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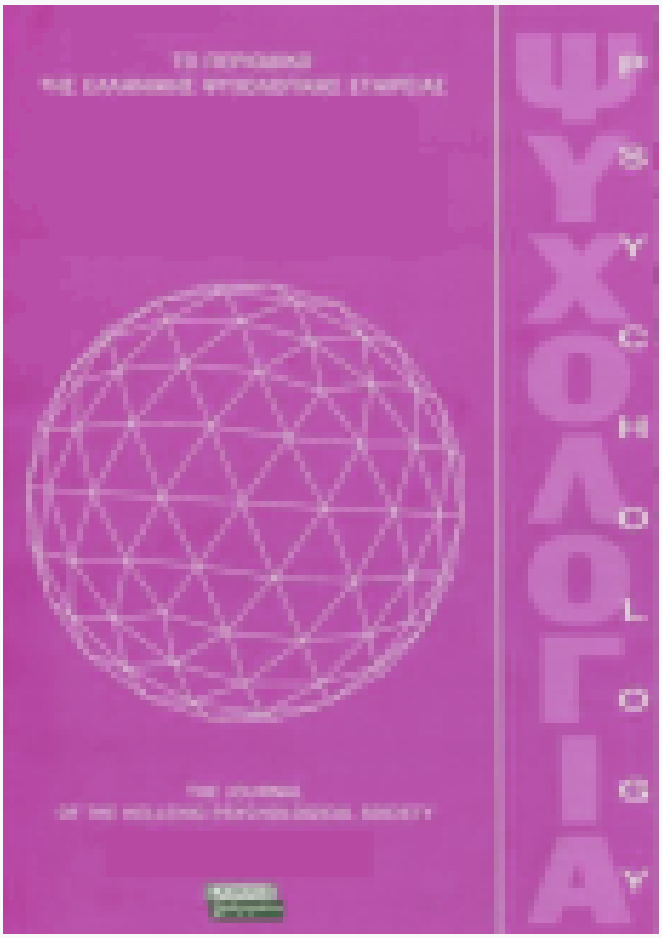

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Learning to read in English

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ABSTRACT The paper provides an overview of the process of learning to read in English with special reference to a programme of research carried out at the University of Dundee in Scotland. Learning in a language such as English, which has a complex syllabic structure and deep orthography, is contrasted with learning in a language such as Greek, with its simpler syllabic structure and consistent grapheme-phoneme correspondence system. A theoretical scheme, referred to as the 'dual foundation model', is presented as a framework for discussion of learning to read in both types of orthography. Development is characterised in terms of a sequence of phases, each defined by a focus on a particular level of linguistic structure. A distinction is proposed between implicit (epilinguistic) awareness and explicit (metalinguistic) awareness of language units. In the initial (foundation) phase children come to terms with the alphabetic basis of writing and develop explicit awareness of small linguistic units (phonemes). This phase may involve a dual (logographic + alphabetic) process in English. The orthographic phase involves the internalisation of the spellings of monosyllables. Inconsistency of English spelling is, to some extent, offset by grouping words in terms of rime (V+C) units. At a subsequent (morphographic) level higher-order units (syllables, morphemes) are formed. The whole process is much slower in English than in Greek, and all phases are vulnerable to dyslexic disturbance.

Key words: Dyslexia, Literacy, Orthography.

Introduction

We are grateful to Costas Porpodas of University of Patras for the invitation to contribute to this special issue of the Greek Journal of Psychology. Our intention is to give an outline account of the process of learning to read and the occurrence of reading difficulties in the English language. This topic has been the focus of a vast effort of research in the UK, the USA and elsewhere throughout the English-speaking world. We will not attempt to review this huge literature in a systematic way but will instead set out our own ideas on the matter with references to studies which have been carried out by the literacy research group at the University of Dundee in the east of Scotland over a number of years. Costas Porpodas himself participated very significantly in the early stage of this research (Seymour & Porpodas, 1980).

The presentation of this work in the Greek journal immediately raises questions about the possible contrast between English and other alphabetic orthographies. The English writing

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system has been shaped by multiple historical influences from Germanic, French and classical Greek and Latin sources, and is recognised to be a *deep* orthography in which relationships between letters (graphemes) and elements of speech (phonemes) are variable and inconsistent and subject to higher-level morphological constraints. The Greek writing system, by contrast, has a much more transparent system of grapheme-phoneme correspondences and can be described as a *shallow* orthography. One important question concerns the ways in which learning to read in a deep orthography such as English may differ from learning to read in a shallow orthography such as Greek. Katz and Frost (1992) formulated an *orthographic depth hypothesis* which states that skilled reading, as indexed by performance on tasks such as word and non-word naming or lexical decision, differs between deep and shallow orthographies.

"... The orthographic depth hypothesis (ODH) ... states that shallow orthographies are more easily able to support a word recognition process that involves the language's phonology. In contrast, deep orthographies encourage a reader to process printed words by referring to their morphology via the printed word's visual-orthographic structure." Katz and Frost (1992, p. 71.)

Our discussion will include some speculations on ways in which variations in orthographic depth might affect the process of learning to read.

Developmental stage models

The early theoretical accounts of reading acquisition in English took the form of stage models in which distinctive strategies for dealing with printed words were held to emerge in a particular sequence. A common feature of these models was an assumption that a young child's first approach to reading will necessarily be oriented towards meaning rather than sound structure. In this respect, reading acquisition was thought to recapitulate the historical evolution of written languages which supposedly had developed from meaning-based pictographic and logographic systems towards phonographic systems, including syllabaries and, eventually, alphabets (Gleitman & Rozin, 1977).

Marsh, Friedman, Welch, and Desberg (1981) adopted a Piagetian framework and believed that children were limited to a whole word strategy until their cognitive development advanced into a concrete operational stage at about 7 years of age. Gough and Hillinger (1980) also perceived the first stage of reading acquisition as a matter of identifying familiar words on the basis of partial features. Progress to a subsequent stage of *cipher* reading was held to depend on knowledge of the alphabet and access to the phonemic structure of speech. Similarly, Frith (1985) considered that the first stage in reading involved a whole word *logographic* strategy and that the critical step towards adoption of an *alphabetic* strategy depended on capacity to develop a phonological awareness of speech structure. She also argued that a further *orthographic* strategy could be identified in which reading and spelling were organised in terms of abstract structures corresponding to syllables and morphemes.

