Single-Word Naming in a Transparent Alphabetic Orthography

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Abstract

The cognitive processes involved in single-word naming of the transparent Turkish orthography were examined in a series of nine naming experiments on adult native readers. In Experiment 1, a significant word frequency effect was observed when matched (i.e. on initial phoneme, letter length and number of syllables) high- and low-frequency words were presented for naming. However, no frequency effect was found in Experiment 2, when an equal number of matched (i.e. on initial phoneme, letter length and number of syllables) nonword fillers were mixed with the target words. A null frequency effect was also found in Experiment 3 when conditions were mixed-blocks, i.e. high- and low-frequency were words presented in separate blocks mixed with an equal number of matched nonword fillers. Experiment 4 served the purpose of creating and validating nonwords (to be used in Experiments 5 and 6) that could be named as fast as high- and low-frequency words by manipulating the letter length of nonwords. A significant word frequency effect emerged with both the mixed-block design (Experiment 5) and mixed design (Experiment 6) when the nonword fillers matched the target words in speed of naming. Experiment 7, however, found no frequency effect when high- and low-frequency words were mixed with word fillers that were slower to be named (longer in length) than the target words.

In Experiment 8, frequency was factorially manipulated with imageability (high vs. low) and level of skill (very skilled vs. skilled) which found significant main effects for word frequency and level of skill, and a significant 2-way interaction of skill by imageability and a significant 3-way interaction of skill by imageability by frequency. In Experiment 9, however, there was only a main effect for frequency when previously skilled readers performed on the same words used in Experiment 8.

These findings suggest that whilst a lexical route dominates in naming the transparent Turkish orthography, an explanation that the readers shut down the operation of this route in the presence of nonword fillers is not entertained. Instead, the results suggest that both routes operate in naming, with the inclusion of filler stimuli and their “perceived difficulty” having an impact in the time criterion for articulation.

Moreover, there are indications that a semantic route is involved in naming Turkish only when level of skill is taken into account.

Implications of these findings for models of single-word naming are discussed.

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1 Chapter 1: Introduction - Overview

The directness with which the spelling of a particular word conveys the phonology of the spoken language has, during the past 30 years, played a key role in the development and architecture of cognitive models of single-word naming and visual word recognition. Until recently, as explained briefly in Chapter 2, interest focused mainly on whether recognition of words is mediated via visual, or phonological, or both codes. However, questions surrounding the nature of visual and/or phonological codes and factors affecting the utilisation of either code still remained a debatable issue, until the classic work of Coltheart (1978) which drew attention to peculiarities of English spelling and its relationship in understanding cognitive processes involved in visual word recognition. In particular, evidence from the regular-irregular dichotomy of English spelling, together with employing single-word naming tasks, as reported in Chapter 2, was taken by Coltheart (amongst other contemporary reading scholars) as having psychological reality, i.e. imposing upon readers at least two qualitatively separate processing routes - a dual-route model of naming. The regular words, and regularly transcribed nonwords, were assumed to be named by a system of spelling-sound rules, i.e. the nonlexical route, whilst those words defined as irregular (exceptions to spelling-sound rules) were assumed to be named by addressing their mental/lexical representations (phonological and/or semantic) directly, i.e. a lexical route. The nature of this lexical route, insofar as derivation of phonology is concerned, was also argued to be twofold: i) a direct orthography-to-phonology route or ii) an indirect orthographic-to-semantic-to-phonological route (i.e. postlexical phonology). These two alternative lexical and nonlexical routes for deriving phonology from print were also assumed to reflect duality of processes involved in visual word recognition. However, as will be explained in Chapter 3, whilst peculiarities of English spelling gave rise to a dual-route model, follow-up research based on English, and validated by both human and computer performance, posed serious challenges to the dual-route model, in particular the existence of a rule-based nonlexical route. As a result a family of single-route, connectionist models was born that attack the existence of qualitatively distinct routes in oral naming. It is important to note that, whilst a single-route model for deriving phonology from print was proposed, this did not have a direct impact on the debate of whether word recognition is visual or phonologically mediated. What, however, a single-route model of naming contributed to the latter debate was the manner or nature of the "prelexically" generated phonology from print. The dual-route model supposition is that it could be via two qualitatively separate routes; single-route, connectionist models argue not, a single visual, computational process could suffice for generation and involvement of both visual and phonological codes mediating word pronunciation and/or recognition. Thus, to many reading researchers it became apparent that the issue of whether recognition of words is visual or phonological may also link (perhaps depend) on resolving cognitive processes involved in single-word naming (the main topic of the present thesis). Although the general consensus from dual-route supporters (by virtue of a horse-race logic) is that the visual/lexical route is the faster and the dominant route in word naming in English (an issue with which single-route models by virtue of their theoretical architecture have no dispute), yet there is always a concern as to the extent that evidence of lexical dominance in single-word naming is an artefact of research on peculiarities of English. As documented in Chapters 4 and 5, neither the dichotomy nor the nature of regularity-irregularity of English is shared by other writing systems. Indeed writing systems, in particular alphabetic systems, differ widely in their degree of orthographic-to-phonological transparency. At one extreme, one could identify alphabetic scripts such as Semitic Hebrew, in which no vowels are specified in written text, thus the relationship between orthography and corresponding phonology for a consonantal string is very opaque. In contrast, in alphabetic scripts such as Italian, Serbo-Croatian and Spanish, letter-sound correspondences are said to be regular to a large extent, thus the relationship between orthography and phonology is transparent or shallow. English spelling falls somewhere in-between the two camps, transcribed with a mixture of words, a large majority that conform to spelling sound rules known as "regular", and a minority that are exception to such rules - "irregular" or exception words. Therefore, in line with such differences between (and within) scripts in the degree and nature of orthography-to-phonology transparency, the issue of whether a single-route or dual-route is involved in naming or the extent to which lexical and nonlexical routes may dominate when experimenting on English also ties in with the issue of whether these findings in cognitive processes involved in single-word naming are "universal" or "script-specific". In other words, on the basis of experimental data obtained from single-word naming in English, should one generalise on how other scripts are also read aloud (the universal position), or are there differences in cognitive processes in single-word naming, depending on the nature and degree of orthography-to-phonology transparency? Single-route models, by virtue of their theoretical framework, argue not, as reflected in Seidenberg and McClelland's (1989) words "We assume that this general architecture underlies visual word recognition in all languages" (p559). On the other hand, based on the initial excitement of the dual-route supposition accounting for the dichotomy of cognitive processes involved in single-word naming, as dictated by the peculiarities of English and as noted by Henderson (1984), there was soon "an attempt to colonise the orthographies of the world with the dual-route model" (p7), resulting in one strong version which maintains that the route to be used is determined exclusively by orthographic transparency, in that opaque scripts, such as Hebrew, are named aloud via the lexical route, whilst transparent scripts such as Serbo-Croatian (Turvey, Feldman & Lukatela, 1984) “constrains the reader to a phonologically analytic strategy” (p81), i.e. the nonlexical route. This position is generally referred to as the orthographic depth hypothesis. A weaker version of the orthographic depth hypothesis, however, maintains that whilst both routes are available to readers of different writing systems, the degree of involvement of a particular route is nevertheless determined by orthographic transparency (Frost, Katz & Bentin, 1987). Opaque scripts should make greater use of the lexical route for single-word naming, whilst transparent scripts are read more often through the nonlexical route. Within the dual-route framework one could account for yet another position in relation to single-word naming in different writing systems - a position generally referred to as the universal hypothesis (Baluch & Besner, 1991). According to the universal hypothesis, although both routes are available to readers, by default, readers of all scripts make prime use of the lexical route for naming regardless of orthographic transparency, whilst the involvement of the nonlexical route in particular, is dictated by task demands and is under the strategic control of readers (Baluch & Besner, 1991).

Thus the questions i) does the same underlying architecture hold for single-word naming in different writing system? ii) are these shared “universalities” manifested in greater use of a lexical route? iii) is the manner in which a particular orthography is read aloud dictated by its orthography-phonology transparency? are issues that could only be investigated by evaluating evidence from orthographies which represent extreme polarities on the transparency continuum.

The cognitive processes of single-word naming amongst adult Turkish readers have not to this date been the subject of systematic investigation. Turkish, as explained in Chapter 5, is more transparent than any script that has previously been the subject of systematic investigation of cognitive processes of single-word naming. This is because the orthography-to-phonology correspondences in Turkish are one-to-one, invariant and context-independent, even more transparent than scripts such as Italian, Serbo-Croatian or Spanish. By utilising the peculiarities of Turkish orthography, in a series of single-word naming tasks the present thesis takes the following key steps in contributing to the aforementioned literature:

- First, in view of its very transparent nature, it is argued to be the most ideal test for at least the strong version of the orthographic depth hypothesis.
- Secondly, it makes a critical evaluation of evidence reported in relation to Baluch and Besner's (1991) claim of strategic control on processing routes, and re-examines their claim in relation to reading Turkish, and in view of recent supposition of a time criterion hypothesis as opposed to the notion of changing routes.
- Finally, it examines the possible involvement of an orthographic-to-semantic route in naming Turkish.

These objectives are achieved by a series of nine experiments employing adult native Turkish readers as participants and examining their Reaction Time (RTs) measured in milliseconds (ms) in naming single words (and nonwords).

Perhaps the general body of this series of nine experiments falls into two broad categories: The first seven experiments deal with the issue of the nature of routes (lexical-nonlexical) and possible effects of factors (filler words or nonwords) affecting the operation of the route(s). The final two experiments deal with a novel issue in the literature, namely, the semantic effects in single-word naming of a transparent orthography. More specifically, Experiments 1 and 2 reported in Chapter 6 are aimed at examining the validity of the universal vs. orthographic depth hypotheses in relation to single-word naming in Turkish. In Experiment 1, evidence from 23 Turkish readers presented with 40 high- and 40 low-frequency words in a mixed design (i.e. all words high- and low-frequency were presented in one randomly determined order) showed a significant word frequency effect (52ms difference). Word frequency is a factor that is argued to affect naming only if the lexical route is used for articulation. This significant word frequency effect was therefore taken as evidence to indicate that the lexical route must have been utilised in the naming of Turkish words (thus supporting the universal hypothesis). The follow-up experiment was designed to examine the impact of nonword fillers on word naming, in particular the effect this may have on word frequency. The strategic account incorporated within a dual-route model of single-word naming (e.g. Baluch & Besner, 1991; Monsell, Patterson, Graham, Hughes & Milroy, 1992) would predict that the inclusion of such nonword filler stimuli may encourage a shift to nonlexical route (or a de-emphasis of the lexical route), a prediction that by virtue of their general architecture cannot be entertained by single-route models. In Experiment 2, readers were presented with high- and low-frequency words mixed with an equal number of matched (i.e. on initial phoneme, letter length and number of syllables) nonword fillers. Results from 17 Turkish readers found that the word frequency effects found in Experiment 1 disappear when nonword fillers were added to the stimuli set (a 3.7ms nonsignificant difference). Since the operation of a nonlexical route, by definition, is not sensitive to lexical factors (e.g. frequency), hence the null frequency effect found in Experiment 2 is taken to indicate that, on this occasion, a shift to nonlexical strategy has occurred in the presence of nonword fillers. As expected, however, naming latencies to matched nonword filler stimuli were significantly slower than the words, in particular low-frequency words. Although one interpretation of the results is that Turkish readers exercise strategic control in the presence of nonword fillers and switch to a nonlexical route for naming (cf. Baluch

& Besner, 1991), equally plausible (in light of a recent claim) is that the mixing of "slower naming" filler nonword stimuli in the same set of target words might have altered the criteria that subjects would normally use to initiate articulation (Lupker, Brown & Colombo, 1997). Central to this claim is the notion of "perceived difficulty" of stimuli to be named. When slow naming stimuli (in this case nonword fillers) are added to fast naming stimuli (in this case words) there is a repositioning of the time criterion to accommodate all types of stimuli, thus a tendency of regression towards the mean, i.e. fast gets slower and slow gets faster! Following this logic, in the naming set of Experiment 2, fast naming target stimuli (i.e. high-frequency words) tend to be named slower (than they normally would be without the nonwords present) because they are mixed with slow naming nonwords. Assuming that there is either no change in naming latencies for the low-frequency words, or indeed low-frequency words may even be encouraged to be named faster when slow naming nonwords are added (see general discussion for an explanation), there is then a tendency of reduction in the magnitude of differences in reaction time latencies between high- and low-frequency words. Thus the null effect reported in Experiment 2 may not be due to changing processing routes, rather changing time criteria for initiation of articulation. These contradictory claims were put to the test in a series of experiments (3, 4, 5, 6 & 7) reported in Chapter 7. The first experiment in this series (Experiment 3) examined whether a mixed design (words and nonwords mixed randomly) as opposed to a mixed-block design (i.e. high- and low-frequency words being presented separately in two blocks mixed with matched nonword fillers) would have a significant impact on word frequency effect (the rationale for this experiment is reported in Chapter 7). In Experiment 3 a null frequency effect was found (a 9ms nonsignificant difference) thus replicating the finding from Experiment 2. It was, therefore, argued that the mixed vs. mixed-block manipulation does not have a large impact on target word naming in Turkish, in particular when matched (i.e. on initial phoneme, letter length and number of syllables) nonword fillers are included in the naming list. Follow-up experiments, however, were conducted to investigate the impact of filler stimuli manipulations according to Lupker et al's (1997) notion of "perceived difficulty", i.e. easy vs. difficult naming stimuli on target word naming. In this respect, it was observed that by increasing or decreasing the number of letters in a letter string (word or nonword) perceived difficulty can be manipulated in Turkish, thus creating fast and slow naming filler stimuli. Experiment 4 was conducted to further validate this observation and to validate the stimuli to be used in Experiments 5 and 6. The 20 high- and 20 low-frequency words used in Experiment 3, together with newly created 20 three-letter or 20 four/five-letter nonwords were assigned each to a separate block. Subjects in Experiment 4 were presented with these four blocks (in a counterbalanced order) for naming. All nonwords matched words on initial letter. There was an expected significant difference between high- and low-frequency words (57ms difference) and between three-letter and four/five-letter nonwords (69ms difference). However, no significant differences were found between high-frequency words and three-letter nonwords or between low-frequency words and four/five-letter nonwords. Thus it was confirmed that if nonwords are on average shorter in length than their "matched" words (high- or low-frequency), they could be named as fast. In Experiment 5, participants were required to name the 20 high- and low-frequency words used in Experiments 3 and 4, together with 20 speed-matched nonword fillers, in two mixed-blocks i.e. high-frequency mixed with three-letter nonwords in one block and low-frequency mixed with four/five letter nonwords in another block. The results showed a significant frequency effect (38ms difference) between high- and low-frequency words. To ensure that the significant frequency effect is not an artefact of experimental design, (i.e. mixed-blocked as opposed to mixed design) the experimental stimuli from Experiment 5 was presented to participants in Experiment 6 in a mixed design (similar to the design of Experiment 2). A significant, although reduced, word frequency effect (26ms difference) prevailed. Combining the data from Experiments 5 and 6, no main effect for experimental design (i.e. mixed vs. mixed-block) was found, whilst there was still a main effect for frequency. Moreover, an independent groups t-test conducted between words (high- and low-frequency) in Experiment 3 and the same words in Experiment 5 showed that high-frequency words were named significantly faster when they were mixed with speed-matched nonword fillers as opposed to being named when they were mixed with matched (i.e. on initial phoneme, letter length and number of syllables) nonword fillers. The type of nonword fillers did not appear to have an impact on the naming of low-frequency words when RTs for low-frequency words in Experiments 3 and 5 were compared. It was thus concluded that the inclusion of speed-matched nonword fillers has a differential effect on target word naming, independent of mixed-block vs. mixed design aspects of an experimental design. In Experiment 7 the issue of whether perceived difficulty (naming speed) of the filler stimuli irrespective of their word/nonword status might have been responsible for the effects in previous experiments was examined by the inclusion of filler words that are named significantly slower than all the target words in the stimuli set. This was achieved by selecting words that are longer in number of letters (and syllables) than the target words and are named significantly slower than the target low-frequency words but are named as fast as the nonwords used in Experiment 2. The design of Experiment 7, was as follows: 20 high- and 20 low-frequency words and 40 slow naming filler words, three-syllabic words of high to average frequency presented to 15 participants in a mixed design. The results showed a nonsignificant difference (17ms) between high- and low-frequency words. This series of experiments collectively led to the conclusion that single-word naming of Turkish words arguably depends on both the lexical and the nonlexical routes operating in parallel and in an interactive manner with a time criterion default that is set by the processing system which is adhered to when naming a cohort of (mono- or bi-syllabic) Turkish words. Articulation of a word is initiated when information from both routes is made available within the time set by the processing system. However, when processing via the nonlexical route is made harder by the inclusion of filler stimuli (words or nonwords) this may act in affecting the time criterion. Thus, when in an experimental setting the filler stimuli (nonwords) are speed-matched to target words, there is no change to this time criterion. If, however, the filler stimuli (words or nonwords) are named slower than the target words, this affects the criteria to initiate articulation of target words, in particular, by making high-frequency words slower (and perhaps low-frequency words faster) hence no frequency effect emerges.

The two experiments reported in Chapter 8, i.e. Experiments 8 and 9, explored the impact of a semantic variable, namely imageability, on word naming in Turkish as a function of level of skill. In this respect, it has been argued that in English whenever processing via the lexical route is slowed down (i.e. low-frequency irregular words) readers use an orthography-to-semantics route for naming such items (as opposed to an orthography-to-phonology route) thus there is evidence for word imageability for low-frequency irregular words but not for low-frequency regular words (Strain, Patterson & Seidenberg, 1995). The "universal" aspects of the latter finding however, have not been tested (with the exception of a very recent study by Baluch & Besner, 1999, reported in Chapter 8), in particular in relation to a transparent orthography. One prediction is that imageability effects may not be observed in naming Turkish, as all words are transparent and should in principle behave like "regular" English words. However, Strain et al. (1995) did not analyse their data in relation to level of skill. Indeed as detailed in Chapter 8, if imageability effects are greater when processing is slow and error prone, these effects should be more evident for poor readers (as processing is slow and error prone for these readers Eamon Strain, 1999, personal communication). However equally plausible is that imageability effects become more evident with increasing level of reading skill. In particular the recent account of the single-route connectionist model (Plaut, McClelland, Seidenberg & Patterson, 1996) makes the strong prediction that the reliance on the semantic route for naming (as opposed to an orthography-to-phonology route) should increase as a function of reading competence. If this were true, very skilled readers ought to show larger effects of semantic variables (imageability) than skilled readers. Whichever the direction of imageability effects on single-word naming, it was therefore considered worthwhile to examine the possible relationship between level of skill and imageability effects in naming Turkish. In Experiment 8, readers (all native undergraduates in Cyprus) were of two types: 16 very skilled and 28 skilled. This distinction was made by a pilot examination of naming latencies and error rates to 100 Turkish words by an initial sample of 78 participants. Participants whose RTs fell beyond 1.3 standard deviation higher than the mean (851ms) were classified as skilled (n =28). Participants whose RTs were 0.9 standard deviation below the mean were classified as very skilled readers (n =16). The results showed a significant main effect for frequency and level of skill and a significant 2-way interaction between level of skill and imageability, and also a significant 3-way interaction between level of skill, frequency and imageability. That is, skilled readers named low-frequency high-imageability words significantly faster than low-frequency low-imageability words. Experiment 9, was a replication of Experiment 8, by employing participants who were adult Turkish readers living in the UK for the last ten years who had little daily contact with Turkish reading materials, henceforth referred to as previously skilled readers. Results from 24 previously skilled participants showed a significant effect for frequency but not for imageability.

The results of the latter findings are discussed in Chapters 8 and 9 in relation to similar research on English (Strain et al., 1995) and Japanese (Derek Besner, 1999, personal communication) and a recent study on Persian (Baluch & Besner 1999).

The general conclusion offered in Chapter 9 is that readers of a very transparent orthography, i.e. Turkish, make prime use of both the lexical and nonlexical routes in an interactive manner when naming high- and low-frequency words. The timing for the articulation of words is set by default and depends on activation of information from both routes. When however, non-target filler stimuli are included that could not be named as efficiently, or as fast, as the target words (i.e. slow naming nonwords and three syllabic words), this affects the timing of the criteria which initiates an articulation for the target words, i.e. the criteria for naming high-frequency words are more prolonged than "normal" conditions but perhaps speeded up for low-frequency words. Thus, the null effect observed in Experiments 2 and 3, and in parallel studies reported for scripts such as transparent Italian (Tabossi & Laghi, 1992), or Spanish (Sebastián-Gallés, 1991) may not be reflecting a change in processing route (lexical to nonlexical), rather changes in criteria to initiate an articulation. Moreover, the present results also suggest that there are some "universalities" in semantic effects on naming words in that there is evidence for semantic involvement for low-frequency words in both Turkish and English. However, semantic effects were only observed for Turkish readers when examining data from very skilled readers. At least two accounts of how this semantic variable may affect naming in different writing systems are suggested. Finally, in the concluding sections of Chapter 9, suggestions are made for follow-up research on Turkish.

2 Chapter 2: The Dual-route Perspective: A Brief Review of the Literature

2.1 Preface

How does one read single words aloud? This question has been the focal point of empirical investigation for the last two decades since the publication of Coltheart's (1978) most influential article. Earlier research, pioneered by the classic work of Huey (1908/1968), was more focused on whether reading is a phonologically mediated process (e.g. Conrad, 1964; Rubenstein, Lewis & Rubenstein 1971) or a visually mediated process (e.g. Baron 1973; Kleiman 1975; Levy, 1977) or both (e.g. Frederiksen & Kroll, 1976; Meyer, Ruddy & Schvaneveldt, 1975). In a novel consideration, Coltheart (1978) attended to the peculiarities of the English orthography in an attempt to understand psychological processes involved in visual word recognition. Coltheart speculated that the "irregular" nature of English had implications for understanding cognitive processes involved in single-word naming, which arguably had the largest impact for the growing body of literature on psychological processes of visual word recognition to-date. The aim of the present Chapter is to provide an overview of the linguistic properties, particularly the regular-irregular dichotomy, of the English writing system which eventually led to the development of models of single-word naming. Moreover, how this development coincided with the advancement of a localised mental lexicon, which was based on an interest in word frequency, will also be reviewed here.

2.2 Regular-Irregular Dichotomy of English Spelling

The relationship between English orthography and phonology is argued to be characterised by linguistically intertangled yet two distinct dichotomies; namely, regularity and consistency (see e.g. Henderson 1982 for a detailed account of linguistic dichotomy of English). Whilst the definition of regularity is based on spelling-sound rules between graphemes and their corresponding phonemes (single letters, e.g. F corresponds to /f/ in FOR, or letter patterns which correspond to a single phoneme, e.g. PH also corresponds to /f/ in GRAPH), in contrast the definition of consistency is based on orthographic units larger than the grapheme (e.g. the spelling component -AVE in GAVE). A word is thus regular if its pronunciation can be predicted correctly based on spelling-sound rules, e.g. MINT, and irregular when the application of these rules yields an incorrect pronunciation, e.g. PINT (see Venezky, 1970; Wijk, 1966, for a detailed account of spelling-sound rules in English). Similarly, if a word's orthographic unit is pronounced the same way in all words that share the same unit then a word is said to be consistent, e.g. SAVE, GAVE and WAVE. If there are discrepancies between the pronunciations of the same orthographic unit in different words, then this is considered inconsistent, e.g. HAVE. In this context a further factor, namely the number of orthographic neighbours (N) that a word can possibly have comes into play which further complicates matters insofar as definitions of regularity and consistency are concerned (see Chapter 3 for details). One can also demonstrate how the two classifications of regularity and consistency are entangled as follows: MINT and PINT are also examples of a consistent and an inconsistent word respectively if their common orthographic unit -INT is taken into consideration rather than the regular-irregular pronunciation of the grapheme I. Noteworthy also is that a regularly transcribed word can be either consistent, e.g. DEEP, or inconsistent, e.g. SAVE. Similarly, an irregular word can also be either consistent, e.g. CALF, or inconsistent, e.g. HAVE. Although the two sources of "exceptionality" are not new to the literature (e.g. Baron & Strawson, 1976; Glushko, 1979, 1981) there is a move towards the specific use of the generic term "exception words" in the recent literature (e.g. Rastle & Coltheart, 1999). For purpose of clarity, the source of exceptionality will also be made explicit throughout the present thesis by using the appropriate terminology. In this respect, regularity will be assumed to indicate invariant and context independent relationships between graphemes and their corresponding phonemes, whilst consistency will be assumed to be based on the relationship between orthographic units larger than the grapheme and their corresponding phonemes. The main emphasis however, is on the regular-irregular dichotomy of words since (as will be explained in the following sections of the present Chapter and Chapter 4) it was originally theoretical considerations regarding this dichotomy that had a major impact on the development of psychological models of oral naming, in particular in the development of the dual-route model which is introduced next. Moreover, regularity is of special interest here as it is very closely related to the subject of orthographic-to-phonological transparency which is the main focus of the present thesis. However, as will be explained in Chapter 3, whilst evidence from the regular-irregular aspects of English orthography led to the development of qualitatively independent routes in oral naming, the consistent-inconsistent nature of English was the main source of empirical evidence refuting such dichotomy in oral naming.

