds of words, or combination of words, led to errors and what kinds of words did not. The point of departure was that if the graphemic or perhaps lexical level really were of major importance for these readers, graphemically complex words and/or words that we could expect to be unfamiliar to the readers would result in reading errors more frequently than graphemically simple and/or expected familiar words. Finally, study four aimed to investigate error frequencies related to grapheme–phoneme correspondences. This was based on the assumption stated in the ‘orthographic depth hypothesis’ (see 2.3.3), namely that shallower orthographies support word recognition processes based on phonology to a greater extent than do deeper orthographies. The assumption was that this hypothesis might hold within as well as between orthographies.

Altogether, these different ways of approaching the overall aims provide a relatively substantial description of beginners’ reading strategies.

An additional underlying aim was more methodological, i.e. to find ways of analysing reading strategies in oral reading among (beginning) readers. Perhaps some of the approaches used in the studies would prove to be useful in the teaching of reading.

In the present investigation the utilisation of higher linguistic levels is clearly a key aspect. It is, however, important to note that the subject of the
investigation is whether higher levels are utilised at all, and not whether these processes operate pre or post (or even during, see Stanovich 1991) word recognition. The methods used in the present investigation are not precise enough to state, for example, whether context effects work beyond word recognition, although substitution errors, for instance, may implicate processes at the word recognition level (see Stanovich 1991).

4.2 Methods

Most previous reading research is based on experimental studies, often involving only single word reading (see Ch. 2). The present investigation uses running texts and has a more exploratory approach, similar to some previous studies (e.g. Biemiller 1970, Magnusson & Naucler 1991, Weber 1970). One advantage of such an approach is that numerous aspects can be explored, using the same data, while one drawback, of course, is that all possible factors that could affect the results cannot be controlled.

Various methods can be used to examine reading of running texts. Just & Carpenter (1980) presumed that eye movements would mirror the reading process in silent reading (see 2.2.1). Error analysis has been used on oral reading (e.g. Biemiller 1970, Goodman 1969, Magnusson & Naucler 1991, Potter 1987). The underlying assumption is that reading errors reveal underlying processes, and bring to light, for instance, what obstacles there are in texts (similarly to error analysis in the study of spoken language).59 The present investigation is mainly based on error analyses, and qualitative as well as quantitative analyses have been conducted. It was assumed that the combination would give a richer picture. Quantitative analyses is a powerful tool when making large-scale analyses, for example, of error frequencies. By combining such analyses with a closer inspection of what the reading errors consist of, what errors are corrected, or what words result in errors, etc., a more substantial picture can be obtained.

All the studies in the investigation aimed to examine to what extent a number of Swedish beginning readers utilised different linguistic levels in their oral reading. In studies 1, 3, and 4 different methods were used in order to prevent our results from focusing too much on one possibly misleading factor and possibly neglecting to take other correlating underlying factors into account.60

The only decision taken at the outset of the investigation as to what kind of analyses the various studies were going to be based on was for study 1. The first study was carried out to examine whether utilisations of various linguistic levels could be revealed at all. Then one study gave rise to the

59 For an overview, see Harley (2001).
60 In study 2 the same methods were used as in study 1, but in study 2 different groups of readers were compared.
next, and all the way through the investigation, results that indicated that the
readers had utilised higher linguistic levels were examined in increasing
depth. When studies 1 and 2 had indicated such utilisation, this gave rise to
the design of study 3, in which I analysed whether words that had resulted
in errors might be related to graphemical complexity, for example (and if
so, we might conclude that although the hypothesis about the utilisation of
higher linguistic levels seems to have been confirmed, the reasons why
words resulted in errors had to do with factors at the graphemic level).
When study 3 revealed no clear connection between graphemic complexity
and error frequencies this triggered the design of study 4, where I analysed
a different aspect of the graphemic level, namely the relative transparency
of words.

4.2.1 The texts

The texts used in the investigation were of varying degrees of difficulty.
The least complicated texts, used for the initial reading stages, were
specially adapted for beginners, taken from easy readers. Texts used for the
more advanced stages were taken from children’s books. The more ad-
vanced of these consisted of the first page(s) of longer books. In some cases
the texts were altered for the purposes of the investigation, for example, to
see how the readers tackled words that were contextually inappropriate or in
disharmony with the children’s knowledge of the world. One such example
is *Eva och Jöns får rida på sin hund* ‘Eva and Jöns can ride their dog’. Below are two examples of texts used to study the first phases of reading
development.

Texts adapted for beginners often consist of short sentences containing
short words with transparent spellings, in combination with high-frequency
words. One example is the easiest text used in the investigation (see below).
This text is based on rhyming, short phrases, and consists only of
monosyllabic words, such as the transparent *hus* ‘house’, *len* ‘soft/silky’,
*mus* ‘mouse’, and the high frequency words *och* ‘and’ and *en* ‘a/an’. The
only exception to this pattern is the disyllabic *sina*, a reflexive pronoun,
which in this context means ‘his’. Naturally, no texts avoiding all words
longer than one or two syllables resemble texts the children have seen
before, for example, when their parents have read aloud to them, and the
child has to accept that the main purpose of reading these texts is to practice
the art of reading. Furthermore, as mentioned above, in some cases these
already unnatural texts were altered in a way that made them even more
unnatural. One could argue that it might be problematic that the texts used
in the investigation to some extent are ‘quasi-texts’ (at least the texts used
for the beginning phases). On the other hand, texts beginners read in school
situations are often these kinds of adapted texts. Therefore this was not a
specific problem for the present investigation (apart from the fact that they
were sometimes altered). Also, if reading strategies in the present investigation differ from these readers’ normal reading behaviour, we would rather expect a tendency towards a letter-by-letter (or at least word-by-word) decoding rather than excessive compensatory use, for example, of knowledge of story grammar or text-binding principles, since these texts deviate from “normal” texts, especially in terms of these aspects. Consequently, for the aims of the present investigation, this issue is not regarded as problematic. If there is any evidence of utilisation of higher linguistic levels or the text level, for instance, these results were obtained in spite of the fact that these texts give less opportunity for such utilisations than would more prototypical texts. Also, if passages with unnatural text structures were found to frequently lead to reading errors, this is an interesting result in itself.