Various studies were conducted in Dundee with the aim of testing some of the assumptions of these models. Seymour and Elder (1986) undertook a detailed monitoring of reading development in a class of new entrants to primary school (aged 5 years) by assessing capacity to identify familiar (already taught) words and unfamiliar (not yet taught) words. The children behaved exactly as predicted according to the proposal that there is an initial *logographic* stage in reading acquisition. Their reading was limited to taught words and they were entirely unable to read unfamiliar words, the most usual responses being refusals or substitutions of known words. A very similar pattern of performance was observed by Evans and

Seymour (1999) in two boys with a chromosomal abnormality (48,XXXY syndrome) who were found to have developed an extensive reading vocabulary of familiar words in the absence of any capacity to derive a pronunciation for unfamiliar words or non-words. This study supports the conclusion that there may be genetic or other factors which permit the development of a logographic strategy while preventing the achievement of an alphabetic strategy. Frith (1985) believed that a pattern of this kind was the basis of what she called "classic developmental dyslexia".

In the case of the normal group studied by Seymour and Elder, it was noted that the teaching philosophy followed in the Primary School emphasised whole word learning and discouraged letter-sound learning and decoding. Hence, the commitment of these children to a logographic approach in their first school year could be a product of the teaching regime rather than evidence of a natural sequence in literacy development. This view was supported in a subsequent longitudinal study conducted in a different school by Seymour and Evans (1992). This second school adopted the 'mixed' method which is typically found in Scotland, involving the concurrent teaching of logographic (whole word) strategies and alphabetic (letter-sound, decoding) strategies. The analysis of reading progress suggested that the children developed the two strategies concurrently and that the processes 'merged' into a single system later in development.

On these grounds, it seems likely that the hypothesis that a logographic process is a *necessary* first step in learning to read can be rejected. Stuart and Coltheart (1988) argued that this approach may be followed *faut de mieux* by children who begin reading in the absence of adequately developed phonemic and alphabetic skills. Where these skills are available children's initial steps in reading may be phonologically and alphabetically based from the start. Stuart and Coltheart made an analysis of error responses in attempts at reading words. They reported that children who possessed a phonological and alphabetic basis for reading produced characteristic word substitution errors which preserved the boundary (initial and final) letter-sounds of the target. These children also went on to show the most rapid subsequent reading progress. Children who lacked this basis generated randomly structured errors and made poorer progress in reading.

Very similar proposals were made by Ehri (1992). She set out to provide an account of 'sight word' learning at the beginning of reading acquisition. Her conclusion was that knowledge of the letters of the alphabet and their names was the critical prerequisite for learning. Prior to this children rely on visual cues to identify words, a process which is inherently imprecise and error-prone. As the letters are acquired word recognition enters a *semi-phonetic* phase in which words are identified on the basis of some letter-sound relationships, usually located at the beginning of the word or at the beginning and the end. As a demonstration, Ehri and Wilce (1985) showed that if beginning readers were asked to learn letter strings as symbols for words their performance was sensitive to links with sound. It was easier to learn JRF as a symbol for "giraffe" than to learn WBC as a symbol for "giraffe". Subsequently, word learning advances to a *cipher* phase in which words are defined by their full set of component letter-sound relationships. Achievement of this stage is dependent on the development of concurrent decoding procedures for systematic sequential analysis of sounds contained in sequences of letters. Ehri (1997) argued that more advanced stages of word learning involved a *consolidation* process in which commonly occurring structures, such as rhymes or syllables or morphemes, were grouped together.

Dual foundation model

The Dundee model of reading acquisition incorporates ideas from these different sources. This framework, referred to as a 'dual foundation' model of reading acquisition, has been developed over a number of years (Seymour, 1990, 1993, 1997, 1999). A diagrammatic representation is shown in Figure 1.

The model identifies two major cognitive components as necessary for the theoretical description of reading acquisition. The first of these is referred to as *Linguistic Awareness* and is envisaged as a system in which the segmental structure of speech is represented. The second is referred to as the *Orthographic Framework* and can be seen as a system in which knowledge of the spelling structure of a language is represented in an organised format. These two central systems contain some internal divisions, the most important being the distinction between phonological and morphological segmentation in the Linguistic Awareness component, and between orthographic (phonologically-based) and morphographic (morpheme-based) levels of the Orthographic Framework. The model also identifies two *Foundation* processes, a *Logographic* process involved in the identification and storage of spellings of whole words, and an *Alphabetic* process involved in the sequential decoding and pronunciation of letter sequences.

As is shown in the diagram, reading acquisition is thought to involve a large amount of interaction among these four components. Unidirectional arrows from the Foundation processes to the Orthographic Framework signify that the foundations accumulate and transmit knowledge and structure which are necessary for the proper formation of the framework. Bi-directional arrows linking Lingui-

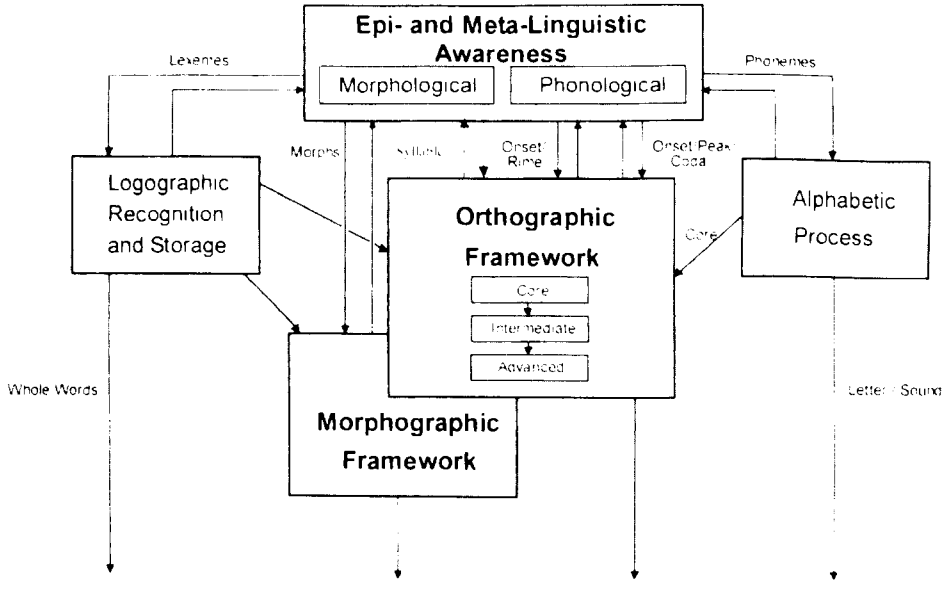

Figure 1
Schematic representation of the dual foundation model of literacy acquisition (adapted from Seymour, 1999).

stic Awareness to the Orthographic Framework and the Foundation processes indicate that there is a two-way relationship between literacy and language awareness, such that Linguistic Awareness is shaped by developing literacy while simultaneously supporting literacy.