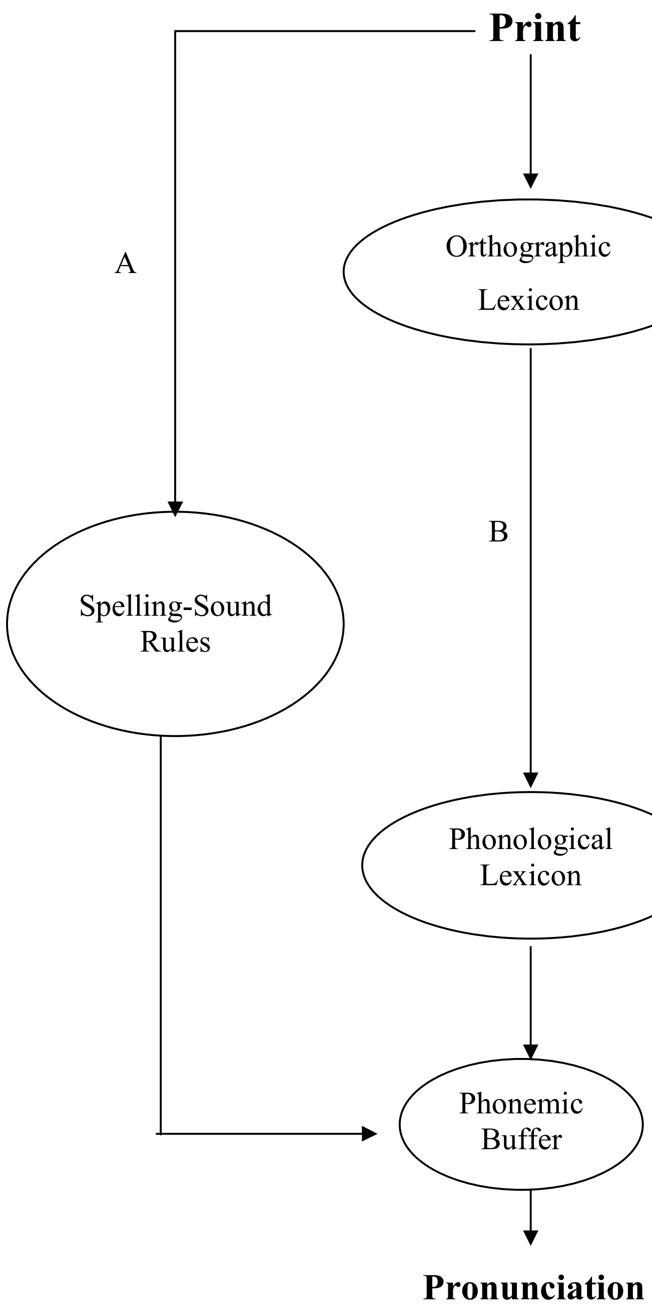
2.3 Visual Word Recognition and the Rise of the Dual-Route Model of Single-Word Naming

Prior to Coltheart's (1978) attention to the irregular nature of English spelling, investigators had developed a variety of experimental tasks, mainly non-verbal in nature, in an attempt to determine whether reading is a phonologically or a visually mediated process. On the one hand, pioneering work by Rubenstein, Lewis and Rubenstein (1971) produced the first experimental evidence for phonological mediation in visual word recognition. Rubenstein et al. (1971) utilised a Lexical Decision Task (LDT) in which participants had to decide whether different types of letter strings (e.g. BRANE, CREPW, BARP) were a word or not. The authors reported that lexical decisions were affected by the extent to which nonwords sounded like real English words. That is, a nonword that sounded like a real word such as BRANE (pseudohomophone) was rejected slower (with higher rate of errors) compared to a nonword that did not sound like a real word, e.g. BARP, hence the so-called pseudohomophone effect. On the other hand, Baron (1973) claimed that visual word recognition was not affected by phonological manipulation of the stimuli and that reading was a visually mediated process. Baron's conclusion was based on evidence from a phrase evaluation task, where readers had to decide whether phrases such as TIE THE NOT, TIE THE KNOT, COME KIN HERE and COME IN HERE made sense or not. Baron (1973) found that participants were faster in rejecting phrases that were visually meaningless than phrases that were phonologically meaningless, thus suggesting that participants must have relied primarily on visual information for "lexical" decisions. However, whilst Baron criticised Rubenstein et al.'s data as being directed to reading nonwords, hence not typical of a normal reading situation, Baron's data can equally be criticised on the grounds that making evaluations to nonsense phrases is also untypical of a normal reading situation. Despite these noticeable shortcomings of this early research, two opposing camps developed; with one camp interpreting their experimental data as strong support for phonological mediation (e.g. Gough, 1972; Smith & Spoehr, 1974; Spoehr & Smith, 1975) and an opposing camp interpreting their experimental data as strong support for visual mediation (e.g. Bower, 1970; Forster & Chambers, 1973; Kleiman, 1975; Kolers, 1970; also see McCusker, Hillinger & Bias, 1981 for a comprehensive review of studies that support each position).

In this respect, Frost's (1998) recent article summarises the kind of scientific endure that has become a typical feature of the state of affairs in visual word recognition: "In a historical perspective, cognitive issues have often been cast into dichotomous alternatives, which have resulted in a pendulum-like swing from one view to the opposite one" (p71). As Frost argues (1998) however, the pendulum is still swinging between the two camps, namely, the visual mediation hypothesis and the phonological mediation hypothesis, even in these closing days of a century old research on visual word recognition. Nevertheless, Frost's remark is demonstrative of the current and past state of affairs when dealing with the literature pertaining to the psychological processes involved in visual word recognition. It also demonstrates how flexible and varied these processes might be, which is an issue that will be adhered to throughout the present thesis.

Returning to the earlier literature on visual word recognition, a compromise between the visual and phonological mediation models was eventually made. This was based on the work of Meyer, Schwaneveldt and Ruddy (1974) which incidentally was based on evidence from yet a different type of "lexical decision task", namely a Word Pair Judgement Task, in which the relationship between word (and nonword) pairs was visually (orthographically) or phonologically manipulated. Meyer et al. (1974) reported faster RTs for word pairs that were both orthographically and phonologically similar (e.g. BRIBE-TRIBE) whereas stimuli, which were orthographically similar only (e.g. COUCH-TOUCH) were slower. In addition to the word pairs, word-nonword (e.g. RUMOR-FUMOR) nonword-nonword (e.g. DEACE-MEACE) pairs were also included in the trials. Nonword-nonword pairs were the fastest to be rejected by participants. Meyer et al. (1974) argued that if readers had relied solely on visual representations to carry out judgements there should have been no difference in RTs to two types of word pairs. In other words, whether or not the word pairs sounded the same should have had no effect on their judgement. However, as the RTs showed, this was not the case. Meyer et al. interpreted the results to indicate phonological involvement during visual word recognition. However, if readers also relied solely on phonological representation of the stimuli then the nonword-nonword pairs would have taken the longest to be rejected. Contrary to this argument, subjects were fastest in responding to nonword pairs than any type of stimuli, indicating that judgements can also be carried out relying on visual information. Consequently, a dual-coding model was postulated in which both visual and phonological codes could be involved independently for the purpose of lexical access (see e.g. McCusker et al., 1981 for a review). This also made sense on logical grounds: For example, the phonological mediation hypothesis could not account for readers ability in distinguishing the different meanings of homophones (e.g. SALE-SAIL and CREWS-CRUISE). At the same time, a solely visual mediation hypothesis could not account for the readers ability to read new words i.e. words which presumably have no previous visual lexical entries. Moreover, the ability to name nonwords suggests that at least a non-visual strategy must exist to deal with such stimuli. As a result of the above considerations, it became apparent that any model of reading would have to account for the flexibility of the underlying processes available to readers. Still many questions remained unanswered, particularly what factors determine which code is to be used? What is the nature of the visual and the phonological codes involved in lexical access? What is the relationship between the two codes in accessing the mental lexicon? Moreover, what type of experimental tasks would be more appropriate to examine processes involved in "normal" reading conditions? Coltheart's (1978) classic article seemed to answer some of these questions. In particular, Coltheart's (1978) dual-route postulation, based primarily on the regular-irregular dichotomy of English (as argued before), was that one could always use knowledge of spelling-sound rules to assemble an articulation for regular words and regularly transcribed nonwords, such as PRANE, via a rule-based route, henceforth referred to as the nonlexical route (see Route A in Figure 1). Any word exception to these rules could be directly looked-up by addressing its representation in the mental lexicon, henceforth referred to as the lexical route (see Route B in Figure 1). Coltheart's assumptions about the routes solved the dispute about the nature of the code used in visual word recognition, i.e. if visual or phonological codes mediate lexical access what is the nature of each code? First, Coltheart proposed that the nature of the phonological code involved is articulatory and through analytical process of nonlexical Grapheme Phoneme Correspondences (also referred to as Conversions), henceforth abbreviated as GPCs. Thus if phonology is used in lexical access then the nature of such processes is articulatory in nature and perhaps only words defined as being regular would benefit from such processes. Secondly, that the visual code is lexical, direct look-up, thus, holistic/logographic in nature. According to Coltheart, this is similar to the manner in which one identifies pictures or logographic symbols such as £ and Arabic numerals. The existence and operations of a lexical route tied in with the notion of a mental lexicon whereby information about words, in particular, orthography, phonology and semantics are assumed to be stored in specific locations, i.e. localised (e.g. Treisman, 1960; Morton, 1969, 1979). Therefore, the lexical route, in principle, enables the reader to gain access to the mental lexicon where previously stored information about words including phonology can be addressed. It follows that if visual word recognition is a visually mediated process this visual lexical route should be applicable to recognition of all words insofar as they have an established lexical entry (e.g. not applicable to new words or nonwords). Although not explicitly incorporated in the original dual-route model, the lexical route, insofar as its first point of contact in the mental lexicon is concerned, is assumed to be further subdividing into two “routes”; an orthography-to-phonology route (a direct route to phonology) and an orthography-to-semantics route (an indirect route to phonology, henceforth referred to as the semantic route, see Route C in Figure 1). Noteworthy is that the semantic route did not become the subject of serious experimental investigation until recently (see e.g. Besner, 1999; Besner & Smith, 1992; also Chapter 8). If the semantic route is used in naming, the phonology generated is basically postlexical, whilst any phonology generated prior to accessing the semantics could by definition be labelled as prelexical. The logical assumption, however, is that although phonology can be directly addressed via orthographic representations, a semantic route between orthographic and semantic representations must exist since readers also read for meaning. Coltheart, Curtis, Atkins and Haller (1993) however, in their more recent writings, caution that this should not be misinterpreted as a triple route model; “One might refer to this kind of model as a triple-route model, but it is vital not to overlook the fact that such a model is still based on fundamental distinction between lexical reading (not available for nonwords) and nonlexical reading (which will incorrectly transcode exception words)” (p590). Thus the main focus of any research on routes involved in single-word naming could be at least twofold: i) whether two qualitatively separate routes (lexical and nonlexical) are involved in single-word naming (an issue that is dealt with in Chapters 6 and 7 of the present thesis); ii) an investigation for the type of lexically alternative “routes” that may be available to readers (an issue that is dealt with in Chapter 8 of the present thesis). The post-Coltheart (1978) era, however, set to seek evidence in support of the psychological reality of a “dual-route” model ignoring to a larger extent the issue of the existence of different lexical “routes” (see Chapter 8).

Figure 2.3.1 Routes in the Dual-Route Model of Oral Naming (adapted from Besner, 1999)



2.4 Routes in Naming and Codes in Lexical/Semantic Access

For the purpose of clarification, the distinction between the more recent line of enquiry, i.e. routes involved in single-word naming, as opposed to whether visual or phonological codes are involved for lexical/semantic access insofar as the present thesis is concerned, is as follows: The former line of research aims to investigate how one generates phonology from print, and, as will be explained in Chapter 4, whether the manner in which a particular orthography encodes phonology has an impact on the cognitive processes of this phonological code generation. The latter enquiry, however, is aimed to investigate whether the generated phonological code (regardless of how it may be generated) is involved in the process of lexical and/or semantic (direct and/or indirect) access. As will be explained in Chapter 9 it is reasonable to suppose that orthographic-to-phonological transparency may also affect the nature of code (visual or phonological) involved in lexical access, thus in itself an interesting line of enquiry where research on different writing systems is concerned (see e.g. Baluch, 1993). A comprehensive understanding of psychological processes involved in visual word recognition would therefore depend on both understanding of how one generates phonology from print as well as whether phonological and/or visual code(s) are involved in lexical access. The present thesis focuses on the issue of routes in single-word naming in the transparent Turkish orthography. In the final section of the present thesis suggestions are made for follow-up research on Turkish aimed at examining the nature of codes involved in lexical access of this transparent orthography.

2.4.1 In Search for the Psychological Reality of the Lexical and Nonlexical Routes

Search for the psychological reality of the lexical and nonlexical routes was directed on several pathways and lines of inquiry on i) a priori grounds, ii) evidence from skilled, beginner and impaired readers and most importantly, iii) evidence from different writing systems. Whilst one of the main aims of the present thesis is to evaluate evidence from different writing systems regarding the validity and existence of such a dual-route possibility in relation to writing systems other than English it is important, first, to summarise the gist of evidence both on a priori grounds and experimental data on skilled, beginner and impaired readers of English. This is the topic reported in the next section.

2.4.2 Experimental Data and A Priori Arguments

Empirical evidence for the psychological implications of the regular-irregular linguistic dichotomy in English were reported by Baron and Strawson (1976); Bauer and Stanovich (1980); Forster and Chambers (1973); Frederiksen and Kroll (1976); Stanovich and Bauer (1978) and many others. In particular, Baron and Strawson (1976) found that in single word lists regular words were named significantly faster than irregular words. This ability to differentiate between the linguistically dichotomous regular-irregular words was concluded to have “psychological reality” in that they must be processed by different underlying mechanisms. The assumptions accounting for this phenomenon are that whilst regular words benefit from the operations of both the lexical and the nonlexical route for naming, irregular words can only be named by the operations of the lexical route. This also makes sense on argumentative grounds. For example, since applying GPCs to name irregular words would yield incorrect pronunciations it is plausible to assume that irregular words be named by directly “addressing” their specific representations in the lexicon. In addition to the lexical route regular words, however, could also be named by using GPCs to “assemble” phonology (since this would yield correct pronunciations). Thus, the faster naming of the regular words was attributed to the advantage of both routes being utilised whilst the slower naming of irregular words was attributed to utilising only the lexical route. This interpretation of the regularity effect consequently led to further questions regarding the relative speed of the two routes and also, whether the operations of one is independent or dependent on the operations of the other (the subject of following sections in this Chapter). Further empirical evidence in support of the operations of a nonlexical route emerged from reports of naming nonwords that are created according to spelling sound rules (e.g. Frederiksen & Kroll, 1976). Since nonwords do not have previously stored information or representations in the lexicon, the only way they could possibly be named is by using one’s spelling-sound rules, i.e. GPCs. Notable, however, is the relatively slower naming and lexical decision RTs repeatedly reported for nonwords than for words which again highlights questions about the relative speed of the two routes in attaining phonology from print (e.g. Frederiksen & Kroll, 1976). It is necessary to make a distinction between the demands made by lexical decision tasks and single-word naming tasks on participants. Lexical decision tasks are non-verbal in nature whereby the phonological/orthographic (e.g. Rubenstein et al., 1971) or lexical (semantic) aspects of stimuli are manipulated and subjects are required to carry out decisions that involve consulting the lexicon. The primary concern is thus to investigate whether a visual or a phonological code is used for accessing the mental lexicon. Naming tasks, however, attempt to demonstrate the possible involvement of routes in deriving phonology from print according to the type of stimuli manipulated, e.g. naming of words and nonwords. It is thus important to differentiate between the two types of tasks which place different demands on participants.

Whilst the brief review of the literature providing evidence in support of the dual-route model here stems from work with adult skilled readers, often evidence from beginner readers has also contributed to the psychological evidence for the routes. This is because in an alphabetic writing system, beginning to read is argued to be characterised by use of GPCs to attain phonology (e.g. see Barron, 1986 for a review) although children are also able to visually recognise and sound out a limited number of whole words or symbols early on as if they are logographs (Frith, 1980; 1985). This logographic stage, however, soon becomes taxing when a large number of words enter into children's vocabulary (Gough & Hillinger, 1980). Bearing this in mind, the emphasis shifts towards the acquisition of phonology via spelling-sound rules in order to read novel words. It thus follows that the rule governed nonlexical route during acquisition of reading skill is the predominately used one with a possible gradual shift towards the use of the lexical route with increasing level of skill and mental representations (Barron, 1986). In this respect, the acquisition of reading skill in children has been demonstrated to be directly linked to their phonological awareness, i.e. the ability to distinguish and manipulate phonemes within a word (e.g. Bradley & Bryant, 1979, 1983; Gleitman & Rozin, 1977; Liberman, 1973; Mattingly, 1972). The high rate of regularisation errors by beginner readers of English is taken as strong evidence that the nonlexical route is being used within the dual-route framework. One distinction between the skilled and the less skilled, is thus the yet to-be-established visual mental lexicon in the latter, which has implications for the use of either route. Moreover, if children show an inability to acquire the use of either the letter-to-sound correspondences or the use of lexical route at a normal rate this is shown to have significant consequences on their reading as adults which is referred to as developmental dyslexia. The dual-route model (Coltheart et al., 1993) account for developmental dyslexia is that "...just as each of the two routes can be selectively affected by brain damage with the other remaining intact, it is possible for a child to have difficulty acquiring one of the routes, with the other being acquired at a normal rate" (p597).

In this respect, the ability to explain certain reading impairments, in particular types of acquired dyslexia within the dual-route model of oral naming were also taken as strong evidence for the existence of the two routes. The logical postulation here is that damage is attributed to the processing of either the lexical or the nonlexical route may be taken as an indication of their "psychological reality". That is, reading may become either exclusively lexical, i.e. reading for meaning, or exclusively nonlexical, i.e. reading for sound. Although not within the scope of the present thesis to provide an extensive review, a brief overview of psychological evidence for such dissociation is considered below. One type of impaired reading is so-called phonological dyslexia which is characterised by the poor reading of nonwords but spared ability to read real words. Within the dual-route framework, this is taken as evidence for the sole impairment of the rule-based nonlexical route (e.g. Funnell, 1983; Coltheart, Patterson & Marshall, 1980) whilst the lexical route is assumed to be intact. Thus, whilst GPCs cannot be employed to name regularly transcribed nonwords, words can be named because the lexical route by which readers can access words mental representations is presumed intact. By contrast in another form of acquired dyslexia, namely surface dyslexia, the patients performance on nonword and regular word reading is laboured but good, whilst performance on irregular words is poor and typically accompanied by a high rate of regularisation errors. This is taken to suggest impaired use of the lexical route and reading that is reliant on the rule-based, nonlexical GPCs (Shallice, Warrington & McCarthy, 1983). Evidence from the latter two forms of dyslexia is often referred to as double dissociation which further supports the existence of two distinct routes for deriving phonology from print.

Finally, evidence for the use of the orthographic-to-semantic route is provided by deep dyslexia which is typically characterised by errors not phonological, rather semantic in nature. For example, when presented with the word TULIP deep dyslexics will often call out CROCUS (Coltheart, 1980). This has been taken to suggest that in deep dyslexia readers do not access the phonology rather the semantic representation of the word. A similar account was reported by Saffran, Bogyo, Schwartz and Marin (1980) indicating this problem in the activation of phonology by the semantic system, suggesting that perhaps the lexical route further divides into two: The orthography-to-phonology route and the orthography-to-semantics route. Deep dyslexia is attributed to the possible damage to both the nonlexical route (since nonword naming is also poor) and the orthography-to-phonology route with only the orthography-to-semantics route available for naming. Since the functioning of this semantic route is still based on accessing lexical presentations, i.e. it is not qualitatively different from the operations of the orthography-to-phonology route, it was incorporated within the original dual-route model proposed by Coltheart (1978) as a branch of the lexical route.

2.4.3 Summary Remarks and Issues Needing Further Examination

To summarise, evidence from a) a priori grounds, b) skilled, beginner and impaired reading suggests that at least two qualitatively different routes, namely, lexical and nonlexical, are available to the reader for generating pronunciation from print. The dual-route model of oral naming seems to account for many phenomena, such as the naming of regular vs. irregular words, and the ability of novel word and nonword naming. However, provided that one entertains the notion of qualitatively separate routes in oral naming there are still many questions that need an explanation, in particular the manner in which these two routes operate: Are they interactive or do they function in an independent manner? Do these routes operate automatically or is the operation of one route (or both) under the strategic control of the reader? Is the speed of processing the same for both routes or is there a “race” involved with one route a typical winner? In other words, does one route predominate over the other? If so, does this dominance apply to all words in all writing systems or does it depend on the orthographic-to- phonological transparency of a particular writing system? These are the type of questions that will be addressed throughout the remaining sections of the present thesis, in particular the latter issue regarding the possible impact of orthography-to-phonology transparency as a factor affecting the nature and operation of route(s) in single-word naming.

2.5 Word Frequency and Models of Visual Word Recognition

One topic, however, that will be addressed throughout the present thesis is the issue of word frequency effects on single-word naming. This interest was fuelled by two assumptions: First, that the mental lexicon is built up of orthographic, phonological and semantic stores each with an entry for known words (Treisman, 1960). Second, a factor that could influence the organisation of these stores is the frequency of encountering a particular word (Morton, 1969, 1979). Moreover, since Coltheart’s (1978) lexical route was modelled on assumptions about the mental lexicon it was inevitable that any factor which may influence its organisation, e.g. frequency, also had implications for the use of routes (and psychological evidence of its operation) within the dual-route model. Thus, it may follow that, if at any stage in the process of phonological code generation lexical information is consulted, one should expect effects of word frequency (amongst effects of other lexically stored information, e.g. semantics). Absence of such frequency effects in the generation of phonology may indicate that the process is essentially nonlexical. These assumptions provided guidance for researchers in setting experimental tasks to explore the conditions under which single-word naming requires (maximum) lexical involvement and under which conditions these effects are minimal or absent. Described next are three alternative models with differing underlying mechanisms for word frequency.

2.5.1 Word frequency and Theoretical Architecture of Models of a Localised Mental Lexicon

Central to Treisman's (1960) "dictionary units" supposition was the notion of tuneable activation thresholds which are assumed to be permanently adjusted in accordance with word frequency. The concept of dictionary units may be thought of as the specific location whereby the effects of sensory stimulation and of previous linguistic knowledge meet. A most important theoretical consideration in this respect is that internal representations are not fixed entities but have activation thresholds which are constantly adjusted via exposure to stimuli. Thus the threshold factor became an integral architectural component of many influential models of visual word recognition, that accounted for a reliable phenomenon in experiments on visual word recognition. Namely, the finding that words seen more often, high-frequency words, are recognised faster than less often ones, low-frequency words (see Henderson, 1982; p316 for a discussion).

Following Treisman's (1960) seminal paper, research interest focused on how the mental lexicon may be organised. It seemed only plausible to suggest a framework for the architecture of the lexicon with a set of word detectors with each word represented as a local holistic unit, or a node. Thus, each word known to the reader is represented in a localised mental lexicon as a lexical entry, with independent stores for a word's meaning, pronunciation and spelling. A given node or representation is responsible for recognising all occurrences of the word in print, regardless of variations in typeface, ink colour, letter spacing or other properties that do not change the identity of the word. It thus follows that more frequently encountered words may require less information to activate their thresholds than less frequently encountered words. Moreover, the mental lexicon is assumed to be organised hierarchically whereby high-frequency words are placed at a higher level than less frequent ones. Therefore, the reader's task is to gain access to these lexical representations. Three different models based on alternative accounts for the manner in which these lexical representations become activated, hence accessible to the reader are introduced in the next Section. Furthermore, particular attention is paid to mechanisms that account for frequency, an integral part of the theoretical architecture of each model described below, as introduced next.

2.5.1.1 The Logogen Model

An innovative model founded upon and utilising Treisman's dictionary units hypothesis was developed by Morton (1969, 1979) in an attempt to tackle the issue of lexical organisation, hence lexical access. The model is based on the notion that localised representations, referred to as logogens, operate as threshold-type detection devices. In line with Treisman's assumptions, logogen thresholds are assumed to be tuneable or modifiable entities. Each logogen responds to sensory stimuli, i.e. print, as if they were pieces of evidence either for or against the presence of a particular word's stored representation. The evaluation of evidence is thought to be carried out in parallel since several logogens can be activated in response to a single word. Also, that this is a cumulative process, i.e. as sensory evidence accumulates, logogens representing words that are visually most similar to the stimulus approach their threshold faster than those representing words that are less similar. The first logogen to exceed its threshold, i.e. to fire, wins the competition and leads to the activation of a set of codes containing information about the word. This in turn becomes available to decision making and response mechanisms that might act on it, e.g.

articulation. Thus, logogens for more frequent words will require less evidence for their activation than logogens of less frequent words. In sum, threshold values of logogens are assumed to be inversely related to word frequency, i.e. biased towards an easier recognition of words that are more familiar. Therefore, according to the logogen model, the mechanism that accounts for frequency effects is at the level of lexical access. Despite the huge impact of this model on understanding of how the mental lexicon may be organised it was not without criticism. In particular, the assumption that the whole lexicon becomes activated in the search was considered neither an economic nor an efficient manner for the cognitive system to function. This led to the development of other localist models as introduced and discussed below.

2.5.1.2 Lexical Search Model

The lexical search model (e.g. Forster, 1976; Taft, 1979) differs fundamentally from Morton’s logogen model although the logogen concept of activation is retained as a “set of files” or “bins”. The emphasis is now based on morphemes rather than whole word detectors. The breaking up of poly-morphemic words into their constituents introduces more steps into the recognition process, which the proponents of the lexical search model claim the logogen model overlooks. Instead, the lexical search model first assumes to evaluate evidence from words through serial matching against a list of possible representations retrieved from the mental lexicon. This is contrary to the reliance on simultaneous and parallel access to the entire body of word detectors in the logogen model. Arguably, this is considered a more efficient way of engaging the mental lexicon in the search. Furthermore, an “access code” is postulated in order to achieve the breakdown of words into subword or morphological units and map them onto morphemes presented in the lexicon. The access code consists of a sub-set of the letters from printed stimulus, i.e.

sub-word unit, which must have a matching representation in order to qualify a lexical entry to become a candidate in the search. Noteworthy is that both the lexical search and the logogen model share the same bias towards frequency. That is, the mental lexicon is ordered via frequency whereby high-frequency words are recognised faster than low-frequency words. Both the logogen and the lexical search models were heavily criticised by Becker (1976, 1979) who argued that activation alone, whether at word or morpheme level, was not sufficient for word identification and that a verification stage was necessary. Becker's model is explained further in the following section.

2.5.1.3 Activation Verification Model

In the activation verification model (Becker, 1976, 1979) the central emphasis is on a top-down checking process, or verification, in which activated lexical codes need to be verified before they become available to decision and response mechanisms. This checking process verifies whether the word chosen in the initial search of the lexicon is indeed the presented word. If the initial verification fails other possible lexical candidates are tried until the right one is found. The comparison is assumed to be carried out serially and ordered according to frequency of occurrence. However, contrary to the activation models, such as the logogen and the lexical search models, the mechanism sensitive to frequency effects is not assumed to be at the level of activation, i.e. lexical access, but one that incorporates both the activation and verification processes. Thus, the faster recognition of high-frequency as opposed to low-frequency words can be attributed to their being represented at the top of the checklist. Again, the process described by this model is thought to be more streamlined than the logogen model, as the large internal competition among logogens in the lexicon is eliminated.