Examples of texts used in the investigation (the translations are approximate):

<table>
<thead>
<tr>
<th>Swedish Text</th>
<th>English Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tor är en mus.</td>
<td>Tor is a mouse.</td>
</tr>
<tr>
<td>Han bor i ett hus.</td>
<td>He lives in a house.</td>
</tr>
<tr>
<td>Han får mat</td>
<td>He gets food</td>
</tr>
<tr>
<td>på ett fat.</td>
<td>on a plate.</td>
</tr>
<tr>
<td>Tor är len</td>
<td>Tor has soft legs.</td>
</tr>
<tr>
<td>på sina ben.</td>
<td>(‘Tor is silky on his legs’)</td>
</tr>
<tr>
<td>Eva och Jöns bor i ett gult hus nära en å.</td>
<td>Eva and Jöns live in a yellow house close by a brook.</td>
</tr>
<tr>
<td>De är syskon.</td>
<td>They are brother and sister.</td>
</tr>
<tr>
<td>De bor där med sin mamma och pappa.</td>
<td>They live there with their mother and father.</td>
</tr>
<tr>
<td>Till huset hör en grå lada.</td>
<td>The house has a grey barn.</td>
</tr>
<tr>
<td>Där bor en häst.</td>
<td>There lives a horse.</td>
</tr>
<tr>
<td>Eva och Jöns får rida på sin hund.</td>
<td>Eva and Jöns can ride their dog.</td>
</tr>
</tbody>
</table>

### 4.2.2 Subjects

Fifty Swedish beginning readers were followed during their first two years at school. The participants all went to the same school near Stockholm, Sweden. At the beginning of the investigation, they were in classes that mixed pupils from the final year of preschool with pupils in Grade 1 in primary school. At the beginning of the investigation, the group consisted of 22 pupils in the final year of preschool (10 girls, 12 boys) and 28 pupils in the first year of primary school (13 girls, 15 boys), ranging in age from 6 years and 3 months to 7 years and 10 months, with a mean of 7 years and 2 months. During the two years the data was being collected, three pupils left the class. One new pupil also came to the class at the end of the first term, and was not present at the time of the first video recording. Since participation in the investigation was voluntary (i.e. the parents could choose not
to have their child participate), some of the children in these classes did not participate, though the vast majority did so.

All pupils but four were monolinguals with Swedish being their mother-tongue. The four exceptions were one boy who spoke Danish with his father, one girl who spoke Farsi with her parents, one girl who spoke Spanish with her mother and one boy with a Spanish-speaking father. None of the children in the classes had diagnosed dyslexia, but a few of them turned out to have a slow reading development as the investigation proceeded.

The school is in a typical middle class suburban area, with mostly privately owned homes.

4.2.3 Procedures

The investigation was based on video recordings in which beginning readers were recorded twice a year, during the second half of each school term (autumn and spring), when reading unknown, running texts orally. To ensure that no other sources than the texts could be utilised by the readers, no pictures or preparatory chats about the texts were utilised. In this sense the reading situation was unnatural, as was the fact that each subject read the texts individually in the presence of the investigator and a video camera. The subjects were asked to read the texts at their own pace and as well as they could. No other explicit reading goals (cf. Just & Carpenter 1980) were given. They were also encouraged to re-read or correct passages they found problematic. The investigator was familiar to the subjects since they had met her both in the classroom, and individually when a test on linguistic awareness was performed. Each video recording started with some small talk to warm the subjects up. The fact that a video camera was used did not seem to bother the readers. In fact, a number of the subjects wanted to see the “film” afterwards, and some of them started to pretend that they were part of a TV-programme.

The fact that the investigation was based on oral reading is worth commenting on. On the one hand, it could be argued that oral reading is an unnatural act of reading. On the other hand, it is quite natural for beginners to read out loud. In fact this is very common behaviour in early reading. Therefore, this choice is not considered to be a problematic factor in the present investigation.

Texts were chosen to match the readers’ levels of reading proficiency. To establish the subjects’ reading level, and to be able to choose appropriate texts, the teachers’ ratings of the pupils reading proficiency was used, especially at the first recording, but these ratings were also combined with

---

61 On the last recording occasion, some riddles were used, and in these cases the readers were told to read the text as well as they could and after that try to answer the riddle.
62 The results of this test were not used in this thesis.
the experience in the reading situation. The subjects read slightly more complex texts at each of the succeeding recordings. Since the investigation was to be based on error analyses, each subject read texts that were chosen to be at a level of difficulty that would result in some reading errors (see e.g. Campbell 1993).

As mentioned above, the texts used would hardly bias the readers towards an extensive use of higher linguistic levels; nor would the reading situation as such. The readers read texts they had never seen before, and they were not explicitly asked to read for comprehension. Thus, if the texts and the reading situation biased the readers at all, it would be more likely that they were biased towards letter-by-letter recoding, or perhaps word-by-word decoding, rather than using a guess-work strategy.

4.2.3.1 The database

The recordings were transcribed and entered in a database created for the purpose of the present investigation. In previous analyses (both early and more recent studies) of oral reading of running texts, hand-made notations were usually made in the original texts (e.g. Biemiller 1970, Goodman 1969, Iversen Kulbrandstad 1996, Malmquist 1958, Weber 1970). Such a method reduces the possibility of making more advanced analyses of the material, since only a limited number of comments can be made without risking the lucidity of the comments. This method also makes it difficult to get a simple picture of how the reading might have sounded. Lange (1987) worked out an alternative method, inspired by research on children’s language acquisition (e.g. Lange & Larsson 1977), in which oral reading is transcribed with parallel comments of the reading. Basically, the oral reading is transcribed in one column, while a parallel column is used for comments on the reading, regarding factors such as errors, pauses, and what linguistic levels are affected by the errors. Lange’s method has several advantages compared with traditionally used manual notations, but it is less useful for large-scale analyses. It also makes it difficult to search for specific types of errors, for example, in a simple fashion. If one wants to make more detailed comments, Lange’s method is also too cumbersome. So for the present investigation, the method was modified. A database was created in which one column was used for the transcription of the reading, while a number of other columns were used for qualitative analyses (see 4.2.3.2) of each deviation from the printed text. Each row in the database concerned only one such deviation. The aspects of the database used in the

---

63 For a discussion about using reading fluency as an indicator of reading proficiency, see Fuchs et al. (2001).
64 As mentioned in note 61, some recordings used riddles. The purpose of including such texts was to check whether such an explicit read-for-understanding situation would alter the subjects’ reading behaviour. The check revealed no differences as to linguistic consequences of errors, correction tendencies, etc.
various studies are commented on below. Beyond this, the database was modified in other ways to satisfy the needs of other possible analyses.

The database had separate columns in which subject, reading level and recording were identified. This made it possible, for instance, to make comparisons between reading levels and to make analyses of the reading of specific individuals (the latter being outside the scope of this thesis). Tagging of the errors indicated, for example, whether the reading error resulted in a deletion, an addition, or a substitution, or what linguistic level was affected (phoneme, morpheme, or word) by the reading error, as well as linguistic consequences of the errors. The classifications of the errors are described in greater detail in 4.2.3.2.