There is one further general point to be made in this connection. The diagram indicates that Linguistic Awareness has two representational levels which are labelled, following the analysis of Gombert (1992), as *Epilinguistic* and *Metalinguistic*. The epilinguistic level refers to an organisation of language structures which exists in an implicit form which is inaccessible to conscious processes of inspection or control. The metalinguistic level refers to an organisation of these same structures which is articulated in an explicit format and which permits isolation and manipulation of elements. These two levels are integrally involved in the two-way interactions between linguistic awareness and literacy acquisition and will be referred to in what follows as the *epi-* level and the *meta-* level.

In a recent account (Seymour, 1999), it is suggested that the model can be discussed in terms of *phases* of development. These phases are not supposed to be discrete or strictly sequential in the sense of the earlier stage models of reading acquisition. Rather, it is allowed that they overlap in time in a cumulative fashion. The distinction is mainly that a particular component (or set of components) of the model could be seen as the dominant area of change within a given phase. Four main phases have been identified: *Phase 0*: Pre-literacy, referring to the period prior to the development of literacy; *Phase 1*: Foundation literacy, referring to the initial phase of literacy acquisition when the foundation processes are formed; *Phase 2*: Orthographic literacy, when the orthographic framework is constructed; and *Phase 3*: Morphographic literacy, when the morphographic framework is constructed.

We will discuss each of these phases in turn and will consider evidence regarding the acquisition of literacy in English and the possible contrast with acquisition in shallower orthographies, such as Greek.

Phase 0: Pre-literacy

This phase refers to children who have not yet started to read. In the UK, where formal primary school education starts at 5 years, these will be 3-4 year old children whose knowledge of reading may be non-existent or restricted to the recognition of one or two letters and possibly a few printed items, such as their own name or commonly occurring signs or logos. The only component of the model which is present at this time is the Linguistic Awareness structure. The issues which are of interest in terms of theory and educational practice concern the content of Linguistic Awareness in pre-literate children, the significance of this organisation for later reading acquisition, and the possibility that pre-school (kindergarten) education might help to create a suitable linguistic basis for learning to read.

From this it follows that the analysis of Phase 0 requires an understanding of the linguistic organisation available to pre-literate children. This is essentially a question about the *linguistic units* which are represented and whether these units are defined at an *epilinguistic* or at a *metalinguistic* level. On the question of units, the preliminary distinction is between morphological structure and phonological structure. Words might be divided into their component morphemes, as in Figure 2a, or into component syllables, as in Figure 2b. Syllables, in turn, can be analysed into sub-syllabic components, either a sequence of phonemes as in the linear model of the syllable (Figure 2c), or into a hierarchical structure which identifies intermediate onset-rime or body-coda structures between the syllable and phonemic levels (Figure 2d) (Treiman & Zukowski, 1991).

The proposal here is that the words of the language are decomposable into smaller elements which recur in numerous contexts and

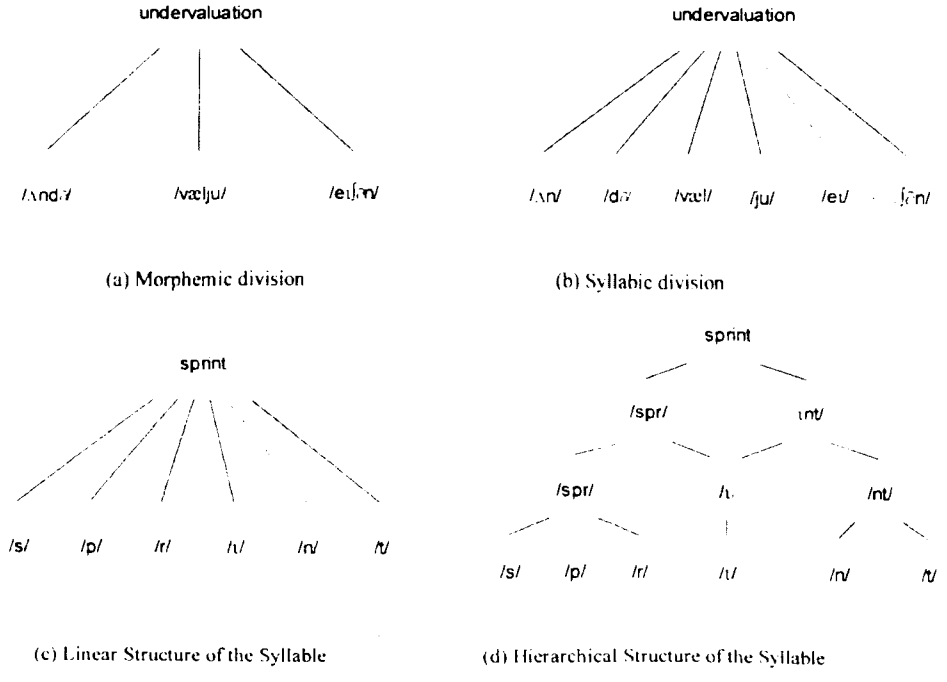

Figure 2
Examples of sub-lexical linguistic structures based on (a) morphological units, (b) syllabic units, and sub-division of the syllable into (c) phonemic units or (d) a hierarchical structure including body/rime and onset/peak/coda levels.

form the building blocks which are combined in the production of speech. The Linguistic Awareness system becomes functional as soon as this feature is acknowledged. As previously noted, the organisation may exist at a purely epilinguistic level. If so, a child might be unable to point out the units composing their language but could nonetheless perform tasks which suggest the presence of some sensitivity to the units (Gombert, 1992). From this, we can move towards the suggestion that there may be some linguistic tasks which can be performed using epilinguistic awareness of language structure alone and other tasks which can only be performed if an explicit metalinguistic awareness is available. There is already a very large literature regarding the assessment of linguistic awareness and a wide range of tasks and procedures which have been used (Goswami & Bryant, 1990). What we would like to propose is that these tasks can now be re-examined and re-classified in order to establish: (1) which linguistic units are essential for performance of the task, and (2) whether the task can be performed using epilinguistic awareness or whether metalinguistic awareness is required.