2.6 Summary Points

The three models introduced above are examples of a localist framework of the mental lexicon with differing but yet one converging assumption, i.e. that regardless whether representations are holistic or segmented they are localised in nature. In addition, words' meaning (semantics), spelling (orthography) and sound (phonology) are thought to be organised and stored as separate entities, and further assumed to function independently from each other. Thus, access to a word's entry into one of them does not necessarily provide immediate access to the corresponding entry in the other. Generation of phonology is possible by either a prelexical code, i.e. prior to looking up an entry in the lexicon, or alternatively, after consulting an entry within the lexicon. The point of consulting the mental lexicon, as explained earlier, is by either accessing a phonological or a semantic representation. In the case of the former, generation of a phonological code is prelexical whereas in the latter case it is essentially postlexical. Noteworthy also is the degree of sensitivity of these routes to frequency, a lexical variable. Since the nonlexical route is assumed to operate based on GPCs and independent of lexical knowledge there is no logical reason to expect a difference between high- and low-frequency words if it is used. On the contrary, since the operation of the lexical route is based on accessing lexical knowledge it is thus conceivable to assume that any differences between high- and low-frequency words is attributable to its involvement. Forster and Chambers (1973) are often cited as the first to report an effect of word frequency in English. In a naming task high-frequency words were reported to be named faster (508ms) than low-frequency words (579ms) which in turn were named faster than pronounceable nonwords (598ms). The authors concluded that the naming of words could be accomplished by a "dictionary look-up" whereby the faster the location of a word's entry the faster it will be named. Their finding supported the assumption that the internal mental lexicon is organised in such a fashion that words with higher occurrences are located faster, hence the difference in naming latencies for high- and low-frequency words. In addition, the slower naming latencies for nonwords was attributed to the involvement of the GPCs of the nonlexical route which was argued to be slower of the two routes. The sensitivity of the routes to lexical variables such as frequency has implications for psychological research within the dual-route model as well as the organisation of presentations in the lexicon.

In the next section of this review, early investigations utilising word frequency in English and the implications of findings for the dual-route and the mental lexicon are discussed. Particular attention is paid to early reports of what are labelled as "strategic control", "list effects" and methods of "blocking" in naming tasks. These latter topics are the type of manipulations that researchers have incorporated into their experimental design in an attempt to tackle the issue of how the two routes may operate (e.g. strategies as opposed to automaticity in single-word naming and interactive as opposed to independent).

2.7 Evidence For Strategic Control

Frederiksen and Kroll (1976) devised experimental conditions, namely, blocking, to further explore the issue of the manner in which the two routes may operate in single-word naming. Frederiksen and Kroll (1976) argued that if the lexical route is used to name words and the nonlexical route is used to name nonwords, by providing conditions that maximise their use should yield to differences in RTs. That is, a pure-block condition whereby the stimuli consist of one type only, such as words, should enhance the use of the lexical route. In a mixed-block which comprises of at least two types of stimuli, words and nonwords, the sole use of the lexical route is impossible because of nonwords which can be named by the nonlexical route. Frederiksen and Kroll (1976) reported that type of blocking indeed had an impact on naming latencies, such that responses in the pure-block condition were faster than the mixed condition even for nonwords. The systematic differences observed in the pure vs. mixed-blocks were attributed to possible changes in strategies, i.e. lexical vs. nonlexical, a reader may adopt under task demands. It is worth noting Bradshaw's (1975) earlier observation here that "...different demands placed on subjects..." when they are presented with only words as opposed to the presence of nonwords. Bradshaw argues that "... it would be expected that they should go back for a phonological retake" (p130) under experimental conditions that incorporate nonwords. An important issue here is the notion that subjects can be encouraged to utilise a particular route depending on task demands. This also makes sense on logical grounds as in pure-blocks readers could adopt the most appropriate route for naming, such as the nonlexical route for the naming of nonwords. On the contrary, in a mixed-block, when nonwords are mixed with words (regular and irregular), the sole use of nonlexical route would fail for the naming of irregular words whilst the sole use of the lexical route would fail for nonwords. The notion that readers can exercise strategic control, thus flexibility, over the use of the two routes according to task demands was born.

In addition to manipulations of frequency, Frederiksen and Kroll (1976) manipulated the effects of word length and syllabic structure on word recognition. It was reported that word-length had a significant effect on naming in that participants took longer to respond to six-letter words than to either five- or four-letter words. An increase of 28ms per letter was reported. On the contrary, syllabic structure did not have a significant effect on word recognition. That is, one-syllable words were not recognised significantly faster than two-syllable words. This finding is somehow paradoxical in nature, as when syllables increase so do the number of letters in words! Insofar as the effect of increasing letter length on RTs is concerned, it has recently been shown to be a reliable effect (e.g. Weekes, 1997) and will be discussed in detail in Chapter 7.

Frederiksen and Kroll's (1976) contribution, however, paved the way for future research by addressing the issues of relative speed of the two routes; under what conditions could strategic control be enhanced; by the type of experimental manipulations such as pure-blocks as opposed to mixed-blocks of different categories of stimuli. Within the scope of investigating possible strategies in single-word naming but using different experimental manipulations, L. Midgley-West (1980) herself a student of Coltheart's, capitalised on the issue of whether the predictability of type of word, i.e. regular-irregular, would have an effect on readers strategies. Predictability was achieved via pure-blocks whereby participants were required to name either a set of regular words or irregular words following a set of relevant practice trials prior to the experiment. Regular words were named significantly faster than irregular words in the pure-block condition. In the unpredictable mixed-block however, Midgley-West reported that naming of regular words had slowed down to a large extent. While the former finding was taken to indicate the involvement of the nonlexical route, the latter was taken to indicate that readers abandon this in favour of the lexical route since the GPCs would fail when reading irregular words. This finding was taken as evidence to suggest that readers exercise strategic control over the use of lexical and nonlexical routes in tasks requiring them to pronounce specific type of words and/or nonwords. Moreover, the use of a sole route yielded faster RTs than when switching between the two alternatives.

To summarise, it became evident that manipulations of the type of stimuli in the naming list had differential effects on RTs of target words. These manipulations are interchangeably referred to as, e.g. list-composition and list-effect. More recently Jared (1997) reports that "In list-composition studies, experimenters look for changes in performance on a set of target words that result from including the words on lists with different type of filler words (or on lists with different type of filler and no filler)" (p1425). Fillers, in this respect, can also be thought of as non-target stimuli. It could thus be argued that the role of fillers is to encourage readers to use a particular route or adopt a particular strategy. For example, the presence of irregular words as fillers can be argued to encourage readers to use the lexical route. Similarly, if fillers are novel yet regularly transcribed words or nonwords the use of the nonlexical route is encouraged. This is also referred to as the de-emphasis and emphasis of the routes (e.g. Monsell et al., 1992). Therefore, one possible explanation of these results is that the involvement of routes in naming is considered a flexible process, i.e. under strategic control of readers.

Evidence regarding the relative speed of the two routes led to the development of a dual-route model with a horse-race logic between the routes involved in naming. That is, the lexical and the nonlexical routes are assumed to operate in parallel yet race to a "finish" independent of each other. An influential development based on this horse-race logic was put forward recently by Paap and Noel (1991) which successfully encapsulates the essence of Coltheart's (1978) dual-route supposition. Their assumption is that the two alternative routes start simultaneously, operate in parallel and functionally independent of each other, and race to a solution, i.e. naming, whereby a response is executed depending on which one gets to the finishing line first (e.g. Paap & Noel, 1991; Paap, Noel & Johansen, 1992; see also Humphreys & Evett, 1985; McCusker et al., 1981 and the following commentaries for a review of an earlier debate on dual-route models).

Paap and Noel (1991) examined whether the operations of the two routes are automatic or under the strategic control of readers in two separate naming tasks. The rationale for their investigation was based on Norman and Bobrow's (1975) earlier assumptions regarding attentional demands and resources allocated to automatic and controlled processes. In this respect the lexical route is assumed to be more automatic than the nonlexical route (see Section 9.1 for a discussion). To put these claims to the test Paap and Noel (1991) examined the naming of words factorially manipulated for regularity and frequency under memory load, that is, when subjects are required to retain a digit in their memory whilst naming the word stimuli. Memory load was further manipulated as either high, i.e. five digits, or low, i.e. one digit. The authors hypothesised that naming RTs for low-frequency irregular words should be faster under high memory load if this is to have the most impact on the operations of the nonlexical route. This is because the greater the demands on the resources the larger the impact on the nonlexical route, thus the generation of conflicting phonology from the nonlexical route for low-frequency irregular words. It was indeed reported that low-frequency irregular words were named 39ms faster in the high memory load condition compared to the low memory load condition. In a second task participants were required to name either all irregular words (pure-block) or regular and irregular words mixed together (mixed-block) under a further interference task (tone probe). Paap and Noel (1991) reported that whilst interference was minimal for the pure-block this was not the case for the mixed-block. This was taken to indicate that the resource demanding nonlexical route must have been “turned off” in the pure-block, hence no interference. Based on this evidence, Paap and Noel (1991) concluded that the operation of the lexical route is more automatic whereas the nonlexical route is more likely to be under the strategic control of the reader. In this respect, two immediate points are raised here: First, the lexical route is automatic and faster than the nonlexical route which is typical of all writing systems. Second, this automaticity and the faster operation of the lexical route compared to the nonlexical route in English is brought about as a result of its irregular characteristics.

2.8 Summary and Concluding Remarks of the Chapter

Based on evidence from the linguistic peculiarities of English, a dual-route model with at least two qualitatively distinct routes for deriving phonology from print was proposed. A parallel, equally influential development was the notion of a mental lexicon with localised representations whereby frequency was assumed to be an integral part of the theoretical architecture. Empirical evidence from intact and impaired reading strongly suggested that these routes also have psychological reality. For instance, participants were faster in naming high-frequency words than low-frequency words. Regular words were also named faster than irregular words. Moreover, words were named faster than nonwords. All these factors (namely, frequency, regularity and word/nonword status of the stimuli) were taken as evidence for the possible existence and the nature of the operations of the two routes. However, follow-up questions were raised regarding the automaticity (as opposed to strategic control), independence (as opposed to interactive processing) and the speed with which the two routes operate in accessing phonology.

Whilst little was said in this Chapter on whether the routes operate independently or interactively, several pioneering studies suggesting some degree of strategic control in the use of lexical, and in particular nonlexical routes, in response to task demands (e.g. blocking vs. mixing, the effect of changing filler items) were reviewed. Moreover, on the subject of speed of processing, it was suggested that perhaps the two routes operate with a horse-race logic. That is, they are activated and simultaneously race to a finish in parallel, although within such a horse-race logic the issues of automaticity and strategic control could still be a debatable issue. It was also commented that perhaps the lexical route is faster than the nonlexical route.

Whilst the dual-route supporters were debating on the kind of questions addressed above, a fundamental challenge was made to the claim that two qualitatively different routes exist. Specifically, the notion of psychological reality of a rule-based nonlexical route was attacked by researchers such as Glushko (1979, 1981) and Marcel (1980). Both investigators argued that pronunciation of both words and nonwords can be derived lexically i.e. there is no rule-based nonlexical route, hence they advocated a single-route perspective in understanding the psychological processes involved in single-word naming (see Humphreys & Evett, 1985, for an early debate between single-route and dual-route supporters). The main classical research led by the pioneering work of Glushko will be addressed in Chapter 3 which covers some of the fundamental issues from a single-route perspective.

3 Chapter 3: The Single-Route Perspective: A brief review of the literature

3.1 Preface

The classic work of Glushko (1979, 1981), challenged the dual-route model of reading, especially the existence of the rule-based, nonlexical route which had been the hallmark of a dual-route postulation. The challenge by the opponents of the dual-route model was developed around two issues; a) the regularity-consistency effect, i.e. the faster naming of regular English words than irregular words and b) the processing of nonwords. Within the dual-route framework the regularity effect is taken to indicate that qualitatively different routes are used when naming regular and irregular words. This is also valid for the naming of nonwords that have no previous lexical entries, thus nonwords are assumed to be named via the same rule-based nonlexical route (that is also used to name the regular words). It was these predictions that were challenged by Glushko (1979, 1981), which will be examined next.

3.2 Rules vs. Lexical Analogies: Attack on the Nonlexical Route

As explained in Chapter 2, English spelling reflects linguistic regularity as well as consistency. Regularity, as explained earlier, is how dual-route supporters account for the existence of a nonlexical route. Glushko (1979, 1981), however, took advantage of both consistency (orthographic units larger than graphemes) and regularity aspects of English in his experimental manipulations. As will be reported here, he was able to demonstrate that perhaps what previously had been attributed to regularity effects in the possible triggering of qualitatively separate lexical and nonlexical routes could equally be explained by a single process at some "lexical" level.

Glushko (1979, 1981) manipulated the consistency aspect of regular words in English. That is, whether a word's pronunciation is consistent with all the other words sharing the same spelling patterns, or not. For example, as discussed earlier, WAVE is regarded as inconsistent because it shares a spelling pattern with a word like HAVE that has an inconsistent pronunciation. On the contrary, all words that share the spelling pattern of a word such as WADE are pronounced the same way (e.g. MADE, SHADE, JADE); hence, it is regarded as a consistent word. Glushko showed that a regular but inconsistent word such as WAVE takes longer to pronounce than a regular and consistent word such as WADE. A position based on the dual-route model of reading in its strongest form, i.e. the clear dichotomy of the nonlexical route being used for regular words and the lexical route used for irregular words, cannot be entertained here. However, noteworthy within Glushko's (1979, 1981) findings, is that both regularity (in one form or another) as well as consistency aspects of the English orthography, as explained in Chapter 2, have implications for the processing of words. Rather than the operation of two qualitatively different routes, Glushko proposed instead that words (and nonwords as discussed below) are pronounced lexically, utilising pre-existing orthographic and phonological knowledge, i.e. lexical analogies. The novel claim was that a target letter string (automatically) elicits pronunciation of words which are orthographically most similar to it. The resulting pronunciation may then depend on a synthesis of information based on these activated sources, i.e. activation synthesis. In this framework, Glushko argued that "... a word is not regular or irregular only in terms of its own spelling-to-sound correspondence. Rather, a word is consistent or inconsistent with the orthographic and phonological structure that it activates" (p687). Thus, faster recognition of a target word like WADE is attributed to the activation of orthographically similar and phonologically consistent sources or neighbours such as MADE. In contrast, a word like WAVE is recognised slower because of the activation of orthographically similar but phonologically inconsistent sources such as HAVE.

When tackling nonwords, Glushko generated two distinct types of nonwords, namely “regular” and “irregular” nonwords, by replacing a single letter in either regular or irregular words to be used in a series of single-word naming tasks. Thus, “irregular nonwords” differed by one letter from an originally irregular word, e.g. HAVE - TAVE, as opposed to “regular nonwords” derived from originally regular words, e.g. HAZE - TAZE. Glushko reported that (similar to findings from regular-irregular words) “irregular nonwords”, such as TAVE, were also named slower than regular nonwords, e.g. TAZE. Thus, these findings were taken as evidence that nonword naming was influenced by lexical knowledge. This is contrary to the assumptions of the dual-route model whereby naming of nonwords is only possible via the nonlexical route which is presumed to be insensitive to lexical knowledge. Glushko argued that his findings refuted the claims for the existence of a rule-based, nonlexical route utilised to pronounce nonwords within a dual-route framework which should have yielded similar naming RTs for all the nonwords regardless of their “ lexical type”.

Noteworthy here is that although Glushko’s interpretation of findings is plausible, it is not without criticism. First, what should not be overlooked is the manner in which nonwords were created by changing one letter in words. Thus, in view of such orthographic similarity between words and nonwords, is it any surprise that such “lexical similarity” between words and nonwords has a bearing on the activation of lexical analogies? In addition, how can lexical analogies explain the fact that readers are also capable of pronouncing nonwords that are not derived from words, but are random pronounceable letter strings? Moreover, how does one acquire lexical entries for words phonology and lexical analogies in the first place? Should there be some form of "nonlexical" processing in the first instance prior to a well established mental lexicon? Finally, for the purpose of the present thesis, to what extent is the impact of lexical factors on naming English in response to its "deep" orthography? And perhaps absent in scripts whereby there is always a consistent and reliable relationship between letters and their corresponding phonemes, hence no irregularities or lexical inconsistencies? This latter issue is explained in more depth in Chapter 4 and is the main focus of the present thesis.

Insofar as the assumptions regarding the existence of a rule-based nonlexical route in English were considered, the evidence provided by Glushko was rather damaging. The wider implications were twofold: First, that pronunciation could be derived by means of a single "lexical" route. Second, the notion of lexical analogies meant that the organisation of the mental lexicon had to be reconsidered from a localised to a more interactive one in order to accommodate the ability to activate and synthesise lexical information about words. This immediately set the scene that, whilst dual-route supporters had to fight for their camp in supporting the existence of a dual-route possibility in naming, they also had a huge task to fight for the existence of a localised as opposed to an interactive mental lexicon. Although the basis of the lexical route was drawn upon a localised mental lexicon, the dual-route proponents had to substantiate their claim by a novel lexical variable.

Prompted by Glushko's assumptions about lexical analogies, as induced by orthographically similar sources or neighbours, a new variable was implemented in experimental research, known as Neighbourhood size or (N). This is defined as the number of different neighbours of a stimulus that can be created by changing a single letter of a target word gained attention. The following are two examples of how this lexicality, a peculiarity of English, led to two opposing positions regarding theoretical argumentation about the use of the nonlexical route vs. lexical analogies. For example, a word like SAND has many neighbours; e.g. BAND, SEND, SAID and SANK while CLUB has only one neighbour, i.e. CLUE (see Andrews, 1997, for a comprehensive review).

In this respect, Coltheart, Davelaar, Jonasson and Besner (1977) reported that in a lexical decision task high-neighbourhood nonwords took longer to be classified than low-neighbourhood nonwords but that neighbourhood-size had no effect on performance for words. The authors interpreted this finding to be in line with Morton's (1969, 1979) logogen model whereby logogens are assumed to be activated by their corresponding sensory input and not influenced by the activation of other logogens. Similarly, in a naming task, McCann and Besner (1987) reported that high-neighbourhood nonwords were named faster than low-neighbourhood nonwords. This was attributed to the possibility that high-neighbourhood nonwords may contain more common or frequently occurring spelling-to-sound correspondences. Contradictory evidence was, however, reported by Andrews (1989) who manipulated word frequency factorially with neighbourhood-size. She reported that high-neighbourhood size was consistently associated with better performance, i.e. faster RTs and lower error rates, for words in both naming and lexical decision tasks, although a significant neighbourhood effect was found for low-frequency words only in the lexical decision task, i.e. a frequency by neighbourhood-size interaction. However, it is important to note that these effects were for lexical decisions and not for naming. In the naming task, however, Andrews (1989) reported a "tendency" for neighbourhood effect for low-frequency words compared to high-frequency words but that there was no interaction between frequency and neighbourhood-size. This was taken by Andrews to indicate that in English neighbourhood effects for low-frequency words is indicative of an interactive, rather than localised, mental representations similar to that described by Glushko (1979, 1981). Moreover, what is debatable here is the extent to which the evidence for neighbourhood effect could necessarily reflect activation of lexical information as suggested by Glushko (1979, 1981) as opposed to nonlexical processing, i.e., they may instead be due to the effects of orthographic structure on reading processes. That is, high-neighbourhood words or nonwords might be faster to name because they contain more common or familiar spelling-sound correspondences that arguably can be utilised via the nonlexical route, as also suggested by McCann and Besner's (1987) finding.

The notion of lexical analogies and activation-synthesis nevertheless paved the way for a theoretical reconsideration about the way in which the mental lexicon is assumed to be organised. One highly influential development was the rise of the interactive activation framework of mental representations proposed by McClelland and Johnston (1977), McClelland and Rumelhart (1981) and Rumelhart (1977). This framework subsequently led to the rise of a family of models, the so-called Connectionist Models, which will be introduced next.

3.3 The Rise of the Interactive Activation and Connectionist Models

A brief review of the literature highlighting the historical development of the notion of an interactive mental lexicon, rather than a localised one is outlined here. This is due to a localised lexicon being more favoured by the dual-route theorists, whilst the creators of single-route modelling find the notion of an interactive (connectionist) model more appropriate to their general architecture. However as will be explained below the two camps may not necessarily be mutually exclusive. That is, one could accommodate both qualitatively distinct processes in oral reading as well as processes and organisations that are interactive and distributed.

During the mid 1960's through to the early 1980's two opposing schools of thought dominated the field of information processing. On the one hand, there was the top-down or message-driven processing which was originally proposed by Smith (1969), whilst on the other hand was the bottom-up processing or data-driven processing proposed by the now classic work of Neisser (1967). The two positions as applicable to various aspects of information processing (single-word naming as well as text processing and reading comprehension), are respectively defined by Frederiksen (1981, p362) as “Availability of information concerning discourse context influences the depth and character of word analysis (decoding), methods for lexical retrieval, and size of units in encoding text” (the top-down approach) and as “The manner of, or efficiency in, processing information at one level may influence processing of information at a higher level.” (the bottom up approach). The early work of Rumelhart (1977) produced a radical development whereby these two previous assumptions were combined within an interactive framework within the realm of psychological processes of visual word recognition, whereby information flow was assumed to be bi-directional between bottom-up and top-down processes. Moreover, Rumelhart (1977) proposed an interactive information processing system which consisted of various knowledge sources, i.e. phonology, orthography and semantics. According to this model activation in one of the knowledge sources influences the other two and is also influenced by their activation. These fundamental assumptions eventually led to the development of a novel model by McClelland and Rumelhart (1981) and Rumelhart and McClelland (1982) demonstrating how the mental lexicon may be organised. This model will be discussed in detail in the next section.

3.3.1 McClelland and Rumelhart’s Interactive Activation Model

McClelland and Rumelhart’s (1981) model was primarily developed to explain the word superiority effect. That is, the faster recognition of individual letters when presented in words (e.g. the letter K in the word WORK) than when compared to in nonwords or other random letter strings (see Reicher, 1969 for a detailed account). Based on word superiority effects it was concluded that perhaps in the process of visual word recognition, information from higher (word) level interacts in the recognition of information at a lower level (letter features, letters). This could thus suggest that representations in the lexicon are not word-specific, but that different units or nodes represent different visual information regarding words. This could be in the form of letter features, letters and whole words functioning in an interactive manner. These units are assumed to be organised in layers in a large network hierarchy that is fundamentally connectionist in structure. Three layers of units are proposed: Input (stimulus), hidden and output (response). Connections or pathways consist of adjustable weights that determine how much activation has passed. Units which share information are interconnected by excitatory pathways (e.g. A and AN) and those units that do not share information are interconnected by inhibitory pathways (e.g. A and THE). Recognition of a word is possible when a unit specific to the information (i.e. whole word, letters, letter features) exceeds its activation level and activation then spreads by means of excitatory-inhibitory connections through the network. Noteworthy, is that McClelland and Rumelhart's (1981) interactive model is an example of a connectionist model whereby its representations are nevertheless still localist not distributed in nature (see Besner, 1999 for a recent review on this issue). The development of this radical theoretical architecture regarding representations encouraged investigators to reconsider how readers may recognise print and led to the evolution of a new connectionist breed of models of visual word recognition, as introduced in the next section.

3.3.1.a Explaining Frequency and Regularity within a Time-Course Model of Lexical Access

Within the dual-route model incorporating a horse-race logic, a frequency by regularity interaction i.e. regular words being named faster than irregular words only when they are of low-frequency, could be accounted for in terms of the relative speed of the two routes in deriving phonology (the lexical route being faster of the two routes) and also a mental lexicon ordered by frequency. It thus follows that when words are high-frequency the lexical route wins the race irrespective of the regular-irregular characteristics of the stimuli, hence null effect for regularity for high-frequency words. However, in the case of low-frequency words, the lexical route is considerably slowed down, therefore the slower nonlexical route catches-up when most needed, i.e. low-frequency words. Both routes are assumed to arrive at compatible pronunciations for low-frequency regular words, whilst for low-frequency irregular words two presumably conflicting outcomes for pronunciation occur. This conflict is assumed to require additional time to resolve, thus resulting in the slower RTs for low-frequency irregular words (see Coltheart & Rastle, 1994 for a recent detailed account of dual-route interpretation of regularity by frequency interaction). However, replicating the regularity by frequency interaction (e.g. Andrews, 1982, 1989; Seidenberg (1985a, 1985b, 1985c); Seidenberg, Waters, Barnes & Tanenhaus, 1984) prompted a different interpretation of the above account. In particular, Seidenberg (1985a, 1985b, 1985c) proposed that a single visual route which incorporates both visual and/or phonological access codes to lexical representations could account for the reliable frequency by regularity interactions. Seidenberg's (1985a, 1985b, 1985c) single-route model is visual in nature, whereby accessing the mental lexicon is possible via a single, interactive process between visual and phonological codes. According to Seidenberg, whether one recognises words visually and/or phonologically ultimately depends on the time-course of information (visual and phonological) activation, not on a race between two functionally independent routes. In this respect, the fast recognition of high-frequency regular words is attributed to less time required for visual information to be activated, whilst the slower recognition of low-frequency irregular words was assumed to be due to the time course of information activation, in this respect the longer time required for phonological information to be activated. Seidenberg's account for how this slower phonological information is activated is, of course, not one in line with GPCs but a consequence of an earlier lexical activation of the mental lexicon (for a debate on this issue, in particular the lexicality as opposed to nonlexicality of such processes, see Seidenberg, 1985b vs. Norris & Brown, 1985). Therefore, the difference between the time taken for the activation, i.e. the time-course, is due to visual access being faster than the phonological one and is a factor that could account for regularity effects in single-word naming. [1]In this respect, Seidenberg's challenge was twofold: First, the existence of a nonlexical route and second, the manner in which a visual code becomes available to the reader to access the mental lexicon. Incorporated within the time-course framework are effects of frequency and regularity, as well as the interaction between the two. It is noteworthy that Seidenberg's assumptions for the time-course model were also challenged when the notion of a localised but interactive mental lexicon was questioned in an important development by Seidenberg and McClelland (1989), as introduced next.