The benefits of such an elaborated database are manifold. In order to get a picture of how the actual reading sounded, the transcription column can be used (and most of the additional comments in the following columns can be ignored). At the same time, large-scale quantitative analyses as well as searches for certain types of errors can be made. A transfer of data into a statistics programme made it possible to make statistical analyses to examine differences as to correction tendencies depending on types of errors, or to compare readers of different reading levels. (For further detail about the different methods used in the four studies, see 4.2.4.)

The four studies in the present investigation utilised different parts of the data, but in all studies data was used from those subjects who were at least able to read a short, running text without help. In study 1, only data from the first video recording was used. At that time, 30 of the 50 participants were able to read a running text. Study 2 used data from readers who, at the time of the first or second video recording, were at an early stage of reading development (some readers were already too fluent at the time of the first video recording and were thus excluded from that study). Altogether, data from 32 participants was used in this study. Studies 3 and 4 only used recordings from four of the texts used in the investigation, and all readings of these texts were analysed. In these two studies, data from all participants was used.

In studies 1, 2, and 4, descriptive statistics were utilised to characterise the data, and contingency tables were used to evaluate hypotheses about certain variables. In such cases, the chi-square test was used, or, in the case of small expected frequencies, Fisher’s Exact Test (Butler 1985, Everitt 1977). The investigation employs multiple hypothesis testing, where each hypothesis was analysed separately, and the existence of patterns in, and the consistency of, the results were considered in the analysis. The analyses were carried out with the SPSS system (version 11.00) or the SAS system (version 8.02), and 5, 1, and 0.1 % levels of significance were considered. In the case of statistically significant result, the probability value ($p$-value) is given.
4.2.3.2 Classifications

As mentioned above, each reading error was analysed in a number of ways. To some extent these analyses coincide with Goodman’s (1969) taxonomy, which was also used by Biemiller (1970) and Weber (1970) though the present investigation elaborated on the analysis. In the database, one column was used to indicate what word had been misread and what it was replaced with (or if it was a deletion or an addition). Each error was then labelled as to linguistic consequences at the levels of word, syntax, and semantics. At the word level, it was indicated if the reading error resulted in a real Swedish word or a nonword. The nonword group consisted of both words that share phonological and morphological structures with existing Swedish words (so called ‘pseudo words’), such as kakor > karor, and words with non-Swedish structures, such as och > oseha. Words that were sounded out correctly, but with a nonword- pronunciation, were also regarded as nonwords, such as hund > hu:nd. For the purpose of being able to exclude such correctly sounded out nonwords from the analyses, these were given an additional tag in the database. At the syntactic and semantic levels, the clause was used as the basic unit for the analyses and a three-graded level of acceptability was used (abbreviations in brackets):

- Syntactically or semantically acceptable in the whole clause (SyntAcc/SemAcc), e.g.
  SyntAcc: Anna kan baka kakor > Anna kan backa kakor ‘Anna can bake cakes’ > ‘Anna can back cakes’
  SemAcc: Bakom muren står en tjur > Bakom muren står en djur ≈ ‘Behind the wall there is a bull’ > ‘Behind the wall there is an animal’ (correct gender: ett djur)

- Syntactically or semantically acceptable up to and including the reading error, but unacceptable in a possible continuation of the clause (SyntAccU/SemAccU), e.g.
  SyntAccU: Till huset hör en grå lada > Till huset hör en gård lada ≈ ‘The house has a grey barn’ > ‘The house has a yard barn’
  SemAccU: Till huset hör en grå lada > Till huset hör en gård lada ≈ ‘The house has a grey barn’ > ‘The house has a yard barn’

- Syntactically or semantically unacceptable up to and in a possible continuation of the clause (SyntInc/SemInc), e.g.
  SyntInc: Tor är len på sina ben > Tor ärr len på sina ben ≈ ‘Tor [a mouse] has silky legs’ > ‘Tor scar silky legs’

---

65 The vast majority of nonwords were pseudo words.
66 The label ‘semantic consequence’ is perhaps not fully adequate, since it could be used for the word level as well, but since this term has been used in at least two of the appended articles, the term is used throughout the thesis.
SemInc: Till huset hör en grå lada > Till huset hör en grå ladda ≈ ‘The house has a grey barn’ > ‘The house has a grey charge’, where *charge* must be a verb.

For each error, a combination of linguistic consequences at the levels word, syntax, and semantics is obtained; assuming it is not a deletion, which can not, of course, be analysed at the word level. A reading error that resulted in an existing word can be syntactically and/or semantically acceptable in the clause, while a nonword could only be syntactically but never semantically acceptable.67

Apart from the comments about linguistic acceptability, each error was also commented on regarding whether or not the reader tried to correct it, and whether or not the attempt to correct was successful. Five different tags were used:

- Successful correction (SC), i.e. the correction led to a correct reading
- Unsuccessful correction (UC), i.e. the attempt to correct the error led to a new reading error68
- Adaptive error (AE), i.e. the succeeding text was altered to fit a previous reading error
- Request for assistance (RA)
- No correction (NC), i.e. the error was left unrepaired

In the investigation, it was assumed that the extent to which the readers try to correct reading errors, or ask for assistance, reveals if the error is noted and/or found important/possible to correct. All groups except the group ‘No correction’ (NC) imply that the reader has noted the error and chosen to try to do something about it. Of course, we can never know exactly why an error is left unrepaired. It could be due to the fact that the reader did not realise that an error was made, or did not consider it worthwhile trying to correct it for some reason.69

Furthermore, tags were made regarding linguistic similarity between the printed word and the reading error. This was done at the graphemic, syntactic and semantic levels. At the graphemic level, word length and

---

67 The structure of a nonword may resemble existing words, and therefore be regarded as belonging to a certain word class or part of speech, for example, *kackor*, in which the ending *-or* indicates plural of a noun. In cases where there are multiple possible interpretations of a nonword, a lenient analysis has been applied, to favour linguistically acceptable interpretations, for example, the nonword *fär*, which is classified as a verb since it was a substitution for the printed verb *får* ‘can/may’.

68 If an attempt to correct an error led to a new error, the new error was analysed separately.

69 It is also worth noting that the occurrence of reading errors is normal in oral reading even among proficient readers, and that the lack of correction does not necessarily mean that the reader did not notice that an error was made (however, the proficient reader may be inclined to correct an error that alters the gist of the text).
number of similar letters were used as criteria. At the syntactic level, part of speech and/or word form, such as gender or number, were used. At the semantic level, membership in semantic fields was used as the criterion. These classifications were only used for a preliminary analysis in one article (study 1).