Epilinguistic tasks. It is proposed that tasks which assess a capacity to make broad judgements of similarity or difference of spoken words are appropriate for assessing awareness at an epilinguistic level. One example of such a task is the odd-word-out procedure originally

introduced by Bradley and Bryant (1978). In these studies children hear sets of three or four spoken words and are asked to indicate which one appears different from the others. The structure of the items is such that all but one of them share a segment of sound. This shared segment can be defined at different linguistic levels including morphemes, syllables, onset-rimes, or phonemes. Samples of such materials are shown in Table 1. Another example is the same-different matching task used by Treiman and Zukowski (1991). Under this procedure, children hear pairs of spoken words and must respond positively if the words sound similar and negatively if they do not. Again, it is in principle possible to base the similarity on linguistic units which are defined at different levels, including syllables, onset-rimes, and phonemes. Examples are shown in Table 1. More natural tasks, such as creating rhymes or alliterations, are also probably able to be performed at an epilinguistic level.

Metalinguistic tasks. A task may qualify as an assessment of metalinguistic awareness if it demands a capability to isolate, manipulate or articulate specific linguistic segments. There are numerous examples in the literature, mostly employed to assess metalinguistic awareness of *phonemes.* In the deletion task, a child is presented with a spoken word and is asked to report what would be left if the initial phoneme was removed, e.g., "sand" → "and". In an inversion task, a spoken syllable is provided and the child must reverse the order of the component phonemes and report back the outcome, e.g., "os" → "so". Segmentation tasks require the child to break a spoken word into fragments and report the fragments in sequence, e.g., "cat" -"c", "a", "t". Again, it is in principle possible to adapt these tasks in order to vary the level of linguistic structure which is assessed. This can be illustrated by reference to a "common unit" task introduced by Duncan, Seymour, and Hill (1997). The child listens to a pair of spoken words and must respond by articulating the segment of sound which they

Table 1
Example of sets of spoken words used in assessment of epilinguistic and metalinguistic awareness

		Target Unit		
		Syllable	Rime	Phoneme
Epilinguistic level				
Odd-word-out[1]		lettuce-leopard-comic	wall-hall-duck	mop-man-dish
		jumper-jumble-tartan	meat-sheet-roof	boat-bear-moon
Same-different judgement[2]	Yes	button-bubble	pin-win	bank-bird
		window-winter	hot-cot	sun-sock
	No	cobweb-purple	dog-fan	car-leg
Metalinguistic level				
Common unit		panic-paddle	boat-goat	face-food
identification[3]		bunches-bundle	jug-rug	hen-hat

[1] The child responds to 3 (or 4) spoken words by indicating the one which differs from the others.

[2] The child responds to pairs of spoken words by indicating whether they sound similar or not.

[3] The child responds to pairs of spoken words by reporting the segment of sound which they share.

share. For example, given the pair "greek - squeak", the response "eek" should be given. Here, meta- awareness of language structure at the *rime* level is assessed. If the pair was "greek - bake" the response should be "k" and it is the *phoneme* level which is being assessed. Further examples appear in Table 1.

We have carried out studies of pre-readers in Dundee using both epilinguistic and *metalinguistic* tasks with phonological units defined at different levels of the syllable hierarchy (see Figure 2d). A general conclusion has been that English-speaking pre-schoolers (generally aged 4 years in our samples) cannot perform *metalinguistic* tasks at any level of linguistic structure. Seymour and Evans (1994) presented pre-readers with spoken monosyllables (words and non-words) under instruction to segment the item into two parts (onset-rime division) or three parts (onset-peak-coda division) or as many parts as possible (phonemic division). The children were unable to segment at any of these levels. Duncan and Seymour (2000a) presented pairs of items which shared segments defined at a body, rime, onset, coda or phonemic level in a version of the common unit task. Again, pre-readers proved unable to perform the task at any of these levels. In a further study bi-syllabic words containing shared syllables were presented. Pre-readers were unable to articulate the shared syllables in this situation.

From these studies, we conclude that English-speaking children do not possess meta-awareness of *any* level of linguistic structure at the time when they approach the formal task of learning to read. This may not be true of all languages. For example, Pascale Colé and Annie Magnan recently applied a French version of the common unit task to a group of French-speaking pre-readers. These children were able to articulate shared syllabic segments, but not smaller segments. Rather similar findings were obtained by Ana Paula Vale in Portugal. She found that pre-readers were able to retrieve shared (CV-) body structures in her version of the common unit task. The body structure corresponds to the predominant (open) syllable type in Portuguese. French has a clearly articulated syllable structure which also includes a predominance of open CV- syllables. There is an implication therefore that, in languages with simple and strongly defined syllables, children may well achieve meta-awareness of the syllable before they start learning to read. Since Greek has a similarly clear and open syllabic structure, it could be anticipated that repetition of these experiments with Greek pre-readers would also confirm early availability of meta-awareness of the syllable. Porpodas (1989, 1990) has reported studies of 5 year old Greek pre-readers which support this conclusion. The pre-existence of this awareness could then be very helpful to children in forming syllabic units as a basis for fluency in learning to read.

Given these negative findings regarding the availability of meta- awareness of linguistic segments among English-speaking pre-readers, the main emphasis in research has been on the possibility that pre-readers may possess *epilinguistic* awareness of language structures and that this awareness may provide an important basis for later reading. Rozin and Gleitman (1977) thought that the syllable might be a significant structure in initial reading. There is good evidence that pre-readers may often possess epilinguistic awareness of syllables from Treiman and Zukowski's (1991) studies using the matching task and Liberman, Shankweiler, Fischer, and Carter (1974) studies of children's ability to indicate the number of syllables (1, 2 or 3) contained in a word by tapping with a dowel. However, there has been little interest in syllable awareness as a predictor of later reading success in English or in the syllable as a unit to be emphasised in early reading instruction. Much more attention has focused on intermediate sub-syllabic structures, particularly the onset-rime division of the syllable (Figure 2d.). Treiman and Zukowski reported that pre-readers possessed awareness of onset-rime units at a level

intermediate between syllable awareness and phoneme awareness. Data of this type have appeared to support a *progressive* account of the development of epiphonological awareness as following a large unit to small unit sequence, i.e., syllable → onset-rime → phoneme.