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[1] Seidenberg (1985a) further argued that as visual word recognition and phonological code generation is via a single visual process governed by a time course of information activation is not just applicable to English, but should be applicable to all writing systems irrespective of their orthography-to-phonology transparency. That is, in all scripts the visual code is the prime source of lexical access, with the phonological code lagging behind. In pursuing the validity of his universal model Seidenberg (1985a) further made cross script comparison of regularity by frequency interaction in single-word naming of Chinese and English which will be explained in Chapter 4.

3.3.2 Parallel Distributed Representations

The position of the localist framework of lexical organisation and that of the dual-route model of lexical access was further challenged by Seidenberg and McClelland's (1989) single-route Parallel Distributed Processing (PDP) model. In this computational model of visual word recognition, the novel claim by Seidenberg and McClelland (1989) was that "A key feature of the model we propose is the assumption that there is a single, uniform procedure for computing a phonological representation from an orthographic representation that is applicable to irregular words and nonwords as well as regular words" (p525). This is contrary to the fundamental assumptions of the dual-route model whereby as explained earlier two qualitatively different routes, lexical and nonlexical, are responsible for pronouncing different types of words. Regular words and regularly transcribed nonwords are thought to be read via the nonlexical route by rule governed GPCs, whilst irregular words are read via the direct lexical route. In contrast, reading aloud, making lexical decisions and accessing semantics could all be accomplished without the presence of, and reference to, a mental lexicon. Seidenberg and McClelland's (1989) claim is reflected in this quote: "It contains no lexicon in which there are entries for individual words; hence, they cannot be "accessed" ..." (p533). Central to the implemented Seidenberg and McClelland (1989) PDP model is the concept of three levels of units, orthographic, phonological and hidden units. First, a visually presented letter string first makes contact with a set of orthographic units which essentially are distributed letter pattern detectors. These units feed toward to a set of hidden units, which in turn project to a layer of units that correspond to phonological patterns. When the model is at a steady state, there is feedback from the hidden units to the orthographic level, but not from the phonological level to the hidden units. Each unit at the orthographic level is connected to every hidden unit, and every hidden unit is connected back to every unit at the orthographic level. Similarly, every hidden unit is connected to every unit at the phonological level. When a letter string is presented, it is coded at the orthographic level by a pattern of activation across the entire set of units. Activation then spreads to the hidden units. This pattern of activation across all the hidden units is mediated by variations in the strength of individual connections between levels. It is this assumption of "active" representations, which can influence and in return be influenced by representations at other levels of processing, which differentiates the interactive activation approach from others. The implemented models are said to "learn" to perform tasks by way of back-propagation by using feedback that can then be used to readjust the weights on the connections until the desired output is obtained. This is a mechanism which works backward from output to input via a hidden layer. In this respect word frequency effect is assumed to be a reflection in how often it is presented to the network. Thus, word frequency is also an integral part of the architecture of connectionist modelling in a similar way to the localised ones. Seidenberg and McClelland (1989) proposed that "...knowledge of words is encoded in the connections in the network. Frequency affects computation of the phonological code because items that the model has encountered more frequently during training have a larger impact on the weights. .... yielding smaller error scores." (p533). It is also important to note that whereas RTs are used to examine performance in humans, error data is used to assess performance of the implemented models. This is problematic on two accounts: First, it does not enable one to have a baseline for comparison and second, even if one was to examine error rates for humans in comparison with computers, could one assume that the underlying mechanisms are the same for such errors?

3.3.3 Questions About the Connectionist Modelling of Reading

The proponents of the dual-route model attacked the claims of Seidenberg and McClelland (1989) in two major reviews (Besner, Twilley, McCann & Seergobin, 1990; and Coltheart et al., 1993). In particular, Coltheart et al. (1993) raised questions about issues and phenomena in reading and compared how the dual-route vs. the single-route computational PDP models would account for them, as summarised below.

How do skilled readers read exception words? According to Coltheart et al. (1993) this is the only question both models successfully answer. The psychological reality of the regular-irregular dichotomy in English is one of the fundamental assumptions that is embedded into the architecture of the dual-route model, as explained earlier. However, the error rates reported by Seidenberg and McClelland from their PDP simulation are comparable to human readers. Moreover, the main source of these errors were from low-frequency irregular words and an error rate of 2.7% was similar to that made by humans. Based on this information, Coltheart et al. (1993) concluded that "both quantitatively and qualitatively the model succeeds in simulating exception-word reading" (p593).

How do skilled readers read nonwords aloud? The nonlexical route in the dual-route model is assumed to be primarily involved in the successful reading of all regularly transcribed novel words including nonwords via GPCs. On the contrary, the PDP simulation provides a very poor level of accuracy (65%) compared to humans (in excess of 90%) where nonwords are concerned. The indication is that it appears that rules are required for attaining phonology for all novel words, including nonwords.

How is the visual lexical-decision task performed? According to the dual-route model lexical decisions are carried out by consulting the mental lexicon. Simply, if there is a matching lexical representation to the stimulus, as in the case of words, the readers respond “yes”; if not, as in the case of nonwords, then a “no” response is made. On the contrary, a “decision” is assumed to be made in the PDP via the feedback connections from the hidden to the orthographic units in the fully trained model, whereby the input and output patterns are compared and an error rate is computed. The error rates are reported to be around 6.1% for words and over 80% for nonwords. Thus, the PDP simulation of visual lexical decisions in terms of error rates is much poorer than human data.

How does acquired dyslexia arise, in particular surface dyslexia? In its purest form of surface dyslexia irregular word reading is impaired while nonword reading is almost intact - accuracy levels reaching 96.5% with some patients. Coltheart at al. (1993) argue that the attempt to simulate surface dyslexia is “premature” since the nonword accuracy levels of even the unlesioned network is between 51%-65%, thus a baseline of comparison cannot be assumed.

How does phonological dyslexia arise? Coltheart et al. (1993) noted that no attempt has been made to account for phonological dyslexia by the implemented model.

How does developmental dyslexia arise? Developmental dyslexia, as argued earlier, is assumed to arise when the acquisition of the routes is slower than usual. This was simulated by halving the number of hidden units in the training of the network. Seidenberg and McClelland (1989) reported that irregular word reading was less accurate than regular words, regardless of how frequent the network had been trained, i.e. both low and high-frequency irregular words were read less accurately than regular words. They claim that the above observation is typical of developmental surface dyslexia: In its purest form a selective difficulty in reading aloud irregular words but with normal nonword reading accuracy. However, the error rates on nonword reading were not reported for the implemented model. Coltheart et al. (1993) argue that this could be very large since, at full capacity, the network attained a maximum of 65% accuracy. Thus, the claim that symptoms of developmental surface dyslexia are simulated is "inconsistent". It thus became evident that a single-route PDP model without a mental lexicon was far from accounting for major phenomena which the dual-route model successfully did.

As recently argued by Besner (1999), there is nothing new in claiming that a single mechanism could process both regular and irregular words, since this is also assumed to be the case for the lexical route within the dual-route framework. If, however, it could be shown that nonwords could also be read via the same route this would have been taken as evidence that different mechanisms are not essential for reading irregular words and nonwords. In this respect, Besner (1999) addresses two issues in relation to the localist and connectionist debate: "The first issue has to do with how many separable routines mediate print to sound translation. The second issue concerns the nature of these routes. That is, whether they are all distributed, all localist, or whether some might be distributed and some localist." It is noteworthy that the original PDP model has since been revised and discarded in favour of newer models that read both words and nonwords with similar accuracy to humans (Plaut et al., 1996).

Summary points

The human dual-route model is generally stronger in accounting for all the phenomena reviewed above, namely, regular word naming, nonword naming, types of acquired and developmental dyslexia and lexical decisions. Since irregular word naming is the only phenomenon equally accounted for by these two models, the remaining five manifest an issue that connectionist models need further development. Noteworthy also is that whilst the issue of single-route and dual-routes could be debated extensively within the scope of the present thesis, it has been argued on numerous occasions that perhaps some of the conflicting evidence (and issues of lexicality vs. nonlexicality) could be in response to peculiarities of English spelling. Moreover, as will be explained in Section 4.7, Baluch and

Besner (1991) were able to show presence and absence of word frequency effects for the same words in the naming set. As noted by Monsell (1991) that "Frequency effects are intrinsic to connectionist learning models" (p155) this was taken as a major blow to their general architecture (see Chapter 4). Finally, given that a connectionist model would ever evolve that could account for all aspects of human single-word naming, would the nature of underlying processes between humans and computers be still argued to be the same? This topic may still be the subject of debate well into the next millennium.

3.4 The Dual-Route Cascaded Model: A Compromise?

Although the dual-route was based on human data whilst the connectionist view is grown out of computer simulations, there does seem to be a move in the most recent literature to merge the two camps. The recent work of Coltheart et al. (1993); Coltheart and Rastle (1994); Rastle and Coltheart (1999) is an indication of moving towards that direction. In observing such alliances one is often reminded of Campbell and Stanley's (1963) interesting remark namely: "When one finds … that competent observers advocate strongly divergent points of view, it seems likely on a priori grounds that both have observed something valid about the natural situation. The stronger the controversy, the more likely this is." (p3). In a radical move, the dual-route theorists, Coltheart et al. (1993); Coltheart and Rastle (1994); Rastle and Coltheart (1999) also proposed their own computational model, a Dual-Route Cascaded (DRC) model. The DRC is fundamentally different to the single-route connectionist models in that both the lexical and nonlexical procedures are maintained. These procedures are computational modifications of the original routes and as argued by Coltheart et al. (1993) are based on the recognition that the PDP has two desirable aspects that the dual-route model lacked: "The model is computational, and it learns." (p597). The lexical procedure in the DRC is modelled to operate on an interactive activation basis similar to that of McClelland and Rumelhart (1981) with inhibitory and excitatory connections between units. Moreover, an orthographic and a phonological lexicon are incorporated within this procedure unlike the PDP. On the other hand, the nonlexical procedure is described as "a sequence of for processing components or levels" (p483) one of which is grapheme-phoneme conversion. In several articles the implemented DRC model (e.g. Coltheart et al., 1993; Coltheart & Rastle, 1994; and Rastle & Coltheart, 1999) is reported to simulate human behavioural data such as regularity effects and lexical decisions more successfully than the rival PDP models. Coltheart et al. (1993) conclude that " Our ability to deal with linguistic stimuli we have not previously encountered (to coin a new past tense or to read a nonword aloud) can only be explained by postulating that we have learned systems of general linguistic rules, and our ability at the same time to deal correctly with exceptions to these rules (to produce an exception past tense or to read an exception word aloud) can only be explained by postulating the existence of systems of word-specific lexical representations" (p606).

To summarise, it seems inevitable but to recall Frost's (1998) observation about the "swinging pendulum" here yet again. First, it was the dual-route model of oral naming, then came the strong opposition in the form of the single-route model, followed by what appears to be a compromise. This state of affairs is reminiscent of an earlier compromise in visual word recognition experienced in the making of the dual-route (coding) in the first place, namely, the compromise between the visual and the phonological camps.

Below is a summary table of characteristics of models of visual word recognition and lexical access.

Table 3.4.1 A summary table of models of visual word recognition according to their mental representations (in bold), activation and organisation of the mental lexicon

Model/ Proponent	**Representations**	**Activation**	**Ordering of the Mental Lexicon**
Logogen model Morton (1969)	Localist, whole-word **logogens**	Whole lexicon activated in parallel	Frequency
Lexical search model Forster (1976)	Localist, morphemic constituents - **bins**	Serial search via access code	Frequency
Activation - verification model Becker (1976, 1979)	Localist	Activation with simultaneous top-down verification	Frequency
Interactive - activation model McClelland and Rumelhart (1981)	Localist - **nodes**	Connectionist Network hierarchy	Frequency
PDP Models Seidenberg and McClelland (1989)	Parallel Distributed - **orthographic units**	Strength of connections in a Connectionist Network hierarchy	No mental lexicon Frequency determined by strength of weights/ connections between units

As can be seen in Table 3.4.1 models of visual word recognition fall into two distinct groups according to whether a mental lexicon is assumed to be an essential constituent or not. Moreover, a further classification is whether representations are assumed to be localised or distributed. These two assumptions have led to the development of models of visual word recognition as reviewed in Chapters 2 and 3. However, a differentiation between models of visual word recognition and models of oral naming is summarised in Table 3.4.2 below.

Table 3.4.2 A summary table of models of oral naming according to the manner in which phonology is attained from print

Model/Proponent	**Attaining phonology from print**
Dual-route model Coltheart (1978)	Two qualitatively different routes lexical and nonlexical
Lexical analogies Glushko (1979, 1981)	A single visual route. New words and nonwords read via lexical analogies present in the lexicon
Time-course model Seidenberg (1985a)	A single visual route empowered with both orthographic and phonological information which become available over a time-course of activation.
PDP – Versions I, and II I) Seidenberg and McClelland (1989) II) Plaut et al. (1996)	A single source of knowledge via a neural network hierarchy No mental lexicon
DRC Model Coltheart et al. (1993); Coltheart and Rastle (1994); Rastle and Coltheart (1999)	Two procedures A lexical processing based on interactive activation A nonlexical procedure based on serial processing of GPCs

As can be seen in Table 3.4.2, the models of oral naming are polarised under two main camps depending on whether they assume a dual-route or a single-route perspective for attaining phonology from print. What is striking, however, is the recent consideration of DRC, which is an attempt to merge the most desirable aspects of both perspectives.

3.5 Summary of Chapters 2 and 3: Key questions addressed and their implications

The linguistic dichotomy of the English orthography was a focal point contributing to the architecture of a dual-route model of reading (Coltheart, 1978). Much experimental evidence and a priori arguments have been put forward in support of the existence of a dual-route possibility of word naming. The bulk of evidence as reviewed here favours the existence of a lexical route with questions being raised on the existence of its rival a nonlexical route. This is because although the ability of reading nonwords and novel words (and regular words), and the existence of surface dyslexia were taken as evidence of the existence of a nonlexical route, evidence from English has also shown that much of what is attributed to nonlexical reading could be explained in terms of lexical processing (Glushko, 1979, 1981). Consequently, the key questions currently discussed in the psychology of visual word recognition are as follows: i) Are there indeed qualitatively separate routes in single-word naming, in particular one in the format of GPCs? ii) If so, to what extent and under what condition does it enter in the naming process iii) To what extent is evidence from English script-specific and to what extent do the findings have a universal appeal? The focus of the next Chapter is with regard to this last point.

4 Chapter 4: Part I: Historical Development and Classification of Writing Systems

Part II: Visual Word Recognition in Alphabetic and Non-alphabetic Writing Systems

"Brains may be similar from one culture to another but orthographies certainly are not."

(Coltheart, Patterson & Marshall, 1980)

4.3 Preface

The above quote summarises the type of dilemmas reading researchers have been dealing with ever since interest in understanding processes involved in word recognition in English orthography (Coltheart, 1978) was re-channelled to other orthographies. The objectives of this Chapter are twofold: First, In Part I is a brief evolutionary, linguistic perspective of writing systems from pictography to alphabets which will explain how it took many centuries before the alphabetic writing system was invented. This was achieved through a gradual evolution from concrete pictorial representations to the logographic stage, and eventually towards the more abstract letter form expressions seen in today's syllabic and alphabetic scripts. The major impact of this evolution from concrete, pictographic representations to abstract alphabets is notably on the relationship between script and meaning which became systematically more abstract but the relationship between script and units of sound in the spoken language became more one-to-one. Thus one classification of orthographies is based on the concrete, as opposed to abstract, representation of a writing system and its spoken language. Yet another classification is based on orthographic transparency, i.e. how directly a particular script (orthography) reflects its spoken language. The latter is the focal point of interest in the present study. Second, Part II is a review of psychological evidence as to whether orthographic transparency is a factor that could impose psychologically different processes in reading. Consequently, psychological evidence from alphabetic and non-alphabetic orthographies, that has contributed to the development of current key issues in relation to visual word recognition, in particular, to single-word naming, is discussed in the remaining part of this Chapter.

4.4 A Historical Overview of the Development of Writing Systems: From Pictography to Alphabetic Representations

The following references were consulted in writing this review: Besner (1999); Besner and Hildebrandt, (1987); Gelb (1963); Henderson (1982); Hung and Tzeng (1981); Pulgram (1976); and Skoyles (1988).

Pictography, often referred to as the most primitive or pre-writing system, is where a general idea, i.e. a sememe, is represented by simple pictorial symbols. Thus, semasiography can be thought of as the writing of concepts without the mediation of spoken language. However, representing spoken language by concrete representations such as pictographs has faced several problems: First, there is the sheer number of pictographs required to represent an infinite number of linguistic representations, hence too many signs to remember. Second, pictography requires highly skilled draughtsmanship, hence its use is restricted to very few people who can skilfully convey accurate messages in pictographs. Third, drawing abstract concepts is problematic. Fourth, since pictographs are open to interpretation, ambiguities or discrepancies may often exist by decoding a different message to the one intended. Moreover, a pictograph is open to misuse as it can be “read” by others for whom the message is not intended. Representation of speech in a more efficient way was possibly brought about by attempts to eliminate these problems. The next stage in the development of scripts is regarded as one of the most important achievements in the history of mankind. Instead of drawing pictures to express a general idea, symbols were invented to represent speech directly - leading to logographic representation. The transition from pictographic to logographic representations is assumed to be dictated by the "... increasing stylisation of the representation and the tendency to adopt the convention of using one sign to represent one word" (Henderson, 1982). Logography represents speech at the level of the morpheme, the smallest meaningful unit which usually is the word in monosyllabic, noninflective languages such as Chinese. Each logograph is independent of grammatical structure. Grammatical markings such as tense, plural and gender are embedded in the script by means of other morpheme characters, rather than actual modifications to the logograph itself. For example, in Chinese GO, WENT and GONE are expressed by exactly the same character (Hung & Tzeng, 1981). Historically, logographic scripts have been developed independently by the Sumerians, the Egyptians, the Hittites and the Chinese.

4.4.1 Chinese Logography: An Example of a Logographic Script

The modern Chinese logography is characterised by several developments during its formation. From early pictographs developed ideographs which according to Hung and Tzeng (1981) are "... frequently formed by putting several pictograms together to suggest an idea: for instance, putting two trees together side by side to mean grove, and stacking three trees together to mean forest" (p379). A large number of ideographs were created by using this method, namely metonymy. Hung and Tzeng (1981) report that even with this invention difficulties were faced regarding the formation of characters to represent abstract concepts. The invention of phonograms occurred as a result of this need. Phonograms are typically made of two or more components: one component for meaning (signific) and one as phonetic marker. For example, CORN could be presented by a combination of a pictograph (a semantic pointer to cereal crops) and a phonological pointer (such as, rhymes with horn). By using a combination of these methods virtually an infinite number of characters may be created to represent all words used in the spoken language. This is exactly how the Chinese logography was created. Eventually, many compounds were simplified to fit them into a limited space which have led to a purely logographic representation i.e. an arbitrary sign representing a unit of meaning. This efficient way of using sound to improve the writing system rendered so powerful that many Chinese characters are now phonograms. However, the use of phonograms is still problematic. A major problem arising from such a close, one-to-one grapheme-morpheme representation is that one is required to learn and distinguish between thousands of characters before reading can take place. Therefore, learning to read and write is slow (see Hung & Tzeng, 1981).The discovery of the power of representing sound in the development of scripts is observed in the form of Rebus, where a word is constructed from pictographs of the semantic referents of its component syllables with phonological implications. For example, in English a word like CANNOT can be represented by pictures of a tin can and a knot. The general consensus is that it takes a small step to go from a rebus system to a syllabary, in which every written character represents a syllable in the spoken form. The emerging theme from syllabaries is a close grapheme-sound relationship, as opposed to a close grapheme-meaning relationship observed in logographic scripts. The large number of characters required in logography is effectively reduced to a relatively smaller set, which can be transcribed into an infinite number of spoken utterances. In Chinese the use of a syllabary was rendered uneconomical because the spoken form is monosyllabic and noninflective, thus, words are both monomorphemic and monosyllabic at the same time.

Consequently, there is very little economy to be gained by using a character to represent the syllable rather than the morpheme. However, when the Japanese adopted Chinese characters to transcribe their spoken language, logographic Kanji, they were faced with various problems. The inflective syntax of spoken Japanese required additional symbols to represent grammatical markers. A new set of sound symbols, the Kana syllabary, was invented to supplement Kanji. As previously mentioned, the development of a syllabary arises from an increasing application of phonological pointers into a logographic system, as in the case of Kana. Hence, the development from logography to syllabary is assumed to be a gradual and overlapping one. Typically, a syllabary directly represents the spoken language at the level of the syllable by a character independent of meaning. Thus, with a relatively small set of syllable-based symbols one can transcribe an infinite number of spoken sentences. Syllabaries generally supplement ancient logographic systems, and are perceived as intermediate stages in the development towards alphabetic writing systems.

4.4.2 Japanese Kana: An example of a syllabic script

Two syllabaries have been developed by the Japanese to supplement their logographic Kanji script (used mainly for content words). The Katakana syllabary is used for foreign loan words, Hiragana, a second syllabary, is used for grammatical derivatives and function words. They are collectively known as Kana. The Kana syllabary is used in conjunction with logographic Kanji to disambiguate the correspondence between characters and meaning which is not always one-to-one. A spoken word can have several meanings, i.e. polysemous, each with its Kanji representation. Additionally, a single Kanji character can represent several spoken words, each with a different meaning, i.e. homophones. The writing economy achieved by Kana, however, is undermined by the issue of homophones as the spoken Japanese has relatively few syllables. Disambiguation of the homophones is possible by referring to Kanji. These three scripts are used concurrently in text. Their differing writing styles and different linguistic purposes form distinctive visual cues which probably facilitate reading. Although the main focus of the present thesis is on examining evidence from alphabetic writing systems, it is noteworthy that evidence from naming in Japanese has also been taken to examine the operation of the two routes in a transparent syllabary. This is the subject of Section 4.7.3.

4.5 Invention of Vowel Representations

Returning to the review on the evolution of scripts, the introduction of vowel marking in the traditional Egypto-Semitic syllabaries, which traditionally only employed consonantal scripts, marks a turning point in the evolution of alphabetic writing systems. Historically, this transformation is thought to have taken place between the seventh and ninth centuries BC. The development of the first systematic alphabetic script to exhibit a phonological awareness explicitly "... that something like the phoneme was the basic element of spoken language rather than the syllable" (Henderson, 1982) is often incorrectly credited to the ancient Greek alphabet which, in fact, is a modified version of the consonantal, Semitic Phoenician script. Semitic scripts, such as Hebrew, are characterised by their impoverished use of vowels in their script, which is often presented by a string of consonants. Thus, the pronunciation of such letter strings heavily relies upon context. For example, to clarify this point a consonantal letter string such as HT could equally be read as HAT, HIT, HOT and HUT. Skoyles (1988) reports that the addition of vowel markers to the primarily consonantal Phoenician script is believed to arise from the need first, to express the considerably larger number of vowels (seven) in the spoken classical Greek compared to Phoenician and second, to eliminate ambiguities. In alphabetic scripts, the close grapheme-meaning relationship seen in logographic scripts is lost as graphemes of the alphabet represent speech at the level of the phoneme, a linguistic unit smaller than both the word and the syllable. Hence, it is noted that during the evolution of writing systems, from pictography through alphabetic scripts, direct access to meaning from grapheme is systematically lost, and eventually becomes abstract. Moreover, the number of characters representing the spoken language are enormously reduced. Logographic Kanji has about 2000 characters which may take up to eight years to learn, as opposed to alphabetic English with only 26 letters which can be learnt in a relatively short amount of time. Notwithstanding, alphabetic scripts primarily considered as sound-writing systems vary greatly in the manner by which they transcribe the phonological properties of the spoken language. The underlying reasons for this diversity are typically attributed to the scripts individual historical development, importation and adoption of foreign characters, influence from other scripts and innovations in spelling to sound correspondences which led to the existence of orthographies with diverse letter-to-sound correspondences. Thus, one may classify orthographies along the orthographic transparency continuum. A growing body of literature has emerged on psychological processes of reading orthographies that reflect the diversity of orthographic transparency, ranging from the most transparent to the most opaque and those reflecting both extremes. Bearing in mind the main aims of the present thesis, the literature review is mainly aimed at alphabetic scripts; in particular interest is focused on the psychological evidence from transparent scripts.

4.6 The Hypothetical "Alien" and Classification of Orthographies According to "Transparency"

Considerations in this respect focus on the directness with which scripts represent the phonology of the spoken language. The notion of a hypothetical "alien" as described by Max Coltheart and documented by his student, L. Midgley-West (1980) is as follows;

"Consider the situation where an alien from another planet knew the predictable letter-to-sound correspondences in English and predictable syllable-to-sound correspondences in Japanese Kana. He could easily translate the written language into a spoken language without knowing the meaning of either the English or the Japanese words he produced. However, if he was presented with exception English words or Japanese Kanji he would be unable to pronounce any of them correctly." (p34).

This analogy triggered the imagination of many investigators, such that if a hypothetical "alien" encounters a script with an absolutely invariant one-to-one, letter-to-sound relationship with a simple understanding of correspondences, then the "alien" could presumably generate a pronunciation with a very close approximation in that language without any previous "lexical knowledge".

Noteworthy, is the manner in which Midgley-West pairs-up regular and irregular words in the alphabetic script of English with regular syllabic Kana and moreover with logographic Kanji! This matching-up poses problems because the degree and nature of transparency is assumed to be for the same underlying reasons for all three scripts. For example, it is difficult to assume that the nature of nonlexical processes involved in naming regular English words is the same as that of syllabic Kana. Thus, such comparisons along a transparency continuum involving alphabetic and non-alphabetic scripts may be problematic.

Nevertheless, this prompted a further classification of orthographies; whilst those scripts equipped to provide the "alien" supposition with a successful approximation are considered as shallow or transparent, e.g. Italian, Serbo-Croatian and Spanish, those which are lacking this quality are considered as deep or opaque, e.g. English. Insofar as transparency is concerned, one classification is the extent to which purely nonlexical processes could help generate correct pronunciation of words as opposed to the extent to which lexical knowledge is required. In this context, English belongs to one extreme, i.e. deep, because a great deal of involvement of lexical knowledge is needed for pronunciation of irregular words. Scripts, such as Italian and Serbo-Croatian, were placed at the other extreme, i.e. transparent, as it was maintained that little or no lexical knowledge is required for the pronunciation of words in these scripts (Lukatela, Popadic, Ognjenovic & Turvey, 1980; and Lukatela, Savic, Gligorjevic, Ognjenovic & Turvey, 1978).