4.2.4 Methods used in the four studies

In all four studies, the underlying aim was to examine to what extent various linguistic levels were utilised in decoding, and when they were, how this was reflected in the actual reading. For these purposes, the database was used in various ways.

**Study 1**

Study 1 analysed linguistic consequences of the reading errors as well as correction tendencies attributable to linguistic consequences. A preliminary comparison of linguistic similarity between printed words and reading errors was also made. It was assumed that all these measures could to some extent reveal what linguistic levels the readers utilised in their reading. If the reading errors led to syntactically or semantically acceptable errors to a large extent, the readers had probably been utilising higher linguistic levels, whereas if the reading errors only led to real words, this would indicate a more word-by-word decoding.

The study included quantitative analyses of the classifications of reading errors that were made in the first video recording, and a total of 305 reading errors were analysed. First, frequencies for linguistic consequences at the levels word, syntax, and semantics were computed. The rate of errors resulting in nonwords was compared with the rate of real words, and the three levels of acceptability at the semantic and syntactic levels were compared.

As a second step, correction tendencies in relation to linguistic consequences of the errors were computed in contingency tables. In these comparisons, errors that were either fully unacceptable or acceptable up to the reading error were grouped together. Also, all variants of correction attempts were grouped together (i.e. successful and unsuccessful corrections, attempts which failed, adaptive errors and request for assistance), since all these behaviours indicate that the reader wanted to do something about an error, even though the attempt sometimes failed. The various consequences were also combined (i.e. reading errors that resulted in Nonword/SyntInc/SemInc were compared with other combinations, such as RealWord/SyntAcc/SemAcc as regards correction tendencies among the readers).

Finally the errors were analysed as to linguistic similarity to the printed word. If the reading errors were highly similar to the printed words at the graphemic level, we could assume that the graphemic level is of major
importance, and if the errors were similar at the syntactic or semantic levels, we could assume that higher linguistic levels had been utilised.

**Study 2**

Study 2 used data from readers who, at the first or second video recording, had only just started to read, and were at a level in which they were just about able to decode a simple running text without help. At the end of the study, some of these readers had developed a great deal, while others were still at quite basic levels of reading proficiency. The majority of the readers had developed at a pace somewhere in between the two extremes.

The study employed similar analyses as in study 1, but this time the two groups that had developed faster or slower than the average were compared, while data from readers with average reading development served as background. A total of 665 reading errors were analysed. The measures that were used were linguistic consequences of the reading errors, and linguistic consequences in relation to correction tendencies (see study 1). Comparisons were also made regarding whether or not readers’ correction attempts were successful or not in the different groups.

**Study 3**

Study 3 partly used a qualitative approach. In this study, data from all recordings of four of the texts in the study was used. Altogether, 1 180 errors were analysed. It was assumed on the basis of the results that had been obtained in the previous studies, that syntactic complexity and/or unexpected contexts could explain some of the errors. It was also assumed that the graphemic and/or lexical levels could be the core reason why words resulted in reading errors. Each word in these four texts was analysed as to graphemic complexity and expected familiarity. Error frequencies were computed and related to graphemic complexity and expected familiarity. As a second step, the substitutions, etc., the errors resulted in were analysed. Furthermore, when words we could expect to result in reading errors due to their graphemic complexity or expected unfamiliarity did not frequently result in errors, the context in which they occurred was scrutinised. In this part of the analysis, syntactic, semantic and textual aspects were taken into consideration. Error patterns between the four texts were also compared.

The words were tentatively labelled regarding their presumed familiarity, mainly on the basis of common knowledge of the words with which we could expect children in primary school to be familiar, sometimes combined with frequency measures (for a discussion of the concepts frequency/familiarity, see 2.3.5). As regards graphemic complexity, word length, transparency, and consonant clusters were used as a basis for the analysis (see 2.3.2). Words with one or more of the following characteristics were regarded as graphemically complex:

1. **long word** – word length was measured in numbers of syllables, with words containing three or more syllables being regarded as long
2. word without a one-to-one relationship between phonemes and graphemes, e.g. fem ‘five’ (pronounced [fɛmː]; in this case, a one-to-one mapping would result in the pronunciation [fe:m]) – this group also includes words spelt with digraphs, i.e. a phoneme spelt with a combination of two letters, e.g. *ijur* ‘bull’ (pronounced [ɕuːr]), and words including geminates, i.e. a consonantal phoneme spelt with two identical consonants, e.g. *mamma* ‘mother’

3. word containing consonant clusters, i.e. combinations of two or more consonantal phonemes, spelt with two or more consonants, e.g. *stora* ‘big’

In the analysis, the words were grouped into different combinations regarding graphemic complexity and presumed familiarity. The following groups were obtained: (1) words with a simple graphemic structure and presumably familiar, (2) words with a complex graphemic structure and presumably familiar, (3) words with a simple graphemic structure and presumably unfamiliar, and (4) words with a complex graphemic structure and presumably unfamiliar.

**Study 4**

Study 4 used the same data as study 3. Again, the graphemic level was in focus; in this case, correspondences between graphemes and phonemes in the printed words were analysed and related to error frequencies, to examine to what extent error frequencies could be explained by the transparency of the printed words. The basis was the assumption that the relative transparency of the spelling system affects the reading process, the ‘orthographic depth hypothesis’ (see 2.3.3). In this case, it was presumed that the relative transparency of words in an alphabetic orthography (in this case Swedish) could affect the ease with which beginners decode the words. Each word in the four texts was analysed, and the following three variants of relative transparency emanated:

1. Fully transparent words, *i.e.* words with a one-to-one mapping between phonemes and graphemes, e.g. *får* ‘gets’, *ben* ‘leg(s)’

2. Regular words, but transparent only given the graphemical/phonological context, *e.g.*
   a) Words with consistent spelling of syllables with a stressed short vowel followed by gemination, e.g. *pappa* ‘dad’ or by two or more consonantal graphemes, e.g. *häst* ‘horse’
   b) Words with consistent spelling of syllables with unstressed (therefore short) vowels, e.g. *kulen* ‘bleak’, also including inflected words, e.g. *skogen* ‘the wood’

---

70 Thus, factors such as word length or graphemic complexity were ignored in the study.
c) Words spelled with digraphs (no triplets were present in the texts), e.g. *tjur* ‘bull’, *tjuter* ‘whines’, *springer* ‘run(s)’

3. Irregularly spelled words, *i.e.* words that are opaque even given the graphemic/phonological context, e.g. *och* ‘and’, *bakom* ‘behind’, *hoppar* ‘jumps’ and *sen* ‘then’

In short, the given categorisation above is based on the assumption that for some words a basic knowledge of the pronunciation of letters in the alphabet is sufficient. For other words knowledge of spelling patterns for larger mapping units than the individual letter is needed. For the last group of words, even the use of larger mapping units is insufficient to obtain the correct pronunciation. For a more thorough discussion of the various considerations underpinning the above division, see Danielsson (in press, part of this volume), in which study 4 is presented.