Bryant and colleagues in Oxford carried out extensive studies to test the proposition that pre-literate (epilinguistic) awareness of onset-rime structures might predict subsequent reading progress. In these studies, pre-schoolers aged 3 or 4 years performed odd-word-out tasks in which the rime was the basis for detection of the oddity. Scores on this task were then entered into regression analyses to test capacity to predict reading progress following the start of formal instruction in primary school. The analyses followed a fixed order model in which general factors, such as intelligence, memory, and social background, as well as performance on other phonological tasks, were taken into account before considering whether early rime awareness could be shown to have a residual correlation with later reading (Bryant, MacLean, Bradley, & Crossland, 1990; MacLean, Bryant, & Bradley, 1987). Positive outcomes in these stringent analyses led Goswami and Bryant (1990) to propose a causal model in which a link between early rime awareness and subsequent reading development is postulated. Theoretically, this link was interpreted in terms of a connection between rime awareness and capacity to read by analogy, i.e., by exploiting similarities in the rime segments of written words to read new words and group words into rime-defined families (Goswami, 1986, 1988).

The research conducted in Dundee has included studies which bear on this question of a relationship between pre-school epilinguistic rhyming ability and later reading progress (Duncan et al., 1997; Duncan & Seymour, 2000b). Bradley and Bryant (1983) previously argued in favour of a combination of two methodologies when attempting to assess the validity of causal accounts of reading progress: (1) the *intervention* or training study, in which the target capacity (here rhyming) is improved by training and tests are then made for a subsequent effect on reading; and (2) the *predictive* study in which pre-school measures of the capacity (rhyming) are correlated with later reading using the regression procedures to control for extraneous factors. Both of these techniques were used in our study. Children were initially studied in Nursery School (aged 4 years) and were then followed as they progressed through the first two years of Primary School (aged 5-6 years, and 6-7 years). The sample (N = 84) undertook a test of rhyme production at the end of the pre-school period and a formal test of reading (British Abilities Scale word recognition sub-test) at the end of the Primary 1 and Primary 2 years. In addition, a complete class in one of the participating Nursery Schools underwent a training programme which emphasised rhyme awareness and rhyming abilities. Other classes involved in the study received other forms of training or served as untreated control groups.

It was found that the rhyme training was very effective in improving rhyming ability in the group of pre-schoolers but that there was no discernible effect on later reading (i.e., no difference between the rhyme training group and treated or untreated control groups in reading age scores in Primary 1 or Primary 2). Predictive relationships were tested using two statistical methods. Initially, fixed order regression analyses were deployed in order to test contributions of rhyming to later reading. In no case were we able to find a relationship between rhyming and reading when rhyming was entered as the final step in the analysis. Subsequently, a path analysis was carried out and a model of predictive relationships extending across the pre-school and primary school periods was constructed. This analysis suggested that the key pre-school predictor of later reading was the possession in nursery school of a knowledge of a few letters of the alphabet, possibly concurrently linked to the

emergence of alliteration ability (capacity to generate words beginning with the same phoneme). There was no statistically reliable link from rhyming to later reading although rhyming appeared to be connected with the development of arithmetical ability.

On the basis of these analyses, Duncan and Seymour (2000b) concluded that caution was needed before accepting the proposition that a special (language specific) feature of learning to read in English is that it is a rime-based process which builds on pre-school (epilinguistic) awareness of rhyming. It seems more likely that learning to read in English, as in all other alphabetic orthographies, is initially *phoneme* based. If so, the critical question for Phase 0 may be whether or not epilinguistic awareness of the phonemic structure of speech is available at the time when reading instruction commences.

Phase 1: Foundation literacy

According to the model (Figure 1), the important development during the beginning phase of literacy is the formation of the two foundation processes. An additional assumption is that *both* foundations are dependent on the prior availability of a knowledge of the letters and their links with sounds in speech. It is further supposed that the formation of the foundations is accompanied by an interaction with Linguistic Awareness which results in the emergence of *metalinguistic* awareness of relevant linguistic structures. Duncan and Seymour (2000) expressed these relationships in the format of a simplified diagram which is reproduced in Figure 3.

In Dundee we have carried out a series of studies of this preliminary foundation phase of literacy acquisition in English. These studies have been directed towards the analysis of foundation literacy acquisition in different groups, including: (1) normally developing readers in the Primary 1 and Primary 2 classes; (2) reading disabled (dyslexic) children (Seymour & Evans, 1999); (3) children from poor socio-economic background (Duncan & Seymour, 2000); and (4) cross-language comparisons between English

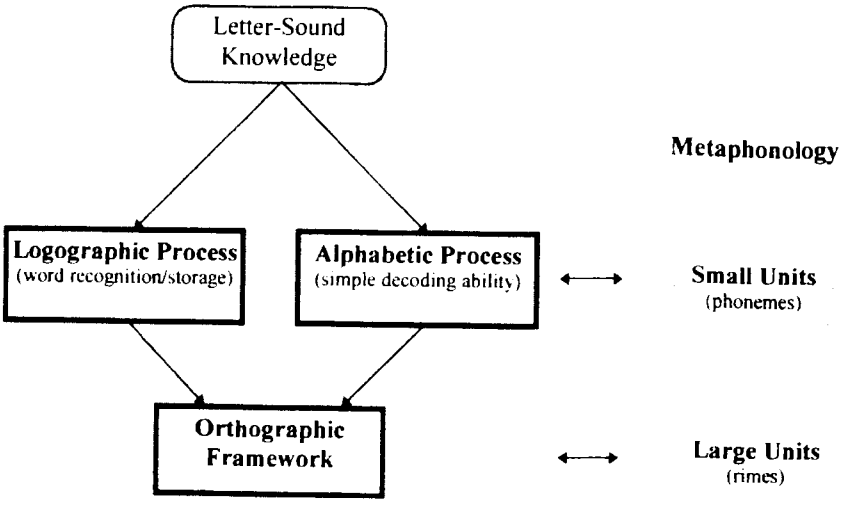

Figure 3
Simplified model of foundation level processes in reading (from Duncan & Seymour, 2000).

and other European orthographies. The cross-language comparisons were conducted within the framework of the COST A8 Action, a European framework program entitled "Learning disorders as a barrier to human development", which forms a background to many of the articles in this special issue. The outcomes will be discussed with respect to each of the three components of the foundation.

Letter-sound knowledge. The essential preliminary step in literacy acquisition is seen as the learning of the visual forms of the letters and their association with speech, either as the letter's 'sound', or as its 'name'. This has been assessed by asking children to give sounds or names for visually presented letters, or to write (or select) a letter in response to a spoken sound or name. We found that letter-sound knowledge is usually acquired within the first year of formal teaching. This occurs in an equivalent way across languages and appears to be independent of variations in orthographic depth and complexity. Letter-sound acquisition was delayed in some dyslexic children and this effect was extreme in a small number of cases, referred to as instances of *literal dyslexia* by Seymour and Evans (1999). These children encountered great difficulty in mastering letter-sound correspondences despite extensive teaching and encouragement and all made exceptionally poor progress in their reading in the primary school. Duncan and Seymour (2000) found that letter-sound acquisition was delayed in children from poor socio-economic backgrounds. They came into primary school with weaker pre-literate letter-sound knowledge than their peers from more advantaged circumstances and took longer to establish the letters. Additional analyses indicated that mastery of 80 per cent or more of the letters was a necessary pre-requisite for development of both the logographic and the alphabetic foundation processes and for achievement of a "reading age" on a formal test (British Abilities Scale word recognition test).