Another classification, however, came as a result of interest in psychological processes of reading Semitic Hebrew (e.g. Koriat, 1984). One interesting aspect of Semitic Hebrew is that it is transcribed by a very regular script, yet in actual fact the small pointers meant to specify vowels are never printed in adult text. Thus by definition almost all Hebrew words require extensive lexical (semantic) knowledge prior to pronunciation. These considerations then placed Hebrew at an even further point on the transparency continuum than English (Frost et al., 1987). This of course means that one is now ignoring many other aspects of the writing systems placed on this continuum. In this respect the fact that Hebrew belongs to the family of Semitic scripts is ignored and placed directly with a family of Latin scripts. For instance, the direction that Hebrew is written (from right to left as opposed to left to right), its letter features and vowel structure amongst many others. Similarly, other researchers have further made additions to this continuum even disregarding their alphabetic, non-alphabetic nature. For example, Chinese is often placed at an even further end of orthographic depth than English (Seidenberg, 1985a, 1985b, 1985c). Whilst it may be true that logographic scripts are deep, because in principle, GPCs are argued to be an impossibility in reading such scripts, yet the underlying processes involved in reading a logographic script may be entirely different to that of an alphabetic script. For the same reasons, as argued above, one may find that placing the two scripts of Japanese, logographic Kanji and transparent syllabic Kana, at the two ends of the orthographic transparency continuum alongside their alphabetic counterparts, is also of some concern. One may argue here that perhaps this haphazard placing of orthographies represents an unholy alliance along a transparency continuum whilst ignoring many distinguishing features about them that may indeed act independently in the manner in which they may be recognised (see e.g. Hung & Tzeng, 1981). Thus a note of caution is that it may be a fallacy if one designs experimental tasks that compare directly how one reads Chinese and replicates the same experimental paradigm to investigate how one reads English, with the further intention of attributing any differences to an orthographic transparency factor (see the debate between Seidenberg, 1985b and Norris & Brown, 1985). Even making inferences from a direct cross script comparison between alphabetic scripts may be problematic (e.g. see Section 4.6 and Frost et al., 1987), since alphabetic scripts also differ on many dimensions, such as methods upon which they are taught and grammatical structure of the language. What is perhaps more favourable is either to take a particular orthography representing an extreme end of the continuum and through experimental manipulations (i.e. orthographic and/or phonological) examine how readers respond to such manipulations. Alternatively, one could take advantage of within-script manipulations that may be offered by a particular script along the transparency continuum, e.g. pointed and unpointed Hebrew (Koriat, 1984), Japanese Kana and Kanji (Morton & Sasanuma, 1984) and examine possible differences in the manner in which they are recognised as a function of such spelling dichotomies. Indeed, one such script that incorporates a dichotomy of spelling is Persian (Baluch & Besner, 1991). Modern Persian belongs to the family of Semitic scripts that has been the subject of empirical investigation and offers excellent within-script comparisons along the transparency continuum (see Section 4.7). As will be explained later, Persian shares some peculiarities with Hebrew. In essence, similar to Hebrew there are Persian words with consonantal spelling only.

However, Persian also shares some of its features with transparent scripts as some of the words are always vowelised thus are highly transparent (see Khanlari, 1979, for a detailed account of Persian). In this context, Persian has an interesting and unique orthography for investigating issues of transparency.

Returning to the issue of orthographic transparency, the question is how much lexicality is needed to shift from an “alien-type” nonlexical pronunciation to a lexically driven pronunciation? This has not been argued in the literature, but it has been assumed that readers of “transparent” scripts can rely entirely on nonlexical pronunciation, even if there is a need for some previous knowledge of lexicality. This is an issue that needs to be tackled further. For purposes of clarity and simplicity it is proposed here to rearrange the transparency continuum by placing the hypothetical “alien” in the most transparent extreme and rank alphabetic Latin orthographies (and its derivatives) according to degree of success in attaining purely nonlexical based phonology. Whilst English, due to its irregular nature, would be classified as “deep”, the claim here is that a script such as Turkish (see Chapter 5 for a description of its characteristics), on the other hand, would be classified as atypically “transparent”. This is because the Turkish orthography enables the “alien” to attain phonology based purely on nonlexical processing. Thus, in Part II of this Chapter, evidence from orthographies previously cited to be “transparent”, e.g. Spanish, Italian and Serbo-Croatian, will be re-examined with a view to suggest that perhaps a more appropriate candidate for the extreme transparency continuum is Turkish.

4.7 Part II: Visual Word Recognition in Alphabetic and Non-alphabetic Writing Systems

A research question, which often arises with regard to the orthographic transparency, is whether word recognition is affected by the manner in which a writing system encodes the phonology of the spoken language. Specifically, does the degree of reliance on the lexical vs. nonlexical route depend on orthographic transparency? In the last two decades, a growing body of research has focused on a diverse spectrum of scripts in an attempt to address the question whether the manner in which writing systems encode the spoken form had any implications on reading processes.

Early interest into orthographies with differing regularities of spelling-to-sound conversion rules focused on bi-alphabetic scripts of Serbo-Croatian, consonantal Hebrew, and more recently on Persian which embodies both opaque and transparent representations. Thus whilst evidence from Serbo-Croatian was assumed to represent the transparent extreme, evidence from Hebrew (e.g. Bentin, Bargai & Katz; 1984; Frost et al., 1987; and Koriat, 1984) was assumed to be representative of the opaque extreme of the orthographic transparency continuum. The peculiarities of the Persian orthography, however, were argued to capture both the transparent and the opaque characteristics (Baluch & Besner, 1991). The result of such exercise into research on orthographies led to the development of two opposing hypotheses in relation to the impact orthographic transparency might have on psychological processes involved in visual word recognition as will be reviewed below.

4.8 Orthographic Depth Hypothesis: Evidence from Serbo-Croatian

The assumption underlying the orthographic depth hypothesis is based on the effect orthographic transparency may have on lexical processing. To-date two versions have been proposed, namely a strong version and a weak version. According to the strong version of orthographic depth hypothesis, deep or opaque scripts are assumed to be read lexically whilst shallow or transparent scripts are assumed to be named nonlexically. The weak version, however, maintains that degree of involvement of each processing route is determined by the transparency of the script. An alternative position, namely, the universal hypothesis in contrast claims that all writing systems, regardless of their transparency, are read lexically.

The bi-alphabetic scripts of Serbo-Croatian, Roman and Cyrillic, with their argued transparent nature, were historically the first writing systems to draw the attention of researchers (e.g. Lukatela et al., 1980; Lukatela et al., 1978; Lukatela & Turvey, 1998). The two scripts of Serbo-Croatian have overlapping alphabets. Each alphabet was developed to represent the spoken language by deliberately attempting to "Write it as it sounds, and say it as it is written" a century ago (Katz & Feldman, 1981; Lukatela et al., 1980; Lukatela et al., 1978; Lukatela & Turvey, 1998). Although most of the letters in each alphabet are unique to that alphabet there are nevertheless ones that are shared by both. Those letters shared by both either have a unique phoneme or an ambiguous phoneme depending on the script. Typically, readers are taught to read with one of the scripts first, either Cyrillic or Roman, followed by the other. The order of the two alphabets with which Serbo-Croats learn to read has been reported to have an impact on skilled reading in adults (Lukatela et al., 1978). In a letter classification task, i.e. participants had to classify whether a letter was written in Roman or Cyrillic, a bias towards the first learned alphabet was reported for adults fluent in both scripts. If readers exhibit a bias even in a letter classification task, the immediate question that arises is whether this bias could be even more exaggerated and thus, confound visual word recognition in both non-verbal and naming tasks? The fact that some letters common to both scripts also share the same pronunciation (unambiguous letters) while some have their own individual pronunciation in each script (ambiguous letters) lead to three possibilities: first, same word in both Roman and Cyrillic; second, words in one script but nonword in the other; and finally, words in both scripts (bi-alphabetic) with individual pronunciation and meaning in each script. The last category is rendered phonologically the most ambiguous of the three types. Experimental manipulations in Serbo-Croatian targeted bi-alphabetic words and those which are words in one script only (Lukatela et al., 1980; Lukatela et al., 1978). Employing a LDT and a single-word naming task, the authors reported that RTs for both lexical decisions and naming of unambiguous words were significantly faster than ambiguous counterparts, i.e. words comprised of the ambiguous bi-alphabetic letters. For instance, participants were reported to be significantly faster when naming high-frequency unambiguous word, e.g. Roman VETAR (wind) pronounced as /vetar/, than ambiguous high-frequency experimental stimuli, e.g. Cyrillic BETAP (wind) which has the potential of evoking four possible pronunciations, e.g. /vetar/ (actual pronunciation), /betar/, /vetap/ and /betap/. If the lexical route was used for both types of words then there should have been no significant difference in RTs in both naming and LDT. It was thus concluded that whilst the lexical route was used for the unambiguous words a nonlexical involvement was assumed for the ambiguous ones. Lukatela and Turvey (1998) took this as evidence that there exists "... a bias of mature Serbo-Croatian readers towards the indirect phonological route", i.e. the nonlexical route (p1061).

Contradictory to earlier claims that a simple knowledge of spelling-sound rules would result in the correct pronunciation of Serbo-Croatian words there is also the problem of stress assignment. Noteworthy is that in a recent article (Lukatela & Turvey, 1998) acknowledge that "It is the case, however, that not all of a Serbo-Croatian word's phonology is derivable from the mapping of graphemes to phonemes. Knowing where to put the stress depends on word memory ...” (p1062). Therefore, it appears that correct naming of Serbo-Croatian is highly dependent on previous lexical knowledge about words and not by using purely nonlexical processing as suggested earlier. In this respect, Frost (1994) also reported that in Serbo-Croatian stress for bi-syllabic words regularly occurs on the first syllable, but not always for words with more than two syllables. Therefore, correct pronunciation of such words requires consulting lexically stored information. Thus, once again the hypothetical “alien” would fail in deriving nonlexical phonology for Serbo-Croatian. Furthermore, using RTs for words of a bi-alphabetic script such as Serbo-Croatian can be problematic in that a certain amount of time is required for the reader to decide which script the reading is going to take place in. It has already been demonstrated that readers are biased towards the first learned alphabet even in letter categorisation tasks. Thus, the RTs in this context cannot be a true reflection of the amount of time it takes readers to articulate a word or make a lexical decision but has the element of added time factor for that decision, i.e. exaggerated RTs.

One may criticise the findings on several accounts: First, claims about the transparency of the Serbo-Croatian orthography are questionable. Even in “deep” English, it is very rare, if at all, to find a single spelling that can simultaneously evoke four possible pronunciations with only one corresponding to the actual word. Is it thus not plausible to assume that such less-than-transparent GPCs could superimpose the slow naming of the ambiguous words by utilising the use of the nonlexical route? In addition, the generation of alternative phonology (three in the BETAP example) in response to such ambiguity can be perceived as “nonwords” which have been demonstrated to encourage readers to adopt the use of the nonlexical route. Moreover, how successful can the hypothetical “alien” be in deriving purely nonlexical phonology from orthography reflecting such ambiguities?

4.8.1 Evidence from Cross-Language Comparisons: English and Serbo-Croatian

It was the interpretation of results from making direct cross-language comparisons between deep English and transparent Serbo-Croatian that prompted the proposition of the orthographic depth hypothesis as defined earlier. Using the semantic priming paradigm, Katz and Feldman (1983) compared RTs to naming and lexical decision for words when preceded by semantically related single-word prime. As mentioned previously, semantic priming is said to take place when performance is affected by prior exposure to a semantically related word. For instance, the word NURSE is named faster when it follows a related prime such as DOCTOR than an unrelated prime such as TEACHER. This phenomenon is attributed to the facilitation in the availability of words semantically related to the target in the mental lexicon. However, semantic priming effects are noticeably less for naming tasks than for lexical decisions. This is argued to be because of the differential demands put on participants by different tasks. By virtue of their design, a LDT encourages readers to consult the mental lexicon for an outcome, i.e. postlexical, whilst in contrast naming can be conducted prelexically (see Balota & Chumbley, 1984, for a critical review on lexical decision vs. naming tasks). It was reported that both naming and lexical decision are affected by semantic priming in English whereas semantic priming affects lexical decision only in Serbo-Croatian. This was taken as further evidence to support the claim that nonlexical route (assumed to be insensitive to the effects of lexical variables such as semantic relatedness) is predominantly used in reading in Serbo-Croatian. As argued previously, however, this could also be an artefact of the ambiguity of generated phonology that could dilute the impact of lexical variables in experimental tasks.

Insofar as Serbo-Croatian is concerned, the results were collectively taken as evidence (e.g. Katz & Feldman, 1983; Turvey et al., 1984) that reading in transparent orthographies relies solely on the rule-based nonlexical route and that the lexical route is never accessed. For instance, Bridgeman (1987) claimed that "In many regular languages a small set of grapheme-phoneme correspondences can unambiguously define all of the utterances in the language. It is possible that in these languages the lexical route simply does not exist..." (p331). Similarly, Turvey et al. (1984) also wrote that "To conclude, the Serbo-Croatian orthography is phonologically very regular ... and as such encourages neither the development of options for accessing the lexicon, nor, relatedly, a sensitivity to the linguistic situations in which one option fares better than another" (p88). This supposition formed the basis of the orthographic depth hypothesis, in particular the strong version whereby lexical involvement is assumed to be solely determined by orthographic transparency.

Interest in this respect focused on demonstrating that lexical involvement was determined by orthographic transparency which prompted a host of cross-language studies some of which are reported next.

4.8.2 Evidence from English, Hebrew and Serbo-Croatian

In another cross-language study of English, Hebrew and Serbo-Croatian Frost et al. (1987) reported greatest word frequency effects and differences in RTs in naming between words and nonwords for Hebrew, less so for English, with minimal effects for naming in Serbo-Croatian. Hebrew, contrary to both English and Serbo-Croatian, is normally printed unvowelised (without its vowels/pointers specified) and so readers have to read words with a consonant-only spelling. For this reason, Hebrew is argued to be an extremely opaque orthography. In support of the orthographic depth hypothesis, Frost et al. (1987) reported that lexical effects, such as frequency effect, systematically diminishes as orthographies become more transparent. Although it might appear that cross-language comparisons are a better test for the weaker version of the orthographic depth hypothesis, several issues should be mentioned. First, as noted by Frost et al. (1987) themselves “The influence of orthographical depth on word recognition processes was apparently confirmed by the comparisons between English and Serbo-Croatian, but this conclusion is not without criticism. Orthographical depth is not the only dimension along which these two languages differ. English and Serbo-Croatian have different grammatical structures and possibly different lexical organisations ... Because it is not known how those other factors may affect word recognition in English and in Serbo-Croatian, attribution of differences in performance only to orthographic depth might be incorrect.” (p105). Thus, it appears that even strong proponents of cross-orthographic comparisons acknowledge that it is hard to attribute the results of their studies to the transparency factor alone. In addition, the main thrust of Frost et al.’s (1987) work is the finding that it takes significantly longer to name nonwords in Hebrew in comparison to English and Serbo-Croatian. In Frost et al.’s study, nonwords were only strings of consonants. What does one really measure in asking subjects to name a string of consonants? If a reader is presented with a string of consonants, he/she may initiate an articulation simply to fulfil the task demands. For example, no two subjects could come up with an identical pronunciation. A reaction time measure to a string of consonants is, therefore, questionable in the absence of such baseline comparisons.

Moreover, the implications were that the lexical route is used predominately in opaque scripts such as Hebrew, whilst a shift towards the nonlexical route is emphasised as scripts become more transparent. According to the proponents of the orthographic depth hypothesis this made sense on argumentative grounds: naming in opaque Hebrew would fail if readers attempt to employ GPCs but successful in transparent Serbo-Croatian. According to the weak version of orthographic depth, both nonlexical and lexical processes are in operation for readers of all writing systems, but the relative involvement of each route depends on the transparency of a particular orthography.

However, criticisms regarding the methodological shortcomings of cross-language comparisons, as reported previously, encouraged researchers to focus on examining within-script dichotomies in order to examine the involvement of routes in naming. In this respect, the peculiarities of Hebrew drew attention from Frost (1994), as reported next.

4.8.3 Further evidence from Hebrew

Frost (1994) reported significant word frequency and semantic priming effects in naming unpointed Hebrew words. However, according to Frost (1994) the word frequency and semantic priming effects were minimal when the same words were pointed. Frost argued that because the pointed script is very transparent, the latter factor has encouraged Hebrew readers to use a nonlexical strategy although they are accustomed to reading the words unpointed. In other words, in spite of the fact that experienced readers name these words using the lexical strategy, a single introduction of the pointers encourages a complete recourse to a nonlexical strategy for naming. Frost considered this finding to generalise to readers of transparent orthographies i.e. to indicate that readers of transparent orthographies may have no reason to name words lexically.

There are, however, a number of problems with Frost's (1994) study. First, it is not clear why Hebrew readers, who have not seen their script pointed since early childhood, so efficiently make use of pointed spelling. It was even reported that participants named words faster when they were pointed (541ms) than unpointed (569ms). One would have expected some form of graphic surprise because of adding the unexpected pointers. Baluch (1988) found that when opaque Persian words, which are very similar to Hebrew words, were introduced with their diacritics (pointers) specified, there was a significant delay and increase of errors, in naming compared to when they were presented without diacritics. Baluch (1988) argued that this was because readers were not accustomed to naming words with diacritics, consequently when they were introduced they had a graphic surprise effect. Moreover, in Hebrew and Persian, because vowels are not specified, a consonant only spelling may imply different pronunciations depending on vowel assignment. It is more likely that when diacritics (pointers) are re-introduced a competition will be initiated in which the lexically driven pronunciation is different from the one elicited by the diacritic. To clarify this argument for those not accustomed to Hebrew or Persian orthographies, suppose English is printed without vowels: a letter string like HT could either stand for HOT, HAT, HIT or HUT. Suppose also that the vowels were like diacritics or pointers added on the top of the consonant spelling. A reader of such a consonant-only spelling, through many years of experience, develops skills in naming HT without the aid of diacritics, possibly by using contextual information for disambiguation. If, however, the same reader is presented in an experimental setting with diacritics/pointers the argument is that: a) the presence of diacritics/pointers produces graphic surprise; and b) a pronunciation assembled by the use of pointer (e.g. i on top of HT) may conflict with the pronunciation generated (automatically) by the lexical route (e.g. HOT). Both these possibilities mean that one should expect the inclusion of pointers to slow down the naming of a consonant-only word, not to facilitate the process as Frost suggests. Indeed, Frost's (1994) study suggests that after many years of reading experience with unvowelised words using the lexical route, Hebrew readers could easily shift to a nonlexical route which, in a very short period of time (i.e. under experimental conditions), produces much faster and more efficient access to the words pronunciation. So why are diacritics omitted in the first place if the lexical route, in spite of all the years experience, is relatively inefficient? It is therefore interesting for future researchers to explore why Hebrew readers benefit in naming words with missing diacritics re-introduced in spite of years not experiencing them, while for readers of Persian the re-introduction of diacritics has a more inhibitory role.

4.9 Universal Hypothesis: Evidence from Persian

Frost et al.'s (1987) findings from the cross-language comparisons of English, Hebrew and Serbo-Croatian were argued to be an artefact of the experimental manipulation in that words were presented mixed with nonword fillers. The study was heavily criticised by investigators on these grounds, particularly by Baluch and Besner (1991) who refuted Frost et al.'s (1987) claims based on evidence from Persian.

There are at least two attractive features about the study published by Baluch and Besner in (1991) aimed at examining the effects of orthographic transparency in Persian. The first of these was the unique peculiarities of Persian script as an attractive tool for the investigation of psychological processes in single-word naming (Baluch, 1988). Persian is transcribed by a modified version of the Arabic script and is transcribed by a mixture of opaque and transparent spellings. This is because three of the six vowels in spoken Persian spelling are conveyed by letters and are always presented as a fixed part of the words spelling, whilst the other three vowels are diacritics and are only used for beginner readers. Skilled readers are therefore accustomed to read words that represent extremes of opaqueness (consonantal spelling only) and transparency (words with vowel letters). Capitalising on the type of methodological flaws that might be applicable regarding across script comparisons of orthographic transparency (e.g. Frost et al.'s, 1987 study), Baluch and Besner (1991) based the selling point of their study on re-examining the issue of orthographic transparency by taking advantage of a within-script characteristic of Persian script. In a series of experiments the authors examined the effects of two lexical variables namely, semantic priming and word frequency on naming transparent and opaque Persian words. The results showed significant effects of both word frequency and semantic priming regardless of the words spelling transparency. Because these significant lexical effects were demonstrated within the peculiarities of just one writing system, rather than making inferences across transparent and opaque scripts, the results were taken as strong support for the universal hypothesis.

A second attractive aspect of Baluch and Besner's (1991) study was the inclusion of nonword fillers mixed with target transparent and opaque words. The authors reported that both semantic priming and word frequency disappeared for transparent words but not for opaque words when nonword fillers were included in the stimuli set. Baluch and Besner (1991) concluded that transparent words were now being read by reliance to a nonlexical GPCs "a consequence of reading these words in the context of transparent nonwords" (p649).

Such flexibility in processing strategies and reliance on nonlexical processing in response to the inclusion of nonword fillers (initially reported at the meeting of the Psychonomic Society, Besner & Baluch, 1990), gained immediate attention within the academic community. The reason for such excitement was twofold: First, those interested in research on the subject of orthographic transparency incorporated the paradigm of inclusion of nonword fillers, as a test for strategic control over routes in single-word naming, into their own investigation of transparent scripts such as Spanish (Sebastián-Gallés, 1992) and Italian (Tabossi & Laghi, 1992). These studies will be reviewed in the next section. Second, a further reason for excitement came from the demonstration that lexical factors, in particular word frequency could appear and disappear for the same target words according to inclusion of fillers. Such an effect, if replicated in other scripts, and specifically in English, would have been a major blow to the foundation and general architecture of the connectionist modelling as frequency effects are said to be intrinsic to connectionist modelling. Monsell (1991) speculated that "Words of high-frequency differ from words of low-frequency, all things being equal, in their degree of learning and acquisition. Frequency effects are intrinsic to connectionist learning models" (p155). Thus dual-route supporters were jubilant of the prospect to replicate such effects on English which would mean a major set back to the growing interest to connectionist modelling of reading and set their aim to examine the role of fillers in naming English. One such influential study was reported by Monsell et al. (1992) which provided parallel evidence that the presence and absence of filler stimuli (words or nonwords) as well as the nature of their regularity (regular, irregular) does indeed affect naming target words in English. A finding that was, indeed, bad news for the supporters of the connectionist models. Monsell et al.'s work is discussed further in Chapter 7.

4.9.1 Comments on Baluch and Besner (1991)

Returning to Baluch and Besner's (1991) study, however, two issues still require elaboration: First, the issue of the universal vs. orthographic depth hypotheses. It may be true that Persian is an ideal script for within-script comparisons of opaqueness and transparency, and perhaps the fact that both truly transparent and extreme opaque Persian words are read via the lexical route is a clear demonstration that at least for reading Persian the lexical route dominates. The problem, however, is that perhaps this lexical dominance, similar to what was the general consensus from English, is dictated by the mere presence of opaque words in reading everyday Persian text (or irregular words in case of English). Both Persian and English skilled readers may "strategically" decide to make greater use of the lexical route because it is efficient for both opaque/irregular and transparent/regular words and suppress any nonlexical reading because it fails for the vast number of opaque/irregular words. So by just focusing on Persian (or English) not much could be said by the way of generalisation that a lexical route should also dominate in a very transparent orthography. Indeed a strong demonstration that a lexical route is the preferred route in all writing systems would be one in which the effects of lexical factors are investigated in a very transparent orthography. If the relationship between letters (graphemes) and phonemes are always one-to-one in a particular writing system and if applying a nonlexical route is always successful in reading words, then presumably the lexical route has no reason to play a dominant role. Although (as will be reported in the following Sections) there are also reports of evidence of lexical reading from the "transparent" scripts of Italian and Spanish that substantiates Baluch and Besner's claim, yet as will be argued at the end of this Chapter even those scripts labelled as transparent are not truly transparent. In particular, considerations such as stress assignment and context-dependent phonology renders a true definition of transparency for such scripts invalid. Thus, if indeed there was an occasion that one could provide convincing evidence in support of either the universal or the orthographic depth hypotheses it would be a case where the peculiarities of a truly transparent script were explored in single-word naming tasks. If orthographic transparency is indeed affected by the degree of lexical involvement in single-word naming such effects should be minimal or completely absent when only words are read in a truly transparent orthography. The subject of Chapter 5 is the introduction of Turkish orthography together with a claim that this is truly a transparent script unlike Italian, or Spanish.

4.9.2 Is the Lexical Route Completely Shut Off?

Another problem faced by Baluch and Besner's (1991) data is that even if one entertains, in view of the absence of word frequency effects, the notion of strategic switch to naming regular words via a nonlexical strategy the fact remains that words are still named significantly faster than transparent nonwords. The question is that if a truly nonlexical route was used in naming (hence no frequency effect) why should there be a difference between words and matched-nonword naming? Perhaps the lexical route is not completely shut off even when nonwords are mixed with transparent words. Or perhaps this is an indication that, as the nonlexical route is not a favourite route for reading scripts such as Persian it remains the slower, less efficient of the two routes. Perhaps this difference between transparent words and nonwords in Persian further confirms that Persian readers cannot switch off the activation of their lexical route completely (similar to English), and even with the activation of the nonlexical route in response to nonword fillers the lexical route still maintains its influence on naming words. Again returning to an ideal transparent script, the issue may be better resolved if a truly transparent script is employed for such investigations. This is because, in such a script the nonlexical route should have been continuously exercised in the normal course of reading. Thus when readers are encouraged to do so, it should function with relative ease and efficiency and hence no evidence of frequency or word nonword differences. Therefore, two immediate questions arise first, the issue of universal vs. orthographic depth hypotheses, and second, the inclusion of nonword fillers and the impact they may have on lexical factors, that one would like to explore if the paradigm used in Baluch & Besner (1991) were to be replicated for a very transparent orthography (see Chapter 6).

Before then, however, attention is focused on the psychological evidence from “transparent” Italian and Spanish orthographies often taken as support for the universal hypothesis and the evaluation of their findings.