The concepts of transparency, regularity, and consistency discussed in 2.3.2 are also related to the division above. Words in Group 1 are all transparent, regular and consistent. However, words considered to be fully transparent in the present study are “more transparent” than words considered to be transparent when the definition used by Szczerbinski (2001) is applied. According to Szczerbinski’s definition, words containing phonemes spelled with more than one letter (digraphs, triplets, etc.) were transparent when the pronunciation could be worked out by applying “most typical grapheme-phoneme correspondences”. In the present study a one-to-one relationship at the letter level was the basis on which words were placed in Group 1. Words in Group 2 are transparent to some extent and generally regular. Words in Group 3 are always opaque, but could be regular and to some extent consistent (for example, the spelling of short function words ending with nasals).

The three groups of words were compared as to error frequencies in contingency tables and compared to statistically expected frequencies. Apart from this quantitative analysis, words belonging to the three groups were examined individually, to see whether error frequencies on specific words deviated from what could be expected following the hypothesis about word transparency and error frequencies. In this part of the analysis, the results of study 3 were also used to examine what other factors (e.g. syntax, textual context, etc.) might have influenced error frequencies.

**4.3 Results**

This section begins with a brief summary of the results obtained in each study, followed by a summary of the overall findings.

---

71 *<tj>* and *<ng>* were the only digraphs present in the texts.
4.3.1 Study 1

Study 1 analysed reading errors and their consequences at different linguistic levels as well as tendencies to correct errors relating to linguistic consequences.\(^{72}\)

The main finding obtained in the study was that the readers tended to make linguistically acceptable reading errors more often than they made unacceptable errors, regardless of linguistic unit (i.e. word, syntax, or semantics). The preliminary comparison at the graphemic level revealed that substitutions were often graphemically similar to the printed words. Also, the readers corrected linguistically unacceptable reading errors significantly more often than they corrected linguistically acceptable reading errors.

However, in comparison with the results of Weber’s (1970) study on American beginning readers, the proportion of linguistically acceptable errors was smaller in these Swedish readers. The proportion of graphemically similar reading errors also appeared to be smaller in the Swedish study.\(^{73}\) There are a number of plausible explanations of the differences regarding linguistic consequences. Firstly, the subjects in the present study all read unknown texts, so guessing was a less productive strategy for these readers than for the children in Weber’s study, who were all reading texts that had previously been used in the classroom.\(^{74}\) Secondly, the readers in the present study were all advanced enough to decode a short running text without having access to any facilitating sources, while many of the children in Weber’s study obviously were at a lower level of reading ability, being only able to use a whole-word decoding strategy.\(^{75}\) Thirdly, the differences regarding the grapheme–phoneme relationships in the respective orthographies might lead to different tendencies as to the inclination to use an alphabetic recoding or a guessing strategy (see also Miller Guron & Lundberg in press).

The study only used results from the first video recording, though a later check revealed the same overall pattern when all the video recordings were analysed as a whole.

---

\(^{72}\) The main analysis was performed at the levels word, syntax, and semantics, while a preliminary analysis was carried out at the graphemic level.

\(^{73}\) However, the methods used to measure graphemic similarity were not identical in the two studies. Therefore we cannot draw any conclusions from that part of the comparison.

\(^{74}\) Weber reported that most reading errors resulted in words that had previously been learned in the classroom. The American readers were also taught in a whole-word programme in which guessing from contextual or syntactic cues is encouraged (see Lundberg 1999 or Olofsson 2003 for comments on Swedish teaching of reading).

\(^{75}\) Thus, to connect, for example, to Frith’s (1985) phases of reading development (see Ch. 3), many of the American readers were in the ‘logographic’ phase while the readers in the present investigation were (at least) in the ‘alphabetic’ phase. See also the results in Biemiller (1970) discussed above, p. 31 f.
4.3.2 Study 2

Study 2 compared subjects who developed at different paces during the two years of the investigation. Analyses similar to those in study 1 were conducted.

Two apparently contradictory tendencies were observed. On the one hand, the analysis of linguistic consequences among slow developers’ errors suggested sensitivity primarily to the word level. Slow developers made more errors that led to real words than did fast developers, and their errors more frequently resulted in incorrect syntactic structures than was the case for the fast developers. This result could be interpreted as slower developers being less able to utilise higher linguistic levels than the word level in their reading. On the other hand, slow developers corrected reading errors that resulted in unacceptable linguistic consequences significantly more often than did fast developers. This was the case regardless of what linguistic level was analysed. Thus regarding correction tendencies, slow developers clearly seemed to be aware of higher linguistic levels, such as syntax and semantics.

One interpretation of these seemingly contradictory results is that in decoding, the slow developers might not have focused on higher levels than the word level to any great extent (perhaps because too many of their cognitive resources were needed for decoding), but that after having decoded the word, they were often able to decide whether the word fit into the syntactic or semantic structure. If it did, the error was often ignored, while if it did not, it was often corrected. In contrast, among the fast readers, reading errors were often syntactically and semantically acceptable and thus fast developers seemed to have processed higher linguistic levels than the word level while decoding words.

Compared to slow developers, fast developers corrected errors more seldom, and in a manner that could not be correlated to their linguistic consequences. Also, when fast developers corrected their errors the corrections more often resulted in a correct reading than was the case among slow developers.

4.3.3 Study 3

Study 3 had a new perspective in some respects, in comparison with studies 1 and 2. The point of departure was that the word level (graphemic complexity/presumed familiarity) as well as the context (syntactic, semantic and at the text level) in which the words appeared might influence error frequency. Four of the texts used for readers at different reading levels were used in the study.

76 Regarding semantic consequences, no group differences were found.
In this study it was found that complex graphemic structures could only explain some of the errors. Words with low frequencies or words that could be expected to be unfamiliar to the readers frequently resulted in errors, regardless of their graphemic complexity. This suggests that the readers used their lexical knowledge to boost decoding. Also, a complex syntax, or an unexpected textual context could explain some of the errors.