Logographic Foundation. In the model (Figure 1) a *logographic* foundation is postulated as a process whereby lexical (word) representations are established in memory at the outset of learning to read. The terminology is intended to reflect the derivation from the Greek word 'logos' and the sense of a 'logography' as a system in which written symbols represent whole words. There is no necessity for the term to be restricted to primitive, pre-alphabetic recognition based on purely visual features as documented by Seymour and Elder (1986) and included as a first step in stage-like accounts of reading acquisition (Ehri, 1992; Frith, 1985; Gough & Hillinger, 1980). Hence, the logographic foundation is equivalent to what is referred to as "sight word" learning by Ehri (1992, 1997). On the basis of Ehri's own work, together with the study by Stuart and Coltheart (1988), it can be argued that the development of the logographic foundation is normally contingent on acquisition of the letter-sounds, and that it follows a pattern of partial representation, focusing at first on initial letters, then on the boundary initial and final letters, and eventually on the whole letter array. Seymour and Evans (1999) devised lists of very familiar content and functor words which were commonly found in beginning reading schemes as an assessment of the acquisition of a logographic foundation in English. Performance on these lists by normally developing Primary 1 and Primary 2 children was strongly related to Reading Age and reached ceiling when Reading Age approached 7 years, i.e., after about two years of primary schooling. The development was delayed in dyslexic children (Seymour & Evans, 1999) and in children from lower socio-economic circumstances (Duncan & Seymour, 2000a). Further, Seymour and Evans found some children, referred to as cases of *logographic dyslexia*, who appeared to have a special and selective difficulty in sight vocabulary acquisition. Application of equivalent procedures across a range of European languages in the COST A8 Action suggested that acquisition of a logographic foundation was slower in English than in the other orthographies.

Alphabetic Foundation. The alphabetic foundation is a simple decoding procedure by which individual letters are converted to sounds and the sounds are synthesised to form a pronunciation. Seymour and Evans (1999) constructed lists of simple CVC non-words (e.g., pid) as an assessment of this process. In normally developing groups mastery was again found to be strongly related to reading age and to approach ceiling as reading age approximated 7 years. Thus, English-speaking children apparently required two years of learning in order to master the pronunciation of these very simple but unfamiliar non-words. Development was signficantly slowed in dyslexic children (Seymour & Evans, 1999) and in children from deprived socio-economic background (Duncan & Seymour, 2000a). In Seymour and Evans's study some children were identified, labelled instances of *alphabetic dyslexia,* who exhibited a special and selective difficulty in acquiring the alphabetic decoding process. The COST A8 comparison between English and other European orthographies was based on a more varied range of non-word structures, including VC, CV and CVC monosyllables and CVCV, VCVC, and CVCVC bisyllables. In general, children from across Europe mastered the decoding of these structures within their first year of learning to read but the English-speaking groups required much longer (up to 2-3 years of learning).

The data presented by Seymour and Evans (1999) suggest that learning to read in English may initially require the formation of a *dual* logographic and alphabetic foundation. This is probably a direct consequence of the way in which children are taught to read in English and the complex and deep characteristics of the orthography. Duncan et al. (1997) found that the typical approach to teaching which was followed in the Dundee schools was a "mixed method" involving the concurrent teaching of a "sight vocabulary" of familiar words and of a decoding procedure of letter learning, sequential sounding, and blending. The complexity of the English orthography ensures that the two processes are initially difficult to reconcile. The developing alphabetic process is capable of handling words with simple and consistent spellings, such as 'cat', but cannot deal with numerous very familiar words in English which contain complex structures. For example, the word 'house' is likely to appear in many reading schemes, but contains the complex 'ou-e' structure which cannot be properly analysed by simple decoding. This initial duality may be much less likely to occur in languages with regular and consistent orthographies since these will minimise conflict between the logographic and alphabetic processes. Equally, the adoption of teaching methods which place a primary emphasis on alphabetic decoding and minimise attempts to teach a sight vocabulary (e.g., the synthetic method followed in Germany, Austria and Finland), will reduce the emphasis on development of a distinct logographic process. Conversely, methods which emphasise whole word learning while de-emphasising decoding, as described in Seymour and Elder's (1986) study, will result in formation of a logographic foundation and relative absence of an alphabetic foundation.

According to the model (Figures 1 and 3) foundation literacy acquisition involves a two-way interaction with Linguistic Awareness. In the earlier discussion we noted that Linguistic Awareness contains two representational levels, referred to as *epilinguistic* and *metalinguistic.* Gombert (1992) suggests that literacy acquisition creates an "external demand" for the development of explicit, meta- awareness of relevant linguistic units. Thus, the demand to establish a "sight vocabulary" of familiar words is expected to interact with the morphological component to produce an explicit (metalexical) awareness of what conventionally constitutes a *word* in the language. At the same time, the learning of the letters and establishment of an alphabetic decoding mechanism creates a demand for an explicit meta- awareness of the *phonemic* segments out of which speech is constructed. In

order to test this proposition, Duncan et al. (1997) applied their common unit task to children at various points in the first two years of learning to read in Dundee primary schools. As previously explained, this task involves the presentation of pairs of spoken words to the child who is instructed to report back the segment of sound which the words share. Duncan et al.'s study included conditions where the shared sound was an initial or final phoneme as well as conditions in which it was a larger unit, such as the rime. A clear finding was that phonemic units emerge first as reading develops while rime units are much slower to appear. Thus, children in the foundation phase of literacy acquisition are much better at reporting that "greek" and "bake" share the sound /k/ than they are at reporting that "greek" and "squeak" share the sound /i:k/ ("eek").