4.9.3 Evidence from Italian and English

A cross-language comparison between English and Italian provided contrary evidence to the orthographic depth hypothesis. As previously mentioned Italian has been argued to be a highly transparent orthography because of its regular letter-to-sound mappings. Tabossi and Laghi (1992) compared semantic priming effects in naming Italian and English words, using both lexical decision and naming tasks, in order to put to test the claims of the orthographic depth hypothesis. The authors reported significant semantic priming effects in naming when the stimuli set consisted of words only. However, in a second experiment when equal number of nonword fillers were embedded to the stimuli set, the priming effect was nullified in the naming task whilst it prevailed in the lexical decision task. In follow-up naming tasks, the impact of presence of nonword fillers, i.e. list effect, showed that there were no priming effects for Italian, whilst this prevailed for English.

The conclusions from this study was twofold: First, that readers of Italian (a relatively transparent orthography in comparison to English) primarily make use of the lexical route. These findings are contrary to earlier evidence from Serbo-Croatian. Second, in line with Baluch and Besner (1991), it was suggested that certain characteristics of writing systems may be relevant in determining the strategies that readers adopt in unusual circumstances. For instance, under specific experimental task demands such as the presence of nonword fillers. Although Italian is highly regularly transcribed, sources of irregularity exist: One such source is letter-sound correspondences and another is stress assignment. The former is because the pronunciation of letters G, C, and SC is reported to be context sensitive in that their pronunciation changes depending on whether they are followed by A, O, U or by a consonant; or followed by the vowels E or I. Thus, whilst it is true that when nonwords are not added there is semantic priming effect it is still not conclusive as to whether the lexical factors had encouraged such lexical processing or that it is because the lexical route dominates in this orthography. A second source of irregularity is stress assignment. Stress is regular and unambiguous for mono and bi-syllabic words whilst previous lexical knowledge is required for multi-syllabic words (e.g. Barry & Bastiani, 1997; Colombo, 1991; Job, Peressotti & Cusinato, 1998; Tabossi & Laghi, 1992). Indeed, empirical evidence led Tabossi and Laghi (1992) to suggest that "nonlexical reading has a very limited use, even in ... Italian" (p310).

Colombo and Tabossi (1992) manipulated stress assignment in Italian which they claim is "... the only source of irregularity" (p323). Thus words were classified regular if their stress assignment was as on the penultimate syllable of the multi-syllabic words or irregular if it was on the antepenultimate syllable. The source of irregularity is attributed to the unpredictability of stress assignment, which disambiguates pronunciation, hence meaning, for many otherwise identical pairs of words. It thus follows that under normal reading conditions word-specific information needs to be accessed in order to attain the intended pronunciation of the word. The authors demonstrated that subjects were indeed faster in naming words with regular stress assignment than irregular ones. The results indicate that in Italian lexical information about words, such as stress, is required if one is to attain the correct phonology.

Recently, Job, Peressotti and Cusinato (1998) reported a series of single-word naming experiments manipulating the effect of consistent-inconsistent mapping of graphemes-to-phonemes in the naming of nonwords. The nonword stimuli were created from words with either consistent or inconsistent grapheme-phoneme correspondences, as mentioned earlier. Some letters such as C and G have context dependent mappings in that their pronunciation is determined by the subsequent letters. The study was devised to investigate whether such lexical influences could be induced in nonword naming. For example, from the word DELICATO (delicate) a consistent nonword DELICOTO and an inconsistent nonword DELICETO were created. Job et al. (1998) found that consistent nonwords were named significantly faster than inconsistent nonwords when the naming list was mixed, i.e. target nonwords mixed with filler words (both high- and low-frequency), whilst this effect was eliminated when nonwords were presented on their own, i.e. pure-blocks. Readers also made significantly more errors in naming inconsistent nonwords in the mixed condition than the pure one and a significant frequency effect was observed for the word stimuli. The findings indicate that if strategic control was exercised over routes a null effect for frequency should have been observed. In addition, the findings suggest that the operations of the two routes are not independent of each other rather they are interdependent on each other since even in nonword naming there is evidence for involvement of lexical influences. The implications of this finding are discussed in detail in Chapter 7.

Noteworthy is also Barry and De Bastiani's (1997) study in Italian, which utilised a sound-to-spelling technique, similar to Cuetos' (1993) paradigm in Spanish reported in Section 4.7.2, as opposed to recognition of visually presented stimuli widely used in the domain. The authors capitalised on the consistency-inconsistency aspect of nonword spelling in Italian by employing a modified lexical decision task whereby participants heard lists of words and nonwords and were required to write down the nonwords only. Barry and De Bastiani (1997) reported that regardless of highly regular letter-to-sound mappings "... Italians do not use deterministic, one-to-one conversion rules for spelling the critical sounds used in experimental nonwords." (p511). It could thus be argued that the context dependent letter-sound mappings of Italian are manifest by the recognition of stimuli in both visual and auditory tasks.

Although evidence from Italian has contributed to the understanding of which particular route may be involved in naming for transparent scripts, what is debatable here is the degree of transparency. It is clear from the literature reviewed above that there are ambiguities within the script, insofar as GPCs (and sound-spelling mappings) are not essentially one-to-one. Furthermore, stress assignment imposes upon readers the use of lexical knowledge for correct pronunciation. Moreover, it appears that even nonword naming cannot be carried out by simple GPCs but is rather influenced by “lexicality” aspects as reported by Job et al. (1998). The hypothetical “alien” seems likely to fail in attaining nonlexical phonology for Italian when the evidence is reviewed.

4.9.4 Evidence from Spanish

Spanish, also reported to have a highly transparent and regular orthography, gained attention from investigators too. However, in a similar way to Italian, the letter-to-sound mappings are not always one-to-one or context independent. Sebastián-Gallés (1991) exploited the fact that letters C and G have highly regular but nevertheless context dependent pronunciations similar to Italian. For example, C followed by A, O, or U is always pronounced as /k/ and pronounced /t/ when followed by E or I. Two types of nonwords (consistent and inconsistent) were created with the target letters, C and G. Sebastián-Gallés reported that readers made three times more errors in naming inconsistent nonwords than consistent nonwords. The findings were also taken to indicate lexical involvement during oral reading. However, one of the shortcomings of this study is that words’ frequency was not controlled before deriving the nonwords. Furthermore, consistent and inconsistent nonwords were created from two different sets of words. The disadvantage is that the reported consistency effects could be an artefact of any pre-existing differences between the two sets.

Moreover, when commenting on the context dependent aspects of the Spanish orthography Sebastián-Gallés (1991) speculated that "this peculiarity may slow down the ease of the grapheme-to-phoneme translation routines. In this case, lexical effects would still appear in Spanish under circumstances in which they would not in shallower orthographies." (p476).

More recently, Cuetos (1993) capitalised on the phonology-to-orthography irregularity of Spanish whereby the phoneme /b/ may have two possible spelling outcomes, i.e. V or B. Cuetos reported that the spelling of nonwords was influenced by exposure to the preceding primes, i.e. lexical priming. For example, it was shown that the manner in which participants spelt the nonword /bopo/ was highly influenced by whether they heard the prime VOTO or BOLO.

Evidence from Spanish indicates that it cannot be considered as a typical example of a highly transparent writing system because of irregularities in both orthography-to-phonology and phonology-to-orthography as highlighted earlier. In summary, the "transparent" alphabetic writing systems (Italian and Spanish) although shown here not to be entirely transparent do nevertheless provide support for the universal hypothesis on empirical grounds. That is, regardless of the manner in which orthographies encode the phonology of the spoken language the lexical route is the dominant route. Reviewed next is evidence from two non-alphabetic writing systems, namely Japanese and Chinese, which has further contributed toward establishing the universal hypothesis.

4.9.5 Evidence from Japanese

As reported previously, written Japanese incorporates three scripts. Kanji, is the logographic script whilst the two transparent syllabic scripts, Hiragana and Katakana, collectively form the transparent syllabary, Kana. Hiragana is used to represent grammatical morphemes whilst foreign words are written in Katakana. Research interest has mainly focused on transcribing words which are normally written in one script with the other. For instance, a word normally written in Hiragana can be transcribed in Katakana and pronunciation is attained by using the spelling-sound rules. The same is also true in reverse order. Besner (1999) reports that "In both cases these strings are pseudohomophones much like as in English (e.g. BRANE vs. BRAIN)." Therefore, whilst readers are familiar with words based on their phonology they are unfamiliar with their orthographic presentation. In an earlier study, manipulating Japanese words on this orthographic familiarity Besner and Hildebrandt (1987) reported that words normally written in Hiragana are named significantly faster when the same word in transcribed in Katakana. Similarly, words normally written in Katakana are named faster than when transcribed in Hiragana. This effect has been replicated several times (e.g. Besner & Smith, 1992; Buchanan & Besner, 1995). If readers of Katakana and Hiragana used the nonlexical route to derive phonology from print (as suggested by the proponents of the orthographic depth hypothesis) because both scripts are transparent no such differences should exist. Besner (1999) argues that the faster naming of orthographically familiar words as opposed to unfamiliar words is because the former are named via the lexical route whilst the only way to name the latter is via the nonlexical route. Thus, the view that orthographic transparency determines which route is to be used by readers was shown to be incorrect yet again. A note of caution is that the previous argument regarding the haphazard way of grouping orthographies along the transparency continuum irrespective of many other characteristics still holds. Thus, one should be extremely cautious in generalising evidence from reading Japanese, which utilises a logography and two syllabaries, to writing systems which do not share these peculiarities. Finally, evidence from the logographic script, Chinese, is reviewed.

4.9.6 More Support for “Universality”: Evidence from Chinese

It is noteworthy that although the focus here is on alphabetic writing systems, it is pertinent at this stage to report the findings from a cross-linguistic study of English and Chinese conducted by Seidenberg (1985a). Comparing regular-irregular dichotomy in English (as reported earlier) and phonological aspects of Chinese logographs Seidenberg (1985a) came to the same conclusion as Baluch and Besner (1991) in that there exists a universality in processes involved in visual word recognition, regardless of the manner in which orthographies represent phonology. This was based on evidence from manipulating the frequency and the phonogram-nonphonogram, i.e. presence and absence of orthographic cues to pronunciation, aspects of logographic Chinese. Seidenberg (1985a) reported that similar to regularity effect in English, there was no effect of presence-absence of phonograms for high-frequency words whilst a significant effect was found for low-frequency words. Seidenberg concluded that despite the differences in the manner Chinese and English encode the phonology of the spoken language the results indicate a universality for the two processes, visual and phonological, activated over a time-course involved in word recognition. The faster recognition of high-frequency words is assumed to be on a visual basis with phonology lagging considerably behind. Thus phonological information about high-frequency words has no role in their recognition. Since the activation of the visual processing is assumed to be slower for low-frequency words then it is plausible for phonology to catch up with its operations, hence the effect for regularity in English and presence-absence of phonograms in Chinese. However, one must be reminded of the general criticism applied when making cross-script comparisons, in this case the comparison of a logographic script with an alphabetic script. Seidenberg (1985a, 1985b, 1985c) ignored the fact that for a Chinese logograph a truly nonlexical phonology is impossible, even for a logograph with phonogram (see Norris & Brown, 1985 for a critical review of Seidenberg's, 1985a, study).

4.10 Summary and Concluding Remarks of the Chapter

Based on evidence from studies such as Baluch and Besner (1991) - dual-route universal model; Seidenberg (1985a) - time course model; and Seidenberg and McClelland (1989) - connectionist model of reading, a universal model is suggested. A universal model accounts for little, if any, differences in the manner that words, in particular high-frequency words, are named in all writing systems irrespective of the differences in the manner in which they reflect phonology. There are also suggestions, expressed in the format of the so-called orthographic depth hypothesis, that perhaps the nature and degree of orthography-to-phonology transparency in a particular script may dictate which route is used (Frost et al., 1987) and ultimately how a word is recognised (see Frost, 1998; Lukatela & Turvey, 1998; Van Orden, Stone, Garlington, Markson, Pinnt, Simonfy, & Brichetto, 1992).

Thus, whilst the above is the typical state of current affairs with much of the evidence in support of some universality (e.g. Baluch & Besner, 1991; Sebastián-Gallés, 1991; Seidenberg, 1985a, 1985b; Tabossi & Laghi, 1992) all this could fall short of an argument that which script to-date, if any, has fulfilled the requirements of the true "alien" description. In what Coltheart and Midgley-West (1980) characterised as being the hallmark of a transparent writing system the "alien" would most certainly struggle with the stress assignments of Italian and Spanish or would be most likely confused dealing with the bi-alphabetic scripts of Serbo-Croatian. Therefore, the "alien" would need some degree of "lexical knowledge" in addition to purely rule-based grapheme-phoneme learning to deal with all words in the afore mentioned "transparent" writing systems of Serbo-

Croatian, Italian and Spanish. It will be argued here that Turkish is the most appropriate, if not the only, candidate that best fits the notion of Coltheart's "alien" for deriving nonlexical phonology. Thus, evidence from Turkish is therefore of paramount importance on two accounts:

- The re-examination of at least the strong version of the orthographic depth hypothesis using Turkish
- In view of comments made regarding Baluch and Besner (1991) it would be important (as will be explained in Chapter 6) to re-examine the issue of impact of nonword fillers on the naming of words.

But prior to this the characteristics of the Turkish orthography are introduced next, in Chapter 5.

5 Chapter 5: Turkish Orthography and its Significance for Research on Single-word Naming

5.3 Preface

In view of the critical evaluation of the orthographic transparency of Serbo-Croatian, Italian and Spanish, a script which provides the means for a purely nonlexical pronunciation, namely Turkish, is described here. The aim is twofold: First, to provide a review of the historical development of the Turkish script and second, the implications its salient characteristics have for exploring issues in oral naming within the scope of this thesis. The following references were consulted in the writing of this Chapter: Gencan (1972); Kaya, Öztürk, Yılgör, Altun, and Selimhocaoğlu (1997); and Şimşir (1992).

5.4 History of the Turkish Orthography

Modern Turkish (Türkçe) belongs to the Turkic languages cluster which comprises of three families, namely, Ural-Altaic, Mongolian and Manchu-Tungus. It is currently the spoken language of many nations such as Turkey, Azarbaijan, Turkmenistan, Uzbekistan and Cyprus and is thus spread over a vast geographical area ranging from central Asia to Europe. A classification based on historical-geographical grounds of Turkic languages yields at least seven branches. However, modern Turkish, the official language of the Republic of Turkey, and the subject of investigation in the present thesis, belongs to the South-Western branch of the Ural-Altaic family, also known as Oğuz or Turkmen. Today's Turkish is the successor of Anatolian Oğuz Turkish introduced into Anatolia during the 11th Century AD by Selchuk (Seljuq) Turks and the subsequent Ottoman Turkish.

Historically, the first script to be used by the Turkish people was the runic Köktürk script with 38 characters. Evidence for its use dates back to 688-692 AD to the Çoyren

Inscription, succeeded by the Orhun Inscription in 732-733 AD (see e.g. Çapan, 1989; Gencan, 1972; and Encyclopaedia Britannica, 1994 for details). Both these inscriptions are geographically placed in an area which is now part of modern Mongolia. During this period, the Uygur script was also developed and used from 745 to 970 AD. Both scripts are often reported to be poor in representing the enriched sounds of the spoken language, in particular the vowels. However, based on these early writings it became evident that little has changed regarding the phonological and morphological structure of Turkish over the following 11 centuries. About mid-900 AD the Turks were forced to change their writing system to Semitic Arabic, which was even more impoverished in conveying the richness of the spoken sounds (i.e. phonemic system) of Turkish than the previous two scripts. This is because the number of vowels in spoken, as well as in written Arabic, a typically consonantal Semitic script, is restricted to three vowels, /a/, /i/ and /o/ (expressed in short and long form) as opposed to eight in Turkish, which embodies four front vowels /e/, /i/, /ö/ and /ü/ and four back vowels /a/, /ı/, /o/ and /u/, (so-called front and back to indicate the position of formation in the mouth). However, with the mission of spreading Islam the Arabs were ruthless and intolerant to scripts other than Arabic. Thus, although Turkish was maintained as the spoken language, Arabic became the official script for the next 1000 years, in particular for the elite Ottoman Turks. Although the original Arabic script was modified by the introduction of diacritics to mark vowels, similar to the modification to Arabic to transcribe Persian, it was still inadequate to transcribe all eight vowels. This consequently led to problems in deriving the correct phonology from print, e.g. ambiguity, often associated with consonantal scripts (see Chapter 4 for a detailed account). As a consequence, the acquisition of literacy suffered. The impact of use of vowels in scripts in achieving literacy is well documented in Skoyles' (1988) article. In this context, Çapan (1989) reports that in 1927 only a small minority, about 10 percent, of the Turkish population were literate. The late 19^{th} Century saw (e.g. Gencan, 1972) discontent among a group of writers and journalists who protested against the use of an ill-fitting Arabic script to transcribe Turkish. Since this movement coincided with the break up of the Ottoman Empire, no action was taken upon it. The orthography was eventually reformed in 1928 by transcribing the sounds of the spoken language in a modified Latin alphabet as part of Atatürk's modernisation plans for the young Republic of Turkey. The aim was to deliberately create an alphabet whereby each spoken sound in standard Turkish (i.e. phoneme) had a letter (i.e. grapheme) which directly corresponded to it; thus, ultimately providing an optimal environment to facilitate and enhance the acquisition of literacy skills. In the next section the characteristics of Turkish orthography are introduced, with emphasis on its distinctive orthography-to-phonology mappings.

5.5 Characteristics of Turkish: Phonology and Morphology

By replacing the old Arabic script with Latin, the modern orthography was deliberately designed to embody the sounds in the spoken language in a totally transparent representation, where both grapheme-phoneme and phoneme-grapheme conversions were regular, explicit and consistent. A 29 letter alphabet of eight vowels and 21 consonants (see Table 5.3.1 for details) replaced the Old Ottoman Arabic script. In addition to invariant, context independent mapping between graphemes and phonemes, the high number of vowels enables the modern Turkish orthography to be classified as even more transparent than scripts previously argued to have this status. Thus, Turkish has a very transparent orthography; indeed as described next a deliberate attempt has been made to eliminate any irregularities.

Table 5.5.1 The letters in the modern Turkish alphabet and their corresponding phonetic transcriptions with approximate examples in English/French

Upper case	Lower case	Corresponding phoneme	Approximate pronunciation in English/French (In italics)	Vowel/ Consonant
A	a	/a/	C*A*R	v
B	b	/b/	*B*OOK	c
C	c	/dj/	*G*EM	c
Ç	ç	/ch/	*CH*ARM	c
D	d	/d/	*D*OT	c
E	e	/e/	J*E*T	v
F	f	/f/	*F*OOT	c
G	g	/g/	*G*ULF	c
Ğ	ğ	/gh/	French /r/	c
H	h	/h/	*H*AT	c
I	ı	/ı/	MISS*IO*N	v
İ	i	/i/	K*I*D	v
J	j	/j/	French *J*OUR	c
K	k	/k/	*C*UT	c
L	l	/l/	GOA*L*	c
M	m	/m/	*M*OON	c
N	n	/n/	*N*EVER	c
O	o	/o/	*O*KEY	v
Ö	ö	/ö/	French S*EU*R	v
P	p	/p/	*P*OT	c
R	r	/r/	*R*AM	c
S	s	/s/	*S*EA	c
Ş	ş	/sh/	*SH*UT	c
T	t	/t/	*T*AN	c
U	u	/u/	Y*OU*	v
Ü	ü	/ü/	French /u/	v
V	v	/v/	*V*AN	c
Y	y	/y/	*Y*EN	c
Z	z	/z/	*Z*ERO	c

As can be seen in Table 5.3.1, an attempt has been made to provide examples for the phonemes that correspond to the letters in the Turkish alphabet with as close approximations as possible in English, or alternatively in French, if none were found in English. Each letter in the alphabet directly corresponds to a single phoneme, similarly each phoneme is represented by a single letter. In this respect a total bi-directional transparency is achieved. Notable also is the lack of letter patterns or orthographic units (e.g. unlike English /th/) that collectively correspond to phonemes, which also help eliminate any potential source of irregularity. For example, Ş directly corresponds to /sh/ and Ç to /ch/, similarly G always corresponds to /g/. For instance, ÇAN (bell) is pronounced as /chun/ as if pronouncing gun; GEL (come) is /gel/; SÜT (milk) as /süt/; and TER (sweat) is /ter/, to give a few examples. Moreover, there are no silent letters in Turkish, consequently all the letters in a word are pronounced. Thus, the atypical transparency of Turkish orthography lies within its simplicity in encoding the phonology of the spoken language. Furthermore, there is also no stress assignment in naming Turkish. In this respect, it is unlike Italian and Spanish which exhibit context dependent grapheme-to-phoneme mappings and problems of stress assignment. Furthermore, Turkish is unlike Serbo-Croatian whereby readers have to deal with two scripts simultaneously as well as stress assignment. Hence, the salient aspect of Turkish is the computation of nonlexical phonology in an entirely reliable and context independent manner: it thus has the most fitting description for the hypothetical "alien" to derive correct pronunciation from print without any prior lexical information.

Vowel harmony is a most prominent feature of the Turkish language. Words that are Turkish in origin contain either all front or back vowels. This rule also extends to all grammatical suffixes whereby the vowel in the suffix harmonises with the last vowel in the word. For example, two forms of the plural suffix exist; -LER is used in words where the front vowels E, İ, Ö, Ü occur, e.g. ÜZÜM-LER meaning (grape-s), whilst -LAR is used in the presence of back vowels A, I, O, U, e.g. KUTU-LAR meaning (box-es). For foreign words, such as TELEVİZYON-LAR meaning (television-s) -LAR is the plural suffix because the last syllable -YON contains O. On the other hand, in RİSK-LER meaning (risk-s) -LER is the plural suffix because İ is present. Thus, the vowel harmony is maintained in accordance with the vowel in the last syllable.

Noteworthy, is that orthographic transparency, i.e. at the level of letter sound correspondences, is one way that writing systems can be classified. A further classification is at a higher level, i.e. the level of the morpheme whereby languages are often reported to be one of three "structural types": isolating or noninflective (e.g. Chinese), agglutinating (e.g. Turkish) and inflecting (e.g. English) (e.g. see Henderson, 1982 for further details). In this respect, the agglutinative property of Turkish is another prominent feature whereby words are typically composed of sequences of morphs (smallest meaningful unit) with each morph representing one morpheme or meaning unit. Noteworthy also is the lack of a grammatical marker for gender. For example, from the root word KAL meaning (stay), KAL-MI-YOR meaning (he/she is not staying), and KAL-MI-YOR-LAR meaning (they are not staying), are typical derivations from the root by adding tense and person suffixes. Cromer (1991) reports that "Turkish is often cited as an example of an agglutinating language which approximates very closely to the "ideal" type" (p229). It is important, however, to note that in strings of agglutinated morphemes each element retains its phonological and semantic identity as well as its relative position in the string (Aksu-Koç & Slobin, 1985). The order of noun suffixes, stem / plural (-ler) / first person possessive (-üm) / locative (-de), can be exhibited in the following root word GÖZ (eye).

Table 5.5.2 A demonstration of the agglutinative structure of Turkish language with examples and corresponding translations in English from the root word GÖZ (eye)

Example	Corresponding translation in English
GÖZ	eye
GÖZ-ÜM	my eye
GÖZ-DE	in eye
GÖZ-ÜM-DE	in my eye
GÖZ-LER	eyes
GÖZ-LER-İM	my eyes
GÖZ-LER-DE	in eyes
GÖZ-LER-İM-DE	in my eyes

As can be seen in Table 5.3.2 numerous words can be derived from a particular root word. It should be noted here that the examples in Table 5.3.2 are displayed in a format which indicates the addition of suffixes (i.e. suffix segmentation), and that they do not represent words in a syllabic format. Since the vowel “pulls” the consonant, the derived word GÖZ-ÜM is syllabically segmented as GÖ-ZÜM.

Seven types of syllables exist in Turkish, which can also represent whole words as in the following examples, where V represents “vowel” and C represents “consonant”.

Table 5.5.3 Examples of Turkish words according to types of syllables and their corresponding translations in English

Type of syllable	Example of words	Corresponding translation in English
V	A	verbalising surprise or shock
CV	SU	water
VC	AL	red, take
CVC	BEN	me, I
VCC	AŞK	love
CCVC	KRAL	king
CVCC	KALP	heart

As can be seen in the examples in Table 5.3.3, syllables in Turkish comprise of only a single vowel, whilst those with two successive consonants are extremely rare, and usually foreign in origin, e.g. SPOR meaning (sports) and RİSK meaning (risk). It is also noteworthy that all 21 consonants in the alphabet can be combined with a vowel to form a CV syllable.

Returning to the orthographic transparency issue, the characteristics of the modern Turkish orthography, with its extremely transparent orthography-to-phonology mappings, provides an environment whereby nonlexical phonology can be attained with minimal amount of training. Noteworthy, however, is that Turkish has rarely been the subject of psychological investigation along the lines of enquiry pursued in the present thesis. A review of several studies which have utilised the Turkish orthography with the aim of investigating beginner reading is the subject of next section.

5.6 Psychological Investigations in Turkish

To-date, systematic investigation of processes involved in reading Turkish, with the exception of one study, have been limited to beginner reading (e.g. Öney & Durgunoğlu, 1997; and Öney & Goldman, 1984) and the acquisition of spoken language (Aksu-Koç & Slobin, 1986). The only study whereby processes involved in skilled reading in Turkish was examined is reported by Öney (1990). She investigated sentence-context effects, semantic priming, on both word naming and lexical decisions. Participants were presented with three types of sentences and had to respond (by either naming or making a lexical decision) to the preceding target words which were of three types: contextually consistent, inconsistent or neutral. Öney (1990) reported that word naming was facilitated by consistent context, whereas inconsistent context inhibited naming. Similar results were reported for the lexical decision task. It was consequently concluded that Turkish supports a ‘heavy reliance on phonologically analytic strategy’ in word recognition. Noteworthy is that whilst Öney’s conclusion (1990) is based on evidence for semantic priming in both lexical decisions and naming, Turvey et al. (1984) came to a similar conclusion using the single word paradigm when they found semantic priming effects for lexical decision but not for naming in Serbo-Croatian (see Section 4.6.1)! In this respect, although the two conclusions appear to be similar, evidence from Turkish and Serbo-Croatian are contradictory. If Turkish readers, as suggested by Öney, relied solely on the nonlexical route for deriving phonology from print, there is no reason to expect a significant semantic priming effect in naming. Although, it is beyond the scope of the research interests pursued in the present thesis to explore contextual effects on word naming and lexical decisions in Turkish, Öney’s conclusion appears premature for Turkish. In this respect, one may argue that evidence from single-word naming tasks utilising word frequency as a lexical variable provides a better indication of whether naming in Turkish primarily involves the lexical or the nonlexical route. To the author's knowledge, there has not been any other reported studies investigating the processes involved in single-word naming in skilled reading in Turkish. Thus, in this context, lack of research must be highlighted. However, those investigating beginner reading, in particular Öney and Durgunoğlu (1997) stress that there is a "... strong influence of the characteristics of the spoken language on the nature of the developing phonological awareness" (p3). Moreover, "Turkish provides a clear advantage to beginning readers because of its phonologically transparent orthography. The invariant correspondences between letters and sounds makes it quite easy for beginner readers to use this knowledge efficiently in word decoding" (p3). Indeed, it has been previously demonstrated that beginner readers of Turkish have an advantage in the acquisition of decoding skills over beginner readers of English (Öney & Goldman, 1984). Therefore, it is evident that the simple rules from orthography-to-phonology of Turkish have implications for beginner reading, in that they enhance its acquisition. Thus, in this respect it can be said that the main objective in converting the alphabet, i.e. facilitating the acquisition of literacy, is achieved.