The analysis also suggested a possible transition process through different phases regarding the readers’ utilisation of different linguistic levels. At an early phase (i.e. when reading the simplest text), they seemed to concentrate mainly on the graphemic level. Unfamiliarity and graphemic complexity, as well as an uncertainty about quantity, could explain most of the errors in this text. At a later phase the readers were apparently somewhat dependent on higher linguistic levels. This was shown by that fact that words in misleading contexts led to errors, at the same time as a constraining context sometimes appeared to facilitate decoding of potentially difficult words. At an even later phase, the readers did not seem to use context to facilitate decoding, but sometimes the error pattern suggested that a complex, or misleading syntax or context impeded decoding.

All through the study, instances of reading errors that can be connected to a strategy more or less reliant on sounding out were found, something which, for instance, difficulties with vowel quantity are signs of. Also, it seemed as if these readers used a direct access strategy, shown in the fact that function words quite often were replaced by other graphemically dissimilar function words. These different strategies were used independently of the extent to which higher levels were utilised in the presumed phases.

4.3.4 Study 4

The findings from study 3 gave rise to the question of whether graphemic transparency rather than graphemic complexity might explain why words resulted in errors.

The results from Study 4 revealed no clear relationship between the degree of transparency in words and error frequencies. Opaque words were often decoded correctly, while some fully transparent words led to surprisingly many errors. One somewhat puzzling finding was that words regarded as transparent in their graphemic and/or phonological context often resulted in errors (more often than fully transparent as well as opaque words). Again, other factors, such as syntactic or contextual aspects seemed to have affected the extent to which words were misread. It was confirmed that quantity was a general obstacle, especially in early phases of reading development. Regardless of transparency, reading errors often consisted of substitutions in which long vowels were shortened, or short vowels were
The second group, words that are only transparent given the graphemic/phonological context, consists of a number of sub-groups. Of course, one could have chosen to analyse these separately, since there could be differences in error frequencies within this group. As Söderbergh (1986) remarks, a number of Swedish morphemes such as plural, definiteness, genitive, etc., are marked by final morphemes and might be quite salient for the reader (see note 52, p. 41). Therefore, readers might decode these morphemes correctly quite early in reading development. A number of words in the second group were of that type. Also, as a rule, unstressed syllables have a short vowel sound, so long pronunciation would lead to an impossible sound structure for Swedish. Thus, if the readers utilise at least the word level in decoding they might favour a short vowel sound when the vowel follows a stressed syllable. Vowels preceding a gemination are generally stressed, and a stressed vowel could be either long or short; therefore, the choice of vowel quantity in these cases must be more conscious, and at least to a certain extent be based on some knowledge of spelling principles.

4.3.5 Summary of results

The point of departure for the investigation was to question the view of the predominant impact of lower linguistic levels in reading. It was confirmed that other linguistic levels than those at the sub-lexical level have an impact on reading, since all four studies revealed that these readers had utilised high as well as low linguistic levels in their reading. This was shown in various ways in the error analyses. At all analysed levels (word, syntax, semantics), the readers tended to make more reading errors that were acceptable than unacceptable. Also, according to a preliminary analysis, the reading errors were at the same time often graphemically similar to the printed words. Furthermore, the readers corrected errors that resulted in unacceptable linguistic consequences significantly more often than they corrected linguistically acceptable errors, regardless of the linguistic unit analysed (study 1). At the word level, presumably unfamiliar words frequently resulted in reading errors (study 3). Although the natural point of departure seemed to be the graphemic level (as revealed by the fact that substitutions often were graphemically similar to the printed word, study 1), analyses revealed that graphemic complexity or word transparency alone could not explain error frequencies (studies 3 and 4). In quite a few cases, a qualitative analysis (study 3) revealed that higher linguistic levels as well as knowledge of the world, for example, could explain both why words did and did not result in reading errors. However, phonological quantity

77 And consequently, the quantity of the consonant in the affected syllable was changed, owing to the complementary distribution of quantity in stressed syllables (see p. 28).
appeared to be a major difficulty (study 3) throughout the investigation, which is an aspect clearly related to the sub-lexical level.

The readers were video recorded over a period of two years. Some tendencies regarding the developmental perspective could be found. To investigate developmental factors, the data was analysed in two ways. Firstly, reading errors and correction tendencies were compared between readers who developed at different paces (study 2). Secondly, reading errors were compared between texts used for different reading levels (studies 3 and 4).

Though all readers tended to utilise information from all linguistic levels studied, some differences could be discerned in the data. As regards readers who developed slowly and fast, the former seemed to concentrate on the word level in decoding, but they utilised all linguistic levels in terms of correction tendencies. Slow developers made errors that led to real words to a larger extent than fast developers, but at the syntactic level the errors among the slow developers resulted more often in unacceptable syntax. Slow readers also corrected linguistically unacceptable errors on all analysed levels significantly more often than fast developers. Though fast developers tended to correct errors more seldom, their corrections more often resulted in correct readings than was the case among readers with slow or average reading development.

Some tendencies regarding the developmental perspective could be discerned in studies 3 and 4. Though difficulty with quantity was found in the errors obtained from all texts, this difficulty seemed to be most prominent in the texts used for readers in the earliest phases. The relative transparency of words was correlated with error frequencies only in a text that was read when the reader had advanced from the most initial phases (Text 3). The qualitative analysis (study 3) revealed no clear utilisation of higher linguistic levels than the word level in the text used when the readers were just about able to decode a running text without help. Conversely, such tendencies were found in relation to errors made in all other texts.
5 General discussion

The point of departure in the present investigation was to investigate the possible utilisation of higher linguistic levels in reading and to question the view of the predominant role of lower linguistic levels in decoding. It was hypothesised that higher linguistic levels would be utilised in the reading of running texts, either to enhance decoding or as a checking strategy, for example, to decide what reading errors to correct or leave uncorrected. In short, the first study, which analysed consequences of reading errors along with correction tendencies, found an impact of all linguistic levels studied (graphemic, lexical, syntactic, and semantic). The two studies that aimed to make closer analyses of what words did and did not result in errors, found that factors at the graphemic level could only explain some of the errors, while factors such as syntax or textual context were also able to explain some of the errors (studies 3 and 4).

Of course, although higher linguistic levels might be utilised in reading, we cannot ignore the fact that processes dealing with lower linguistic levels are of great importance when reading alphabetic scripts. This is especially noticeable in an orthography like Swedish, where there is a less complex relationship between graphemes and phonemes in words than is the case in English and other languages.