This demonstration that the primary linguistic emphasis in Phase 1 foundation literacy acquisition in English is *phonemic* is probably equally applicable to other alphabetic orthographies. Hence, it could be predicted that repetition of appropriate variants of the common unit task across the European orthographies should confirm: (1) that Phase 0 pre-readers cannot isolate phonemes or rimes, and (2) that Phase 1 foundation readers display rapid emergence of phoneme retrieval together with persisting difficulties with rimes. Some confirmation of these predictions has already been obtained in the comparisons between English and French which we have made in collaboration with Jean Emile Gombert and Pascale Colé. We already noted that the key difference between English and some other languages may lie at the syllable level. Foundation level readers of English have difficulty with retrieval of whole syllables whereas this is a task which is straightforward for French Phase 0 pre-readers. The emergence of meta-awareness of the phoneme is expected to be linked to reading instruction rather than to age per se. It is, therefore, expected to appear at a later age in cultures which delay the formal start of reading instruction (e.g., to 7 years in Finland, Austria, and Denmark) than in cultures which start alphabetic reading instruction earlier.

Phases 2 and 3: Orthographic and morphographic literacy

The model shown in Figure 1 postulates the formation of orthographic and morphographic frameworks as lying at the heart of literacy acquisition. These frameworks are envisaged as abstract structures in which elements of orthography are organised in a manner which reflects their relationship with sound or meaning. At the orthographic level the elements consist of the vowel and consonant *graphemes* organised into a structure which reflects the subdivision of the syllable into a three-part onset-peak-coda format or a two-part onset-rime format (Figure 2d). At the morphographic level, the elements are likely to consist of whole syllables, or, more obviously, free and bound morphemes (Figure 2a).

To date, the most comprehensive research into the formation of an orthographic framework has been conducted using computer simulations of the learning of print-to-sound mappings. Seidenberg and McClelland (1989) adopted a parallel distributed processing (PDP) approach in the construction of a network containing orthographic units, phonemic units, and an intervening set of hidden units. In training, the network was presented with a large sample of 4-letter monosyllabic words and learned to associate them with their pronunciations according to a regime of supervised learning. In this procedure the model is presented with an orthographic input, attempts a phonemic output, and then receives feedback in the form of the desired response which triggers adjustments on connection weights throughout the system. These adjustments bring about a cumulative reduction in liability to error and enable the system to "learn" the print-sound mappings of the langua-

ge. Seidenberg and McClelland reported that, following training with words of varying frequency and regularity, the system acquired generalised knowledge which enabled the pronunciation of unfamiliar non-words. Subsequently, Plaut, McClelland, Seidenberg, and Patterson (1996) improved the representational capabilities of the model and showed very effective generalisation from word learning to capacity to read non-words.

In the analysis of English, there has been a large emphasis on the significance of *rime* units in orthographic organisation. A likely reason is that spelling-sound consistency is somewhat higher when the analysis is made at the level of rimes than when it is made at the level of graphemes-phonemes (Treiman, Mullennix, Bijeljac-Babic, & Richmond-Welty, 1995). As children learn to read they become sensitive to these rime-level regularities. For example, Duncan et al. (1997) presented children with non-words to read which either did or did not contain potentially familiar rime structures. The first study was conducted with 5-year old children in Dundee who were still in the first (Primary 1) school year and who were consequently at a very early (foundational) level of reading acquisition. Non-words were constructed to share rime units with real words which featured in the sight vocabulary the children were learning in class. These items were contrasted with other non-words which did not share a rime with any known word and which were instead built up out of grapheme-phoneme structures which occurred in the vocabulary. No advantage for non-words containing familiar rimes was observed, suggesting that, at this early stage, the children had not yet developed a rime-based orthographic organisation. A further study was conducted in the second (Primary 2) school year when the children were aged 6 years. The non-words were constructed from simple grapheme-phoneme elements and shared high or low frequency rimes with real words from primary school vocabulary. The frequency of the initial (body) structure was also varied and the experiment included a list of "zero frequency" items, containing rimes which were pronounceable but which did not occur in any English words. At this stage, rime frequency was found to exert a significant effect, suggesting that the children were beginning to develop a rime-based orthographic organisation (Duncan, Seymour, & Hill, 2000).

These results were interpreted by Duncan et al. (2000) as being indicative of a small-to-large unit progression in orthographic development. This proposal is in agreement with Ehri's (1997) suggestion that an initial phase in which graphemes-phonemes are emphasised is followed by a "consolidation" phase in which elements are aggregated into larger units. Duncan et al. (2000) carried out one further study in order to test the proposal that propensity to adopt a rime-based organisation increases as reading development advances. Children in the Primary 2 year were shown non-words on cards and were asked to report whether the non-word reminded them of a particular word, and, if so, what it was. Thus, they were invited to report word analogies for the non-words. Some children reported significant numbers of rime analogies in this situation. This trend was strongly linked to reading age and occurred only in the most advanced readers whose reading ages were above about 7.5 years.

The diagrammatic model (Figure 1) proposes that orthographic development involves a constant two-way interaction between the Orthographic Framework and Linguistic Awareness. As previously explained, this is likely to involve an upgrading of an existing *epilinguistic* organisation into a *metalinguistic* organisation which emphasises the units which are important for literacy acquisition at a given stage of development (Gombert, 1992). Duncan et al. (2000) repeated the phonological common unit investigation in the Primary 2 year. They found that children remained very good at retrieval of shared small units (initial or final phonemes) but that there was emerging evidence of meta- awa-

reness of large units. The significant improvement in retrieval of shared rime units appeared consistent with the proposal that these units become increasingly important as orthographic structures as reading age increases. It was possible, using regression analyses, to show that a relationship existed between pre-school (epilinguistic) awareness of rime, as indexed by performance on the odd-word-out task, and later (metalinguistic) awareness of rime, as indexed by performance on the common unit task in Primary 2. Thus, as argued by Gombert (1992), it does seem likely that capacity to develop an explicit (meta-) awareness of a linguistic unit is to some degree contingent on the prior availability of an implicit (epi-) awareness of that same unit.

These results all tend to support the conclusion that rime units play a special and significant role in the development of an orthographic framework for English. This will not necessarily be true of other languages. English, containing a higher proportion of complex monosyllables, together with the trend towards increased spelling-sound consistency in rime segments, may be particularly adapted to favour a rime emphasis. Consequently, it is quite likely that rhyming makes an important contribution to learning to read in English (Goswami & Bryant, 1990). Other languages, such as Greek, contain few monosyllables and a preponderance of multi-syllabic words in which most syllables have an open CV- structure. In this context, the rhyming segment of the syllable may not be a particularly salient element. Further, the consistency of the orthography will mean that no particular advantage derives from a focus on rime-level spelling-sound segments. Goswami, Porpodas, and Wheelwright (1997) studied naming of two- and three-syllable non-words by English-speaking and Greek-speaking children aged 7, 8 and 9 years. The non-words were constructed so that the post-onset structure shared pronunciation with a known word and this segment either employed the same spelling as the word or a different but phonologically equivalent spelling. Greek materials were formed by exploiting a small number of instances where alternative spellings are possible. Goswami et al. (1997) reported that Greek non-word reading approached ceiling much more rapidly than English non-word reading. The presence of familiar spelling structures facilitated non-word reading in English but had no discernible effect in Greek.