However, returning to the issue of skilled reading, the starting point is to establish whether the degree of transparency has any implications for the routes involved in single-word naming. Turkish provides arguably the most transparent orthography to test the claims of the strong version of the orthographic depth hypothesis. Word frequency, in this context, is the lexical variable to be manipulated in order to determine the involvement of the lexical and the nonlexical route in naming. However, a search for objective frequency counts in Turkish yielded a list by Pierce (1963) which was consequently considered as outdated by highly literate Turkish readers. Considering that the frequency with which words are used in languages is dynamic and changeable and not fixed entities (particularly over a long period of time) the solution was to obtain subjective frequency ratings. It has also been argued in the literature that ratings of subjective word frequency are more indicative of the dynamics of a particular language than objective frequency counts (see e.g. Gernsbacher, 1984; Gordon, 1985). Moreover, investigators of writing systems other than English (e.g. Baluch, 1988), in which there are no readily available objective frequency counts, often use this method to obtain a list of high- and low-frequency words.

5.7 Summary and Concluding Remarks of the Chapter

Returning to the orthography-to-phonology mapping of Turkish orthography, as demonstrated in previous examples a nonlexical pronunciation can be attained with minimal amount of training, and certainly no prior knowledge about words is required. If the controversy whether orthographic transparency determines the routes used in naming is to be resolved, then Turkish orthography is the prime candidate for investigation. It is these preliminary thoughts that prompted the background thinking for Experiment 1, reported in the next Chapter.

6 Chapter 6: Routes Involved in Naming in Turkish

6.3 Preface

The ongoing debate as introduced previously, between orthographic depth and universal hypotheses, has drawn the attention of investigators interested in exploring whether orthographic transparency has an impact on word naming. This constitutes the rationale of the first experiment in the present thesis. If, as argued by the proponents of the orthographic depth hypothesis, readers of transparent scripts predominately use the nonlexical route for the purpose of attaining phonology from print then for exceptionally transparent Turkish this should be even more exaggerated with minimal evidence for lexical involvement. Thus, one would not expect a significant frequency effect if the orthographic depth hypothesis holds true. The universal hypothesis on the other hand suggests that the lexical route is the predominant route of the two and that it is used by readers regardless of the transparency of the writing system. Thus, if the universal hypothesis holds true then a significant frequency effect is expected for transparent Turkish. The implication of the debate between the universal vs. orthographic depth hypotheses in Turkish is as follows: as previously introduced, the salient aspect of Turkish is the total and invariant correspondence between letters and sounds. Thus, it is viable to assume that readers can rely entirely on the nonlexical route for correct articulation. Since the nonlexical route is also assumed to be insensitive to lexical variables such as frequency then there should be no impact on RTs, i.e. high- and low-frequency words should be named with similar RTs, if it is solely used to name high- and low-frequency words. Such an outcome would validate the claims of the strong version of the orthographic depth hypothesis. If, however, as argued by the universal hypothesis proponents the lexical route is the preferred route to name words regardless of the transparency of a writing system then a robust frequency effect should be observed for transparent Turkish. This issue will be addressed in the first experiment whereby high- and low-frequency words in Turkish will be presented for naming.

6.4 Experiment 1: High-frequency Words Mixed with Low-frequency Words

6.4.1 Aim

The aim of the first experiment was to examine possible evidence of lexical involvement in naming transparent Turkish words. Word frequency in this respect, as discussed in Chapter 2, is a good measure of lexical involvement (see also e.g. Balota & Chumbley, 1984; and Monsell, 1991). It is hypothesised that if a reader makes sole reference to the lexical route for naming, high-frequency words should be named faster than low-frequency words. If, however, pronunciation of a word is generated nonlexically, particularly in transparent scripts, as suggested by the proponents of the strong version of the orthographic depth hypothesis, then there is no reason to expect a significant effect due to frequency. Indeed, Frost et al. (1987, experiment 1) reported no significant frequency effect for naming the transparent Serbo-Croatian orthography. It was of interest to see whether the same holds for Turkish orthography.

6.4.2 Method

Participants

Twenty three adult male and female native Turkish speakers resident in the UK took part in this naming task, and were tested in the UK.

Materials

Materials comprised of 40 high-frequency (e.g. İNSAN meaning human) and 40 low-frequency Turkish words (e.g. İBLİS meaning devil) which were selected using the following procedure. Nine highly literate, native speakers of Turkish rated 200 words (from a list of 433, see Appendix 6 for a full list) on a 7-point rating scale ranging from 1 =

"most frequent" to 7 = "least frequent". The median score for the ratings was used due to its robustness to the influence of outliers. Words were classified as high-frequency if their ratings were a maximum of 2 and low-frequency if their rating was a minimum of 6. Words that received a rating of 3, 4 and 5 were excluded from the study. As argued earlier, subjective frequency ratings provided by native speakers are better predictors of word frequency than standard, objective word frequency counts (Gernsbacher, 1984; Gordon, 1985). An attempt was made to choose the target stimuli, 40 high-frequency and 40 low-frequency words, from the list that were matched on a) initial phoneme, b) letter length and c) number of syllables). In addition, a total of ten high- and low-frequency words were selected for use in practice trials (see Appendix 1 for instructions and Appendix 2 for a full set of practice and experimental stimuli).

Apparatus/ Procedure

An Amstrad PC7486 computer was used to present the stimuli. A voice activated key, attached to a necklace type device, was worn by the participants with the aim to detect the immediate onset of articulation. The program was written in VisualBasic for DOS. The experiment was carried out in a quiet room with one participant at a time. The participants were seated approximately 70cm from the screen and were instructed, both verbally and in writing via the computer screen in Turkish, to pronounce the words presented on the screen as fast and as accurately as possible. The experiment commenced after ten practice trials to ensure that the voice key levels were adjusted appropriately and the participants were accustomed to the procedure. The order of presentation of the stimuli was randomised for both the ten practice trials and the 80 experimental trials. Each stimulus was presented in the middle of the visual display screen that disappeared by the onset of articulation and in black print, Times New Roman Font 16, on a dark grey background. RTs were recorded using a microphone which was connected to a voice-activated relay interfaced to the computer which timed RTs from the appearance of the stimulus to the onset of articulation. A two-second intertrial interval was employed before the next stimulus appeared. The participants were given a three minute break after 40 trials. If a word was mispronounced, this was noted by the experimenter as error data. Data were omitted from analysis if the participants mean response time exceeded 1000ms for the onset of high-frequency word articulation. An error rate of a maximum 10% was set as a second criterion for data omission, otherwise error responses were replaced by the mean for that item. There was no repetition of stimuli at any stage of the experiment.

A Statistical Issue

A statistical note, in this context, is made with reference to Clark (1973) who criticised the statistical procedures employed in visual word (and sentence) recognition experiments. Clark's concern was the way in which results from using a relatively small sample of "fixed" stimuli was generalised to a whole population, i.e. the language. He argued that results, such as Rubenstein et al.'s (1971) pseudohomophone effect, could only be replicated provided that exactly the same set of stimuli was used with new participants whilst a new set of stimuli could yield different results even with the same participants. To overcome this, Clark (1973) proposed the use of a conservative statistic, namely Min F', which would treat stimuli as "random" as opposed to "fixed" entities of language. The calculation of Min F' takes into account both the F ratio computed for subjects as well as the F ratio for items. Although the procedure was practised for a while after Clark's recommendations it eventually was dropped because of its conservatism. Noteworthy also is that Min F' has not been used in any of the recent literature reviewed for the purpose of the present thesis. Based on these two grounds, i.e. conservatism and lack of recent report, it was decided not to compute Min F' in the current set of experiments, in particular if results from Turkish is to be comparable to other studies relevant to the research questions addressed in the present thesis. However, an F ratio for subjects (F1) and items (F2) will be reported whenever possible. Also reported in the analyses will be Mean Square Error, MSE, in conjunction with F1 and F2.

6.4.3 Results and Discussion: Experiment 1

Mean reaction times (in ms) and percentage errors were calculated for each subject in each of the two experimental conditions (see Appendix 5 for details of RTs for subjects)

Table 6.4.1 Experiment 1: Mean RTs (in ms) and their corresponding standard deviations (SD) for high- and low-frequency Turkish words, along with the Error % for subjects

Type of stimuli	Mean	SD	Error %
High-frequency words	766.9	74.1	0.6
Low-frequency words	818.9	78.6	0.8
Difference	52.0		

As can be seen in Table 6.2.1, there is a 52ms difference in reaction time latency between high- and low-frequency words. Formal analysis of the data on the differences between high- and low-frequency words was conducted by employing a repeated measures t-test across subjects and was found to be significant, $t(22) = 8.77$, $p < 0.001$. An independent groups t-test across items, $t(78) = 2.32$, $p < 0.02$ was also found to be significant. Error rates were too small for formal analysis.

The significant frequency effect observed in this experiment was an indication that the lexical route is used in naming the transparent Turkish orthography. This finding is contrary to the predictions made by the strong version of the orthographic depth hypothesis and to Frost et al.'s (1987) experiment 1 in which Serbo-Croatian readers were found to demonstrate minimal lexical involvement in reading their orthography. What should be noted here is that in Frost et al.'s (1987) experiment nonwords were also included in the naming list. Thus, the impact of the list-composition on the routes, as introduced earlier, was ignored in their interpretation of the lack of frequency for Serbo-Croatian. Earlier Seidenberg and Vidanovic (1985) reported contradictory evidence indicating lexical involvement for reading Serbo-Croatian. Moreover, evidence for lexical involvement in reading other transparent orthographies was also reported for transparent words in Persian (Baluch & Besner, 1991) and in Italian (Tabossi & Laghi, 1992). The impact of list-composition, nonword fillers, was demonstrated in the former study that in the presence of nonwords any lexical involvement, such as frequency, was nullified. This null effect was attributed to a strategic shift from the lexical to the nonlexical route in the presence of nonword fillers. It is thus of interest here whether the routes used in naming Turkish are also under the strategic control of readers as dictated by the list-composition, i.e. inclusion of nonword fillers. Indeed, reflecting on the transparent aspects of Turkish one would expect a complete shut down of the lexical route when nonwords are added to the stimuli set. A simple application of GPCs should enable generation of nonlexical pronunciation for words (and nonwords) with no lexical involvement.

6.5 Experiment 2: High- and Low-frequency Words Mixed with Matched-Nonword Fillers

6.5.1 Aim

The aim of Experiment 2 was to explore whether the word frequency effect observed in Experiment 1 was influenced by experimental task demands, in this case inclusion of matched nonword fillers. One prediction in line with previously reported research on Persian, Italian and Serbo-Croatian is that the inclusion of matched nonword fillers nullifies the word frequency effect. If so, at least one interpretation offered is that arguably, the lexical route is completely shut down when nonwords are present. Absence of such null frequency effects for Turkish may call into question the findings of the above mentioned scripts.

6.5.2 Method

Participants

Seventeen adult male and female native Turkish speakers resident in the UK took part in this naming task, and were tested in the UK. None of these participants had performed in Experiment 1.

Procedure/Apparatus

The apparatus and the procedure used in Experiment 2 were identical to Experiment 1, with the addition of 40 nonword fillers to the stimuli set. The nonwords created were matched on initial phoneme, letter length and number of syllables with high- and low-frequency words. For example, İGNÖR was created to match with the high-frequency word İNSAN meaning (human) and the low-frequency word İBLİS meaning (devil). The instructions were altered to indicate to participants that they might notice some stimuli that do not sound like known Turkish words, but they should nevertheless attempt to name them. The practice trials included ten nonwords also matched on initial phoneme, letter length and number of syllables to the ten words (see Appendix 2 for a full set of practice and experimental stimuli).

6.5.3 Results and Discussion: Experiment 2

Mean reaction times (in ms) and percentage errors were calculated for each subject in each of the three experimental conditions (see Appendix 5 for details of RTs for subjects).

Table 6.5.1 Experiment 2: Mean RTs (in ms) and their corresponding standard deviations (SD) for high- and low-frequency Turkish words, and matched nonwords, along with Error % for subjects

Type of stimuli	Mean	SD	Error %
High-frequency words	776.1	54.1	0.1
Low-frequency words	779.8	57.0	0.3
Difference	3.7		
Matched nonword fillers	793.6	60	0.9

As can be seen in Table 6.3.1, the magnitude of differences between high- and low-frequency words was reduced to 3ms. Moreover, the RTs to matched nonword naming were slower than low-frequency words. Formal analysis of the data using one-way repeated measures ANOVA for subjects, $F1\ (2,48) = 1.15$, and one-way independent groups ANOVA for items, $F2\ (2,117) = 1.18$, was found to be not significant ($p = 0.1$). Error rates were too small for formal analysis. Repeated measures t-test for subjects showed that both high-frequency words, $t\ (16) = 10.28$, $p < 0.001$, and low-frequency words, $t(16) = 7.52$, $p < 0.001$, were named significantly faster than matched nonwords. One interpretation of this finding is that the null frequency effect was taken as evidence that the presence of nonwords encouraged readers to change from the lexical to the nonlexical route. The involvement of the nonlexical route in this naming task is assumed to take place since readers can successfully pronounce the nonwords presented in the stimuli set. Similar results were reported for naming Italian (Tabossi & Laghi, 1992); Spanish (Sebastián-Gallés, 1991) and Persian (Baluch & Besner, 1991) orthographies.

6.6 Discussion of Results: Experiments 1 and 2

One plausible explanation for the results found in Experiments 1 and 2 is that although readers of transparent orthographies primarily prefer to use the lexical route for deriving phonology from print, they are flexible enough to adopt the nonlexical route if the list-composition (i.e. presence of nonword fillers) so demands. However, two issues need to be noted here: First, that RTs to Turkish words are slower in comparison to those reported for orthographies such as English. For example the mean RTs for high-frequency Turkish words in Experiment 1 is 766ms whilst RTs for high-frequency, regular word in English (e.g. as reported by Seidenberg, 1985a, p17) is 549ms. Why Turkish is generally named slower than English is, as yet, unclear. To-date, there have been no findings to suggest that RTs to naming in different orthographies should follow a similar pattern. For example, one can appreciate that Chinese (naming RTs for high-frequency, phonogram word is reported to be 739ms, Seidenberg, 1985a, p14) and Japanese (naming RTs for a Katakana word is reported to be 605ms by Besner & Hildebrandt, 1987) are read considerably slower than English, yet data from both orthographies have contributed to the type of arguments pursued in the present study. Second, the RTs for words in Experiment 2 is significantly faster than RTs for nonwords. If a truly nonlexical route is used in

Experiment 2, why should RTs for words be significantly faster than nonwords? Katz and Feldman (1983) also observed faster naming of words than nonwords in Serbo-Croatian (in the same experiment in which they failed to find effects for semantic priming!). Whilst one may argue that perhaps this supports the earlier claim that scripts such as Serbo-Croatian are not truly as transparent as Turkish i.e. the lexical route cannot completely be shut off, why is the word-nonword effect so significant in the truly transparent Turkish. It was indeed finding a solution to the latter issue, and the examples of paradoxical evidence that is listed below in relation to the role of nonword fillers, list composition and whether in naming English a particular route is emphasised or de-emphasised in relation to task demands, that prompted further investigations into the effects of filler stimuli on naming Turkish.

6.6.1 Filler Words, List Composition and the Interpretations of their Effects on Naming English

Andrews (1982) and Waters and Seidenberg (1985) manipulated the inclusion of nonword fillers in their lists of regular and irregular English words. However, both failed to report evidence suggesting that such manipulations either encourage, or discourage, readers to use a nonlexical route for naming words. Andrews presented participants with two lists: List one consisted of regular and irregular words whilst list two consisted of the previous list with the addition of an equal number of nonwords. It was hypothesised that, if readers were encouraged to use the nonlexical route in the presence of nonwords, regularisation errors should have been larger in the latter condition compared to the all word condition. Andrews failed to report such an effect. Similarly, Waters and Seidenberg (1985) presented participants with either a list of regular and irregular words, or the same word list, in the presence of “strange” unusual spelling patterns, e.g. AISLE, TONGUE. It was argued that in the presence of unusual spelling patterns readers should primarily rely on the lexical route for correct pronunciation, thus less regularisation errors should be made as compared to a list that do not contain such unusual spellings. However, the authors failed to find significant differences in regularisation errors between the two manipulations, thus suggesting that the presence of unusual spellings had no significant effect in changing subjects strategy to deal with word naming stimuli. The two findings were thus taken to indicate lack of evidence for strategic control over the use, or disuse, of the nonlexical route in naming English. However, this interpretation is open to criticism (Coltheart & Rastle, 1994), in that the list-composition, i.e. the proportion of stimuli, may not have been sufficient to encourage readers to engage the nonlexical route in naming. Moreover, a series of studies by Paap and Noel (1991) and Monsell et al. (1992) have reported contrary findings in single-word naming in English, namely that readers can manipulate their reading strategies in response to task demands. Paap and Noel (1991) reported that participants were more accurate and faster when the naming list composed of irregular words only than when regular words were added to the list. The interpretation of this finding as offered by Paap and Noel is that when naming irregular words only, readers make prime use of the lexical route which is faster than the nonlexical route (assumed to be involved in the naming of regular words). When however both regular and irregular words are mixed together they prompt the operation of both routes which in turn may slow down the naming of irregular words as their pronunciation may be delayed for the (incorrect) outcomes of the nonlexical route to become available to the reader. Such interpretation of the results from list manipulations may also suggest that perhaps the operation of the two routes (once prompted by list manipulations) are not independent of each other rather a checking mechanism must be involved prior to articulation.

In a further manipulation of regularity in English, Monsell et al. (1992) presented readers with either irregular words only or irregular words mixed with an equal number of nonword fillers. This manipulation of list-composition was argued to provide conditions under which the use of both the lexical route, i.e. irregular word naming, as well as the nonlexical route, i.e. nonword naming, is maximised. Note the differences in manipulations as compared with Andrews' (1982); Waters and Seidenberg's (1985); and Paap and Noel's (1991) list-compositions which also included regular words were not as favourable as the Monsell et al.'s in inducing the exclusive use of either route. Although, Monsell et al. (1992) did not find a significant difference between the RTs of two list-compositions (irregular words only or irregular words mixed with nonwords), a significant difference was nevertheless found for regularisation errors, i.e. higher error rates for irregular words in the presence of nonwords. Moreover, Monsell et al. (1992) further manipulated the list-composition in pure (i.e. naming regular words separately from irregular words) vs. mixed-blocks orthogonally with frequency. The findings showed that high-frequency irregular words were named significantly faster in pure-blocks than in mixed-blocks, whilst there was nonsignificant RTs difference for low-frequency words but larger error rates. Monsell et al. (1992) concluded that readers could "de-emphasise" the use of the nonlexical route when the list consisted of only irregular words and "emphasise" the use of the lexical route when they are not present. The main implication of this conclusion was that readers of "deep" English could also exercise strategic control over the use of the nonlexical route. Thus, several accounts can be offered as to how task demands, nonword fillers or list composition may affect naming English. If one follows Andrews' (1982) and Waters and Seidenberg's (1985) claims there is evidence of little or no flexibility in naming English words (perhaps more in line with a view of single-route model of reading). If the results of Paap and Noel (1991) and Monsell et al. (1992) hold there is evidence of flexibility in using both the lexical and nonlexical routes even in the deep English orthography. Even if some of the paradoxical findings reported above on English may be attributed to "weaknesses" in experimental manipulations or the deep (peculiar) nature of English spelling, the results of strategic control over the use of lexical and nonlexical routes in transparent scripts, in response to the effects of nonword fillers, may also be questioned insofar as a complete shut off of the lexical route is concerned. In almost all the studies on transparent writing systems, namely Persian (Baluch & Besner, 1991), Serbo-Croatian (Katz & Feldman, 1983) and the present Experiment 2, words are named significantly faster than nonwords whilst the frequency (or semantic priming) effect has disappeared for the same words! So what prompts words to be named via a nonlexical route - hence no frequency effect whilst the same nonlexical route is seemingly significantly faster when naming words as opposed to naming matched nonwords (see, however, Baluch and Besner, 1991, pp650-651 for an explanation of naming differences between words and nonwords)? Thus, there might be yet a different explanation other than the strategic shut down of the lexical (or nonlexical) route, that may account for the effects of task demands (nonword fillers in this case) in single-word naming of transparent orthographies. Interestingly, this different account was first raised for paradoxical findings on the effects of filler stimuli (words and nonwords) in single-word naming in English, an issue which is dealt with next.

6.6.2 A Different Approach to the Issue of List Effects and Filler Effects in Naming

Jared (1997) argued that Monsell et al.'s (1992) findings were not sufficient to conclude that in English strategic control takes place. "... stronger evidence for strategic control of the phonological route must be provided before recommending that current theories of word recognition be modified to include a control mechanism." (p1426). In a series of four naming tasks Jared manipulated both the type of target and the type of filler stimuli: targets with either nonword fillers or irregular word fillers; the typicality of spelling-sound correspondences of the target words (regular or irregular) and finally, frequency of the target words (high or low). Jared reported that high-frequency, inconsistent and consistent words, were pronounced faster with inconsistent word fillers than nonword fillers. Low-frequency words, however, yielded opposite results. Jared's results failed to support Monsell et al.'s (1992) earlier findings of de-emphasis of the routes. The overall finding was reported to be against the notion that "... readers can alter their degree of reliance on the phonological route depending on the composition of the stimulus list. Instead, the evidence suggests that readers adjust the time at which they make their response depending on the types of stimuli included on a list." (p1435).

In a parallel development, Lupker et al. (1997) came to a similar conclusion as Jared (1997) after their experimentation in English. Lupker et al. (1997) set out to replicate Monsell et al.'s (1992) experiments using irregular words as targets utilising a pure vs. mixed-block design in a series of experiments. Lupker et al. (1997) reported that high-frequency irregular words were pronounced significantly faster when presented by themselves in pure-blocks, than when presented mixed with nonwords. This finding is in line with that reported by Monsell et al. (1992). Low-frequency words, however, were named significantly faster in the mixed-block compared to the pure-bock. Lupker et al. (1997) argued that "... there would appear to be no obvious reason within the dual-route framework for observing a mixed-block RT advantage with any type of stimuli. Presumably, blocks that contain only one type of stimulus present the optimal opportunity for readers to balance their reliance on the two routes in a way that produces the shortest possible naming latencies. Assuming that readers can adopt strategies of this nature, introducing a second type of stimulus into those blocks can only upset that balance, which should lead to longer naming latencies in the mixed-block conditions (rather than speed it up). Thus these particular results do not lend themselves to an explanation in terms of a de-emphasis of routes." (p575).

Arguably, when naming irregular words readers could benefit from de-emphasising the incompatible information produced by the nonlexical route when possible, e.g. in pure-blocks of irregular words. However, when the readers task is to name regular words in a pure-block this may not be the case, whereby output from the nonlexical route is accurate and beneficial. Therefore, de-emphasising the nonlexical route in pure-blocks of regular words would be a counterproductive strategy since useful information could be ignored. To test this, Lupker et al. replicated their first experiment by using regular words with nonword fillers only and hypothesised that if the de-emphasis view holds true then the nonlexical route "... would be kept maximally active in both the pure and the mixed-blocks, and, thus, there should be no effect of the pure vs. mixed manipulation" (p576). Contrary to this, the naming of both high- and low-frequency regular words were reported to have slowed down in the mixed-block condition compared to the pure-block condition. The naming of nonwords, however, were speeded up in the mixed-block. First, Lupker et al. (1997) consider the de-emphasis of the nonlexical route: If this route was de-emphasised then it would be problematic to account for the faster naming of low-frequency, regular words in pure-blocks which are generally assumed to be named via the nonlexical route. In addition, how could one explain the speeding up of the nonword fillers in mixed-blocks than pure-blocks? Because the only plausible way for naming nonwords is via the nonlexical route nonword RTs should be similar regardless whether in pure or mixed-blocks. Thus, it was concluded that the de-emphasis of the nonlexical route could not account for Lupker et al.'s (1997) data.

Second consideration was focused on the de-emphasis of the lexical route, in line with the de-emphasis of the lexical route reported earlier for readers of Persian (Baluch &

Besner, 1991) and Italian (Tabossi & Laghi, 1992). Although the de-emphasis of the lexical route accounts for the word data reported by Lupker et al. (1997), it runs into problems with nonwords. This is because all the stimuli, i.e. high- and low-frequency regular words and nonwords, can be named via the nonlexical route but only half, i.e. high- and low-frequency words, could be named via the lexical route. If the lexical route had been de-emphasised then the naming RTs for nonwords should have been about the same for both the pure and the mixed-block manipulations. Thus the nonword data reported by Lupker et al. (1997) did not fit into this account which led the authors to conclude that neither the strategic shift nor the de-emphasis/emphasis of routes provided sufficient accounts for English. Instead they proposed that there exists a time criterion factor determined by the "perceived difficulty" of the stimuli to be named prior to articulation. Lupker et al.'s (1997) notion of time criterion as an account for null effects observed in the presence of nonword fillers will be dealt with in detail in the next Chapter where it will be put to test in a series of single-word naming tasks. Noteworthy also is that in their second experiment Lupker et al. (1997) report that "... most of the words selected (64 in each set of 80) would be classified as "regular-consistent" words". Thus, almost a quarter of the regular words was inconsistent in nature, which may act as a confounding variable on the findings and consequently on the time criterion account.