Two main methodological choices were made in the present investigation, both of which may have affected the extent to which higher linguistic levels were found to be utilised by the readers. The first choice concerns the texts. The second choice concerns the reading situation as such. As was mentioned above, especially the simplest texts (see p. 47) were quite unnatural and could be regarded as being more or less ‘quasi-texts’, and therefore we should not expect these texts to encourage extensive use of higher linguistic levels. Neither did the reading situation encourage the readers to read for comprehension (see p. 50). Thus, if the texts and the reading situation (in combination with the readers’ possible reading goals, see Just & Carpenter 1980) biased the readers at all, it is likely that they were biased towards a letter-by-letter decoding, or perhaps word-by-word reading, rather than towards a guesswork strategy based on higher linguistic levels. Therefore, if evidence of utilisation of higher levels were to be found in the investigation, this would be in spite of this possible bias towards lower linguistic levels.

In the following, a number of partially overlapping aspects of the results of the present investigation are discussed, starting with the role of a number of linguistic levels.
5.1 The sub-lexical level

Although processes at higher linguistic levels seem to have influenced decoding and correction tendencies, the graphemic level really seemed to be the point of departure for these readers’ decoding. This was shown in the preliminary analysis of graphemic similarities between printed words and reading errors in study 1.

Study 3 investigated the extent to which factors such as graphemic complexity (e.g. word length measured by number of syllables, or consonant clusters) could explain error frequencies (Balota 1994, Treiman 1993). The results were only compatible to a small extent with evidence of word length effects or proposals that complex spelling patterns such as consonant clusters would be complicating factors in beginners’ reading and spelling. However, although the general pattern of error frequencies could not be found to be connected to graphemic complexity in a simple manner (at least not the way it was measured in study 3), very long words containing a number of graphemically complicating features did result in numerous reading errors, even in the texts that were read when the readers were quite advanced. However, it is difficult to establish whether word length and/or graphemic complexity were the cue factors for explaining why these words resulted in errors, since long words often have low frequencies (see 5.2).

Although graphemic complexity (study 3) or relative word transparency (study 4) as such could not explain error frequencies, the qualitative analysis of errors revealed that many errors in the first text could either be explained by difficulties with quantity (see also Wimmer & Landerl 1997) or by the readers having confused similar letters.78 Thus, at an early phase, the readers actually seemed to focus mainly on the graphemic level, while in later phases, more evidence for the use of higher linguistic levels was found.

It could be that features of the Swedish orthography affect the extent to which beginners use a strict letter-by-letter decoding strategy. The fact that words in Swedish orthography are sometimes fully transparent and sometimes opaque is likely to blur beginners’ conceptions of the principles inherent in the Swedish orthographic system. This is especially noteworthy since many frequent Swedish words are opaque, and thus might obscure the pattern regarding, for instance, how quantity is generally marked in Swedish spelling (see also Thorstad 1991).79

---

78 However, the fact that word transparency seemed to have explanatory power in one text (Text 3) could indicate a developmental phase in which word transparency is important. Another explanation, which was never pursued, was that this particular text had features that encouraged greater focus on the graphemic level.

79 As mentioned above, the readers proved to have difficulties with quantity.
5.2 The lexical level

Various factors that could be associated with the lexical level were discussed in the background section. Firstly, in models of reading, some kind of direct decoding of words stored in a mental dictionary of written words has often been suggested. Secondly, in word recognition studies, features at the word level, such as frequency, familiarity or word length, have been presumed to affect reading. (For overviews, see Balota 1994, Harley 2001.)

Some results in the present investigation are clearly in line with models assuming a direct route for decoding frequent words, etc. (e.g. ‘dual-route’ models). An outcome in line with this notion was the fact that function words (see studies 3 and 4) often seem to have been decoded by direct access.\(^\text{80}\) Indications of such direct decoding were that function words were often, on the one hand, decoded correctly regardless of graphemic complexity or transparency, and on the other hand – when they resulted in errors – were frequently replaced by other function words. These results were also interpreted as revealing utilisation of higher linguistic levels than the word level, since the substitutions quite often fit into the syntactic structure. Another outcome in line with the notion of a sight word vocabulary is the reverse result for words that were presumed to be unfamiliar and/or had low frequencies. In the texts used in studies 3 and 4, these words often resulted in errors, even when they had very simple graphemic structures. The readers clearly used their lexical knowledge to boost decoding, and this strategy/behaviour seemed to be maintained more or less throughout the study.

The fact that low frequency or presumed unfamiliar words resulted in reading errors to such a large extent is also in line with Share’s (1995) notion of item sensitivity, and Seymour’s (1994) ‘dual foundation’ model, which is discussed below (5.4).

Another aspect concerning the word level was the readers’ tendency to produce errors that were real words or nonwords, and their tendency to correct them. In the present investigation, more than 60% of the errors resulted in real words. However, although the majority of the errors resulted in real words, a substantial number of the errors were also nonwords. It is quite clear that the readers in the present study as a group were not what Gough et al. (1992) would designate ‘code readers’.\(^\text{81}\) Instead their point of departure was the graphemic representation (see 5.1). This is not a surprising finding, taking into consideration the fact that these readers were all able to decode a running text without help. Errors that resulted in...

---

\(^{80}\) However, dual-route models, etc., are mainly models of skilled reading, even though some of them aim to account for impaired or developing reading as well (e.g. Bjaalid et al. 1997, Patterson & Morton 1985).

\(^{81}\) The term ‘code readers’ refers to readers who are guessing from other sources than the letters, such as syntax, textual context, or world knowledge (similar to the ‘logographic phase’), rather than being engaged in the recoding of strings of letters.
nonwords were corrected significantly more often than errors that resulted in real words, but a sizeable number of the nonwords were left uncorrected, which is surprising if we expect these readers to be reading for comprehension.

However, an important point about words versus nonwords is that children learn an enormous number of new words during their school years and, quite possibly, they first come across many of them in print. Thus, for the beginner, some real words that they read sound more or less like nonwords, since they are unknown to them. Consequently, if the readers produce errors that result in ‘pseudo words’ (see p. 52) these might appear just as ‘real’ as existing words, especially if they fit into the syntactic structure of the text. In fact a later check including all reading errors made in all recordings revealed that nonwords (including both ‘pseudo words’ and pure nonwords) fit into the syntactic structure in almost 80% of the cases.82

5.3 Higher linguistic levels

The results of the investigation gave clear indications of the presumed utilisation of higher linguistic levels among these readers. Reading errors were often acceptable at the syntactic and semantic levels as well as of the word level, and the readers corrected errors that had unacceptable linguistic consequences at these levels significantly more often than they corrected linguistically acceptable errors. Also, the studies that investigated the extent to which graphemic complexity or relative word transparency could be regarded as cue factors for error frequencies found that this was not the case. On the other hand, it was found that aspects at the syntactic, semantic or textual level as well as knowledge of the world could explain some of the errors.