At Phase 3, a higher-order morphographic structure is formed which represents acceptable combinations of syllabic units. In so far as spelling reflects considerations of morphology, this higher level structure may also need to incorporate morphological divisions and conventions. If so, a demand will be created for achievement of meta- awareness of morphological structure, and this will build on pre-existing epi-awareness of morphology, as suggested in Gombert's (1992) proposal. Formation of a Phase 3 morphographic structure will be a necessary step in both English and Greek but may represent the first point at which seriously complex issues arise for learners of Greek. Relevant data are reported by Porpodas and Tsaggaris (1996).

Conclusions: Learning to read English vs. learning to read Greek

In this contribution we have aimed to outline an account of learning to read in English which can be supported by references to research carried out in Dundee over the past several years. The intention has been to set out a general framework – the model illustrated in Figure 1 – which is comprehensive and general enough to accommodate the contrast between learning a deep orthography, such as English, and learning a shallow orthography, such as Greek.

It is suggested that this contrast can be understood by analysing reading acquisition into a 4-phase sequence and by identifying the linguistic units which are significant in each phase. Viewed in this way, a shallow syllable-

based orthography, such as Greek, appears to define a "best case scenario" for the apprentice reader, and a deep, inconsistent and morphologically-based system like English a "worst case scenario". The important contrasts between English and Greek can be clarified by referring to the proposed 4-phase sequence:

Phase 0: Pre-literacy. As a consequence of its poorly defined syllabic structure, pre-readers of English approach the task of learning to read without the benefit of meta- awareness of any of the significant linguistic units. They may, nonetheless, possess an implicit (epi-) awareness of some relevant units, such as the rime. Pre-readers of Greek, and other languages with a clearly articulated and open syllabic structure, approach reading with a pre-established meta-awareness of syllabic units.

Phase 1: Foundation literacy. The critical initial step in reading is the acquisition of a knowledge of the letters and their links with sound. This is probably an equivalent task for beginning readers in English and Greek and instances of *literal dyslexia* (special difficulty in acquiring letter-sounds), as described by Seymour and Evans (1999), could occur in both languages. The development of an alphabetic foundation, involving sequential decoding, synthesis and segmentation processes, and the establishment of meta- awareness of phonemes, is also common to the two languages. Special difficulty with this process, an *alphabetic dyslexia,* might be discernible in both languages as a slowness in acquiring or applying the procedure in decoding unfamiliar items (simple non-words). A logographic foundation, required for rapid identification and storage of familiar words, may be more significant in English than in Greek (see Porpodas, in press). Hence, *logographic dyslexia,* defined as a special difficulty in sight vocabulary acquisition, may be found in English but not in Greek. The foundation literacy phase is traversed very rapidly in Greek but requires up to two years of learning in English. One explanation is that English requires a division of attention between logographic and alphabetic foundation processes which are initially functionally distinct. This division is not necessary in Greek where the two processes are based on an equivalent alphabetic code. One implication is that the development of a grapheme-phoneme based "sight word" recognition process, as described by Ehri (1992), can occur more rapidly and more directly in Greek than in English.

Phase 2: Orthographic literacy. The requirement at this level is for the establishment of a structure to represent the spellings of individual syllables. This is a straightforward undertaking in Greek because syllable structure is clearly defined in the Linguistic Awareness system (Porpodas & Tsaggaris, 1996; Porpodas & Tsoupras, 1999) and because each syllable is consistently based on its component grapheme-phoneme correspondences. Therefore, progression through the orthographic phase will normally be very rapid for Greek children, and dyslexia at this level may be detectable only as a slight slowing in development and as small increases in reaction time to name familiar and unfamiliar monosyllables (Porpodas, 1999). In English, the achievement of orthographic literacy is a time-consuming process, maybe occupying 2-3 years of learning, which is complicated by: (1) absence of a clear definition of syllable boundaries; (2) bi-directional inconsistency in spellings assigned to monosyllables; (3) the need to discover the onset-rime structure as a basis for organising the lexicon and reducing effects of inconsistency; (4) the absence of meta- awareness of the onset-rime structure; and (5) the need to develop such awareness. Dyslexia can have profound effects on progress through this complexity and may appear as a failure to establish the orthographic knowledge base (inaccuracy in reading and spelling) and/or as a dysfluency (increased reaction time in word or non-word reading) (Seymour, 1990). These effects may be primarily discernible in phonological tasks, such as non-word naming, or in lexical tasks, such as naming of words with

irregular or inconsistent spellings (Castles & Coltheart, 1993; Seymour, 1990). Thus, the English orthography, with its dual demand for abstraction of a complex correspondence system and for absorption of lexically specific spellings, can generate contrasting patterns of dyslexia.

Phase 3: Morphographic literacy. At the third level the requirement is for the establishment of a higher-order structure in which syllabic units can be combined. This level is crucial for the development of fluent reading in a language such as Greek in which polysyllables form the large majority of words in the lexicon. It is also essential for English, where a substantial proportion of words, especially those of Greek and Latin origin, are polysyllabic. The principal difference between the languages is that Greek children can progress rapidly through Phases 1 and 2 and approach Phase 3 with an inventory of well-defined syllabic units in place, whereas English-speaking children make only slow progress through Phases 1 and 2 and lack a clear definition of syllabic structure when they approach Phase 3. Fluency in reading complex multi-syllabic words is therefore likely to appear much later in English than in Greek. For both languages it is very likely that the higher-order framework undergoes further re-organisation in which morphological structure is emphasised. This process may be more complex for Greek than for English since Greek has a richer morphology than English but will depend on epilinguistic awareness in both languages and the possibility for formation of metalinguistic representations of morphemes. In English in particular the correct spelling of complex words, especially within unstressed syllables, requires a morphological organisation. Dyslexia at this level might appear quite similar in the two languages, appearing as a dysfluency in reading complex words and in an inability to spell words with due attention to morphological structure.

In conclusion, it seems that learning to read in English differs from learning to read in Greek most obviously in the earlier stages of the process. English-speaking children lack appropriate metalinguistic awareness when they start and require large amounts of extra time to progress through the foundation and orthographic phases.

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