It is of course hard to establish the extent to which the observed utilisation of higher linguistic levels should be regarded as part of a normal reading strategy or a compensatory strategy for insufficient decoding skills (e.g. Stanovich 1980). However, the studies that were partly used to investigate a developmental perspective (studies 3 and 4) gave us some indications that higher linguistic levels were not utilised to any great extent until the readers had completed the very first steps of reading development. Thus, at least in the initial stages of reading development, these readers concentrated on the graphemic level and were neither helped nor disturbed, by information at higher linguistic levels than the word level. At a later phase, they seem to have used higher linguistic levels to enhance decoding or to have been disturbed by complex syntactic structures or unexpected contexts to some extent (study 3). The fact that no facilitating effects were found in

82 These results have not been reported elsewhere.
the most advanced text suggests that the readers were skilled enough by then to rely on their decoding ability, but still not skilled enough not to be disturbed by complex syntactic structures or unexpected contexts, for example. It is possible, however, that the characteristics of the texts that were used early in reading development affected the extent to which the readers utilised higher linguistic levels.

As regards readers with different developmental paces, study 2 indicated that readers with slow reading development did not utilise levels higher than the word level in decoding, but that they used higher levels to decide whether or not to correct their errors. 83

In summary, all the studies revealed utilisation of higher levels among these readers. When higher levels were only sometimes utilised, this was mainly the case early in reading development, or among readers with slower reading development than the rest of the group. Thus, the results from the present investigation are not compatible, for example, with Stanovich’s (1980) view of the compensatory use of higher linguistic levels among less skilled readers. However, as was found in studies 3 and 4, readers who were skilled enough to read the relatively complex Text 4 may not have utilised higher levels to enhance decoding, but were disturbed by a complex syntax or a misleading textual context.

5.4 Reading development

Some aspects that may be associated with the developmental perspective are considered above. Below, a few remarks are made on findings in the present investigation having to do with models of reading development (see Ch. 3). The aim of the investigation was not to evaluate models of reading development, but interesting conclusions can nevertheless be drawn.

It must be pointed out that all analyses in the present investigation used data from readers who had already broken the alphabetic code, and were thus at least in the ‘alphabetic phase’ (or equivalent) according to most models of reading development. Since this phase implies that reading is performed in a letter-by-letter fashion, we could assume that our readers only able to decode the simplest texts that were used in the investigation to exhibit such a strategy. The two studies that could have revealed such strategies (studies 3 and 4) did not fully support such a conclusion. Instead, a number of words seemed to be decoded by sight even in the simplest texts (such as some high frequency function words). Also, when reading texts that were used for more advanced readers, the readers seem to have used various decoding strategies. Some words were obviously decoded letter-by-letter (which was shown, for example, by the reading errors that revealed

83 Though we cannot know whether this is the case, it is possible that errors were not even noted when they fit into the linguistic structure.
difficulties with quantity), while others appear to have been decoded using a
direct strategy.

The implicit notion in most models of reading development is that begin-
nning readers pass from one stage that is signified by certain decoding
strategies, to another stage in which qualitatively different strategies are
used. For example, most models assume an early transition from a stage that
is distinguished by an unanalysed whole-word decoding strategy (‘logog-
ographic reading’) to another stage that is distinguished by an alphabetic recoding strategy (‘alphabetic reading’) and a later transition from an
alphabetic recoding strategy to a final strategy in which words, or larger
parts of words are recognised as whole units (‘orthographic reading’). It is
not regarded a ‘default’ behaviour to use various strategies for different
words in texts. The results of the present investigation clearly reveal that
this is normal reading behaviour among these Swedish beginners, regardless
of their relative reading skill. This result can be connected to the concept of
item sensitivity (see p. 33), advocated by Share (1995), as well as
Seymour’s (1994) ‘dual foundation’ model, in which it is presumed that
readers use a variability of strategies from early in reading development.
Low-frequency words or words that could be expected to be unfamiliar to
the readers frequently resulted in errors (study 3). Qualitative analyses of
the errors revealed that these words were often decoded in a letter-by-letter
fashion, even by quite skilled readers. Also, as was mentioned above, high-
frequency words often seemed to have been decoded by direct access, even
by readers in early phases of reading development. Of course readers differ
as to their inclination to use a letter-by-letter reading strategy, etc., but these
differences appear to be quantitative rather than qualitative.

5.5 Concluding remarks

In conclusion, the use of an exploratory approach such as the one used in
the present investigation can definitely reveal a great deal about reading
behaviour. A combination of qualitative and quantitative analyses also
proved to be fruitful. Quantitative analyses revealed, for example, general
patterns about linguistic consequences and reading errors as well as patterns
of correction behaviour; in both cases showing a clear sensitivity to both
high and low linguistic levels. Qualitative analyses of substitution errors,
etc., as well as the contexts in which errors occurred revealed what the
readers might have expected in the texts, and also to what extent syntax or
textual context might have misled them. In that part of the analysis similar
results to those obtained in the quantitative analyses were obtained; namely
that the readers had utilised linguistic information at all levels. The
qualitative analyses also showed that these readers had general difficulties
with quantity, especially in texts that were read early in their reading
development, and that they used different strategies for decoding different words.

One interesting finding in the present investigation is the fact that these readers – regardless of reading ability – used different strategies when decoding different kinds of words. This is a result models of reading development generally would not predict. In models of reading development, beginners are thought to pass through different stages in which qualitatively different reading strategies can be observed. In the present investigation, however, a pattern in which readers used a sounding out strategy for a number of words (often content words, and at later stages particularly content words with complex spelling patterns), and a direct decoding whole-word strategy for other words (often high-frequency function words) was found. This is in line with Share’s (1995) notion of item dependency, and fits nicely into Seymour’s (1994) ‘dual foundation’ model, in which it is assumed that even beginning readers use a combination of strategies involving alphabetic recoding as well as decoding of larger linguistic units, such as syllables, rimes, and whole words.
References


Ho, Connie Suk-Han & Bryant, Peter. 1997. Phonological skills are important in learning to read Chinese. *Developmental Psychology* 33: 946–951.


SAS, version 8.02, SAS Institute Inc., Carry, NC, USA.

SPSS, version 11.00, SPSS Inc., Chicago, Illinois, USA.


Stanovich, Keith E, Cunningham, Anne E. & Feeman, Dorothy J. 1984. Relation between early reading acquisition and word decoding with and without context: a