Most recently, Rastle and Coltheart (1999) manipulated the position of irregularity in low-frequency English words. To clarify, a word such as CHEF has a first position irregularity because the first phoneme (letters CH) can be read in several ways whilst a word such as SWAP has a third position irregularity because of the third phoneme (letter A). The authors' objective was to validate their claim that the processing of the nonlexical route (nonlexical procedure) is serial, as proposed in their recently developed computational DRC model introduced earlier in Section 3.4. Based on the dual-route account of regularity by frequency interaction, it was hypothesised that if conflicting phonology was delivered from the nonlexical route serially then words with first position irregularities should be slower and less accurate to name than words with second, third, fourth and fifth position of irregularities. Rastle and Coltheart (1999) indeed report such effects for both human data and computer simulations. Manipulating the position of irregularity in filler stimuli the authors went on to demonstrate that naming of target stimuli (both regular words and nonwords) in the presence of first position irregular fillers were slower than for third position irregular fillers. It was concluded that the findings demonstrate a "strategy effect" since the use of the nonlexical route is slowed down in the presence of such fillers. Nevertheless, Rastle and Coltheart acknowledge Lupker et al.'s (1997) explanation of a time criterion, adjusted according to the perceived difficulty of the stimuli, as opposed to their account of a strategic shift and argue that both positions are equally capable of explaining the findings. It thus remains to be seen for investigators in English to validate these claims put forward by each position.

Returning to the Turkish script, the focus of the next Chapter is to devise single-word naming experiments in order to explore whether the null frequency effect reported in Experiment 2 is because of possible strategic shift in using the nonlexical route instead of the lexical route or the predictions made by the time criterion factor could hold for the pattern of results.

7 Chapter 7: Changing Routes or Time Criteria?

7.3 Preface

The issue of whether cognitive processes involved in reading are universal and whether these processes are under the strategic control of readers was addressed in the first two experiments. Evidence from transparent Turkish supports the universal hypothesis whereby single-word naming is thought to be accomplished by the lexical route in all writing systems and in all orthographies. Furthermore, in the presence of nonword fillers the robust frequency effect previously observed was eliminated. This finding was thus taken to indicate that for Turkish reading is flexible and under the strategic control of readers. Moreover, when encouraged by context, i.e. presence of nonword fillers, they were able to “shut down” the lexical route and rely exclusively on the nonlexical route for deriving phonology from print, hence, eliminating the frequency effect. The aim of the present series of experiments is to seek further confirmation as to whether this shut down of the lexical route is the case or whether the null effect was in response to nonword fillers which, according to Lupker et al. (1997), has an impact on the time criterion factor.

As discussed earlier in Section 6.5, Lupker et al. (1997) proposed their time criterion factor based on evidence from a series of single-word naming tasks. The authors reported that high-frequency irregular words are named faster when presented in a pure-block than when mixed with nonword fillers. Mixing high- and low-frequency regular words with nonword fillers also yielded similar results. Finally, the authors presented their subjects with high-frequency regular and irregular words and low-frequency regular and irregular words in pure and mixed-blocks. Moreover, a regularity effect for high-frequency words was also reported in pure-blocks. According to Lupker et al. (1997) the emerging theme was that the stimuli that were usually named with longer RTs were named faster in mixed-blocks than in pure-blocks. Lupker et al. concluded that the strategic shift or the de-emphasis of routes could not account for their data and proposed an alternative explanation, namely the time criterion factor. The novel claim made by Lupker et al. (1997) is that "... in order to maintain an acceptable level of accuracy in any naming task and at the same time to produce responses acceptable rapidly, participants set a time criterion for when an articulation should begin." (p578). The time criterion hypothesis can be argued to be a factor attempting to account for differences in RTs displayed by readers when reading words in different contexts, such as the presence or absence of nonwords. In particular, the premise is that "The position of this criterion would be determined mainly by the perceived difficulty of the materials to be named. ... Thus, it would take some trials in each block before the position stabilises. Once stabilised, however, the criterion would act as a flexible guide for the beginning of articulation for all subsequent responses in the block" (p578). Therefore, when the stimuli set is homogenous (e.g. as in pure-blocks when all the stimuli is of one type only) the criterion setting would then be appropriate for most of the stimuli in order to produce accurate and rapid responses. Lupker et al. (1997) continue with their supposition that "When easy (such as regular words) and difficult (such as nonwords and low-frequency irregular words) stimuli were mixed together, however, the criterion would have tended to stabilise at a point that was beyond the preferred responding point for the fast stimuli but prior to the preferred responding point for the slow stimuli." That is, in pure-block conditions when the stimuli set is relatively easy or "fast" such as regular words the corresponding naming latencies are faster than when the same stimuli set is mixed, i.e. heterogeneous, with difficult or "slow" as in the case of nonwords.

Noteworthy, however, is the lack of definition of what is meant by "slow" or "fast" stimuli. Moreover, the fact that the authors refer to slow stimuli as nonwords and low-frequency irregular words may imply that both may be classed as slow stimuli for the same underlying reasons. To elaborate, one may argue that the reason for a nonword to be named slower than say a regular word may be entirely different. A nonword is slower than a regular word because although both types can employ the nonlexical route for articulation, nonwords can only be named via the nonlexical route, whereas regular words have the additional benefit of being named via the lexical route too. Furthermore, the nonlexical route is much slower in nonword naming as compared to regular words simply due to previous practice in the latter. A low-frequency irregular word may also be slow because it cannot use the nonlexical route at all. Moreover, the use of the lexical route may be slowed down by, for example, frequency ordering and neighbourhood effects. Thus, there could be two very different underlying mechanisms as to why nonwords and low-frequency irregular words are slow to name.

This broad, general definition of fast and slow stimuli is also reflected in Rastle and Coltheart's (1999) recent article: "Simply put, when fast things are mixed with slow things, those fast things slow down; when slow things are mixed with fast things, those slow things speed up." (p494).

7.4 What is "Fast" and What is "Slow" in Turkish

Attention is drawn that, due to the transparent nature of its orthography, Turkish words unlike those in English cannot be manipulated according to regularity or consistency. Indeed, it has been demonstrated by investigators such as Andrews (1989) and Glushko (1979, 1981) that regular-consistent words are named significantly faster compared to regular-inconsistent words. It should be noted here that when one refers to Turkish words as regular, as discussed previously, the issue of inconsistency is never a confounding factor. This is contrary to a recent study (Job et al., 1998) on Italian in which even nonwords can be manipulated according to consistency. In two naming tasks participants were presented with either consistent and inconsistent nonwords in the presence of high- and low-frequency filler words or the two types of nonwords on their own. Job et al. (1998) reported consistency effect for nonwords, i.e. consistent nonwords were named faster than inconsistent ones, in experiment 1 which disappeared in experiment 2. Moreover, a significant frequency effect for the word stimuli in experiment 1 prevailed. Job et al. (1998) suggested that the former result is an indication of lexical influences on nonword naming in Italian and was attributed to the list-composition, i.e. presence of word fillers, for encouraging lexical involvement. The authors hypothesised that removing words from the list may help eliminate the use of the lexical route. In the follow-up experiment there was indeed a null effect for consistency for nonwords when presented on their own. Job et al. (1998) concluded that data could be accounted for by the strategic shift position (e.g. Baluch & Besner, 1991; Sebastián-Gallés, 1991; Tabossi & Laghi, 1992). Job et al.'s findings do indeed indicate that, at best, the two routes can operate interactively, as well as the recent computational DRC (as demonstrated in Job et al.'s experiment 1) or independent from each other (as demonstrated in Job et al.'s experiment 2). This not only demonstrates evidence of how the two routes may interact, but also evidence that filler words could affect nonword naming in Italian.

Returning to the issue of manipulating the "perceived difficulty" of stimuli, a feasible way to create "fast" and "slow" stimuli in Turkish is by manipulating letter length. Letter length has long been known to affect RTs (e.g. Balota & Chumbley, 1984; Frederiksen & Kroll, 1976; Jared, McRae & Seidenberg, 1990). For example, Frederiksen and Kroll (1976) reported that "The cost in processing time for each additional letter in (English) the array is approximately 28ms for both words and nonwords. Moreover, this effect of array length is precisely the same when words were blocked, and the subject named only words or pseudowords" (p365). This increase in RTs is assumed to be at a "letter-dependent processing stage" which could affect the "grapheme-phoneme translation stage" (p375). The reported impact of increasing number of letters vary widely in size, ranging from 6ms to 63ms per letter, depending on reading ability and type of reading task (see Weekes, 1997 for a recent review). More recently, Weekes (1997) also reported that increasing the number of letters affected RTs for low-frequency words and nonwords but not RTs for high-frequency words. It thus follows that, since all words and nonwords are regular and easily pronounceable in Turkish, one could manipulate their naming RTs by increasing or decreasing their letter length, for the purpose of creating a set of "fast" and "slow" naming filler stimuli. Manipulating the "perceived difficulty" of filler stimuli would allow a closer examination of whether single-word naming in Turkish is best explained in terms of the strategic shift or the time criterion account.

To summarise, the time criterion hypothesis provides yet another explanation of results for previously reported research in which the interpretation of data was geared towards emphasis or de-emphasis or complete shut down of a particular route depending on "context or task demands" (e.g. Baluch & Besner, 1991; and Monsell et al., 1992). Of course the interpretation of results from Experiments 1 and 2 of the present thesis run into the same criticism as the latter series of studies. That is, according to Lupker et al.'s (1997) logic the null frequency effect for Turkish in Experiment 2 could be simply due to the fact that the fast naming word stimuli were mixed with slow naming nonword stimuli. Thus, this serious challenge is dealt with in the series of experiments that follow. First, however, relevant methodological considerations are discussed next.

7.5 Methodological Considerations (Mixed vs. Mixed-block)

The experimental design of Experiments 1 and 2 is reviewed here again for clarity of the follow-up arguments. In Experiment 1 participants' RTs latencies for high- and low-frequency words were obtained in a mixed condition, i.e. both types of words were randomly mixed and presented to participants. In Experiment 2, they also named nonwords in addition to the high- and low-frequency words again in a random, mixed condition. It is noteworthy that Lupker et al.'s (1997) experimental paradigm was not the same as Experiments 1 and 2, as they presented their subjects with pure-blocks (i.e. one class of stimuli presented in a block) as well as mixed-blocks (i.e. only one class of word was mixed with nonwords, e.g. high-frequency words with nonwords). As a result, the question that may arise is whether such differences in experimental manipulations may have an effect on the magnitude of word frequency in particular when nonwords are added to the list (i.e. Experiment 2 of the present thesis). The general consensus is that when conditions are pure-block subjects may use the most appropriate strategy accordingly. For example, as mentioned previously, when all words are of one type only (pure-block) RTs are reported to be faster than when two types of words are mixed (mixed-block). In an earlier study Frederiksen and Kroll (1976) demonstrated that participants were significantly faster in naming high-frequency words in pure-blocks than when mixed with low-frequency words. Thus, one would expect to replicate the finding of Experiment 1 in the present thesis in a pure-block condition, possibly with an exaggerated outcome. What however, is debatable is whether the lack of frequency effect, when all words (high- and low-frequency) and nonwords are mixed (as in Experiment 2), could be influenced if high-frequency words are named in one block (henceforth referred to as mixed-block) and low-frequency words are named in a different block mixed with nonwords. Arguably, one reason to suspect that a mixed-block presentation of nonword fillers as opposed to mixed presentation of nonword fillers, is the upsetting of the composition of stimuli in the set that may encourage lexical, as opposed to nonlexical reading. When all words (high- and low-frequency) and nonwords are mixed there is a 75% tendency to use the nonlexical route (low-frequency with nonwords) when however, high-frequency words are mixed with nonwords there is a 50% tendency to name words using the nonlexical route, and a 100% tendency to name all stimuli using the nonlexical route when low frequency words are mixed with nonword fillers. Perhaps such manipulations might affect the magnitude of word frequency effect. This is what is intended to be examined in the next series of experiments.

7.6 Experiment 3: High- and Low-frequency Words with Matched-Nonword Fillers in Mixed-block

7.6.1 Aim

Experiment 3 explored the blocking issue as raised by Lupker et al. (1997), that is, whether mixed vs. mixed-block manipulation of stimuli may change the pattern of results seen in Experiment 2. For this purpose, participants were required to name two mixed-blocks of stimuli, i.e. high-frequency words mixed with an equal number of matched nonwords and low-frequency words mixed with an equal number of matched nonwords.

7.6.2 Method

Participants

Fifteen adult, native readers of Turkish who were teachers of the Turkish language in local schools in London and tested in the UK.

Materials/Apparatus/Procedure

From the original pool of items rated by skilled Turkish readers, 20 high, e.g. ANNE meaning (mother) and 20 low-frequency, e.g. AVUÇ meaning (palm) Turkish words were selected for Experiment 3 and the follow-up experiments (Experiments 4, 5, 6 & 7) reported in the present Chapter (See Appendix 3 for a full set of stimuli). The word stimuli used in this set of experiments were restricted to two-syllables in an attempt to make the experiment as comparable as possible with Lupker et al.'s (1997) design who employed only monosyllabic English words arguing that one "got cleaner data" by using monosyllabic words (p573). As in Experiment 2, care was taken to match high- (e.g. ANNE was matched with ALIF) and low-frequency (e.g. AVUÇ was matched with

APUK) words and nonwords on initial letter, number of syllables and number of letters. The order of presentation of the two mixed-blocks was counterbalanced. Each experimental mixed-block proceeded after ten practice trials appropriate for the block.

7.6.3 Results and Discussion: Experiment 3

Mean reaction times (in ms) and percentage errors were calculated for each subject in each of the two experimental conditions (see Appendix 5 for details of RTs for subjects).

Table 7.6.1 Experiment 3: Mean RTs (in ms) and their corresponding standard deviations (SD) for high- and low-frequency Turkish words, and nonwords, along with the Error % for subjects

Type of stimuli	Mean	SD	Error %
High-frequency words + Matched nonword fillers	731 766	77 86	0.6 1
Low-frequency words + Matched nonword fillers	740 805	72 75	2.6 2.9
Difference	9		

As can be seen in Table 7.4.1, a difference of 9ms between high- and low-frequency words is observed. Formal analyses showed that this was nonsignificant for both subjects $F1\ (1,14) = 0.48$, $p = 0.50$, $MSE = 1195.27$ and for items $F2\ (1, 38) = 0.14$, $p = 0.71$, $MSE = 5367.85$. As demonstrated here the null effect for frequency observed in Experiment 2 (when all word and nonword stimuli were presented in one mixed-block) is not an artefact of experimental manipulation and that the same effect as in Experiment 2, which adopted a mixed design is observed here in the mixed-block condition. It could thus be argued that single-word naming in Turkish is influenced by the presence of matched nonword fillers regardless of type of blocking. One indication of the result observed in Experiment 3 is the involvement of the nonlexical route in the naming of nonwords. At this stage it is not however possible to establish whether the null frequency effect found here and in Experiment 2 is due to strategic shift in the form of de-emphasis of the lexical route or complete shut off or in fact whether the time criterion factor is at play. The aim of the follow-up experiment is to investigate this issue. For this reason high- and low-frequency target words will be presented for naming in two mixed- blocks with speed-matched nonwords appropriate for each block. It is hypothesised that if the presence of nonword fillers encourage readers to switch routes then this should result in a null effect regardless of the speed of the nonword fillers. If however, the speed of the filler stimuli has indeed an effect on the time criterion then the frequency effect should be maintained. Prior to Experiment 5 a pool of nonwords was created and validated to match the speed of naming of high- and low-frequency words with the aim of using them in the experiment as fillers.

7.7 Experiment 4: Creating a Set of Speed-matched Nonwords

7.7.1 Aim

The aim was to create a pool of nonwords that are matched on speed to high- and low-frequency words. This was achieved by manipulating the number of letters in the letter-string, i.e. three-letter and four/five-letter nonwords. This manipulation was considered as appropriate because RTs to nonwords in Experiments 2 and 3 were considerably slower than the word stimuli when they were matched in length. It is important to note that the number of letters in nonwords were reduced to three in an attempt to obtain RTs that matched with high-frequency words and to four/five to obtain RTs that matched with low-frequency word stimuli.

7.7.2 Method

Participants

Eight adult, native readers of Turkish who were undergraduates at the Eastern Mediterranean University. Each participant received course accreditation for participating in the experiment.

Materials/Apparatus/Procedure

Participants were presented with four pure-blocks of 20 three-letter nonwords (e.g. AKO), 20 four/five-letter nonwords (e.g. ARUY), 20 high- (e.g. ANNE) and 20 low-frequency (e.g. AVUÇ) words in a naming task which were counterbalanced for order effects (see Appendix 3 for a full set of practice and experimental stimuli). The participants were told that some of the stimuli would consist of letter strings that they had never encountered before but that they should attempt to name them as fast and as accurately as possible. The experiment commenced after ten practice trials appropriate for the block. The apparatus and procedure were the same as in previous experiments.

7.7.3 Results and Discussion of Experiment 4

(see Appendix 5 for details of RTs for subjects)

Table 7.7.1 Experiment 4: Mean RTs (in ms) and their corresponding standard deviations (SD) for three- and four/five-letter nonwords and high- and low-frequency words, along with the Error % for subjects

Type of stimuli	Mean	SD	Error %
Three-letter nonwords	626	73	3.4
Four/five-letter nonwords	695	81	3.7
High-frequency words	636	49	1
Low-frequency words	693	41	1.8

Mean RTs with corresponding SD to four pure-blocks of stimuli can be seen in Table 7.5.1. Formal analyses were conducted to investigate whether the two types of nonword fillers created for the purpose to test the issue of time criterion vs. strategic control in Experiment 5 were named as fast as the word stimuli, i.e. high- and low-frequency. Since it was essential to conduct multiple comparisons, i.e. four repeated measures t-tests, a statistical concern was to eliminate Type 1 error. For this reason a Bonferroni Correction was employed to make the tests more conservative whereby the significance of the tests were evaluated against the new, corrected level of α, i.e. $\alpha/4 = 0.0125$. The results showed a significant difference between high- and low-frequency words, $t(7) = 9.615$ $p < 0.001$, and a significant difference between three and four/five-letter nonwords, t (7) = 10.617 $p < 0.001$. However, no significant difference was found between the naming of high-frequency words and three-letter nonwords, t (7) = 0.326 $p = 0.754$, and also between the naming of low-frequency words and four/five-letter nonwords, t (7) = 0.068 $p = 0.948$. In this respect, it is argued that the nonword fillers created for the purpose of Experiment 5 are “fast” (three-letter nonwords) and “slow” (four/five-letter nonwords), henceforth referred to as “speed-matched” nonwords because the RTs of “fast” match with the RTs of high-frequency words and the RTs of “slow” match with the RTs of low-frequency words.

7.8 Experiment 5: High- and Low-frequency Words with Speed-Matched Nonword Fillers in Mixed-Block

7.8.1 Aim

The aim of Experiment 5 was to examine the impact of speed-matched nonword fillers in two mixed-blocks (i.e. high- and low-frequency words together with speed-matched nonwords) on the naming RTs of high- and low-frequency target words. It was hypothesised that if the presence of nonword fillers, irrespective of their naming speed, encourage strategic shift by either de-emphasising or a complete shut down of the lexical route then frequency effect should be nullified. If, however, the naming speed of the nonword fillers, in this case matched with target words, have an impact on the time criterion then there is no reason to expect a null frequency effect.

7.8.2 Method

Participants

Fifteen adult, native readers of Turkish who were undergraduates at the Eastern Mediterranean University. Each participant received course accreditation for participating in the experiment.

Materials/Apparatus/Procedure

The target high- and low-frequency word stimuli were the same as in the previous experiment which were presented in two mixed-blocks, i.e. high-frequency words (e.g. ANNE) and 20 low-frequency (e.g. AVUÇ) were presented with 20 speed-matched three-letter nonword fillers (e.g. AKO) and 20 four/five-letter speed-matched nonword fillers (e.g. APUK) respectively (see Appendix 3 for a full set of practice and experimental stimuli). The experiment commenced after ten practice trials appropriate for the block. The order of presentation was counterbalanced.

7.8.3 Results and Discussion: Experiment 5

(see Appendix 5 for details of RTs for subjects)

Table 7.8.1 Experiment 5: Mean RTs (in ms) and their corresponding standard deviations (SD) for high- and low-frequency Turkish words and nonword fillers, along with the Error % for subjects

Type of stimuli	Mean	SD	Error %
High-frequency words + Speed-matched nonword fillers (fast)	688 673	67 85	1.3 3.1
Low-frequency words + Speed-matched nonword fillers (slow)	726 718	81 82	3.2 3
Difference	38		

As can be seen in Table 7.6.1, a 38ms difference between high- and low-frequency words was observed. Formal analyses showed a main effect for frequency for both the subjects $F1\ (1, 14) = 7.43$, $p < 0.02$, $MSE = 1501.04$ and for items $F2\ (1, 38) = 5.98$, $p < 0.02$, $MSE = 2867.81$. As previously argued the prevalence of word frequency effect in the presence of speed-matched nonword fillers can be taken to indicate that it may not be the mere presence of nonwords but the speed with which they are named which has an impact on target word naming. Moreover, a repeated measures t-test conducted for items (high- and low-frequency words) in Experiment 3, and the same words in Experiment 5, showed that high-frequency words, $t\ (19) = 3.874$, $p < 0.001$, were named significantly faster in the presence of speed-matched nonword fillers as opposed to the presence of matched nonword fillers. For low-frequency words, however, this did not have an impact, t (19) = 0.457, p = 0.653. This finding is in line with Lupker et al.'s (1997) claims. Thus, one can argue that the presence of a frequency effect is evidence that the lexical route is operating in parallel to the nonlexical route (since participants are also able to articulate nonwords) but that due to the relatively fast GPCs operations for these three-letter nonwords there is no taxing on the operations of the lexical route. One needs to bear in mind that these operations could be optimal as stimuli are presented in mixed-blocks matched in speed. It is therefore of interest to ensure that this finding is not an artefact of experimental manipulation by presenting the same stimuli in a mixed design (similar to Experiment 2) in the follow-up experiment.

7.9 Experiment 6: High- and Low-frequency Words Mixed with Speed-Matched Nonwords

7.9.1 Aim

The aim of Experiment 6 was to tackle the methodological issue of mixed-block vs. mixed, thus to further investigate the impact of blocking to ensure that the result of Experiment 5 was not an artefact of experimental design.

7.9.2 Method

The experimental design was similar to Experiment 2, whereby participants were required to name all experimental stimuli from Experiment 5 mixed together, i.e. high- and low-frequency target words randomly mixed with speed-matched nonword fillers.

Participants

Fifteen adult, native readers of Turkish who were undergraduates at the Eastern Mediterranean University. Each participant received course accreditation for participating in the experiment.

Materials/Apparatus/Procedure

The materials, apparatus and procedure were the same as in Experiment 5 (see Appendix 3 for a full set of practice and experimental stimuli). The experiment commenced after ten practice trials.

7.9.3 Results and Discussion: Experiment 6

(see Appendix 5 for details of RTs for subjects)

Table 7.9.1 Experiment 6: Mean RTs (in ms) and their corresponding standard deviations (SD) for high- and low-frequency Turkish words and nonword fillers, along with the Error % for subjects

Type of stimuli	Mean	SD	Error %
High-frequency words	693	78	1
Low-frequency words	719	64	2.1
Difference	26		
Nonword fillers	702	58	1.9

As can be seen in Table 7.7.1, a difference of 26ms between high- and low-frequency word RTs is observed in this experiment. This was significant in both the analysis for subjects $F1\ (1, 14) = 9.50$, $p < 0.01$, $MSE = 572.17$ and for items $F2\ (1, 38) = 4.41$, $p < 0.04$, $MSE = 1650.45$. A significant but nevertheless reduced effect is reported here. It can thus be argued that because the speed of the operations of the GPCs output (employed to name speed-matched nonword fillers) is rather fast the effect this has on the speed of the output of the lexical route is minimal hence maintaining the frequency effect. The assumption here is that the two routes race to a finish in parallel each time the reader encounters a letter string such that the positioning of the time criterion influences the lexical output which in turn is influenced by the speed of the GPCs of the nonlexical route.

Moreover, a two (blocking, mixed vs. mixed-block) by two (frequency, high vs. low) ANOVA was also conducted for subjects between Experiment 5 and 6. The results showed a trend for a main effect for frequency, $F(1, 56) = 3.452$, $p = 0.06$, $MSE = 6623.5$, but not for blocking, $F(1, 56) = 0.129$, $p = 0.721$, $MSE = 6623.5$. The reason for a marginal effect for frequency could be attributed to the fact that different subjects took part in the two experiments. Therefore it can be concluded that first, this effect is not an artefact of experimental manipulation, i.e. mixed vs. pure-blocking, and second it is not the de-emphasis of the lexical route that accounts for the difference in RTs but the time criterion position. Therefore, the issue of speed vs. word-nonword aspect of filler stimuli needs to be further investigated in the light of the pattern of findings by examining how slow word stimuli, i.e. longer words, influence the RTs of high- and low-frequency words. A null effect will be taken as evidence to support the above assumption in that the speed of the GPCs has a direct effect on the time criterion factor regardless of type of stimuli. If, however, a frequency effect prevails in the presence of longer words then it will be concluded that the speed of the GPCs has no effect on the operations of the lexical route. This is the aim of Experiment 7.

7.10 Experiment 7: High- and Low-frequency Words Mixed with Longer Letter Word Fillers

7.10.1 Aim

The aim of Experiment 7 was to examine the impact of longer letter word fillers matched on initial letter on target word naming when they are all mixed. Prior to the main experiment, RTs to nine short (four letters), e.g. TUNÇ meaning (bronze), and nine long (seven letters), e.g. CANAVAR meaning (monster), low-frequency words from Experiment 1 were re-examined to ensure that increasing letter length increases RTs in naming Turkish words. Four-letter words (751ms) were named significantly faster than seven-letter words (901ms), $F2\ (1, 17) = 14.55$, $p < 0.002$, $MSE = 7069$, thus validating that the increased number of letters in words resulted in a significant increase in RTs, which is also in line with findings from English, reported earlier

7.10.2 Method

Participants

Fifteen adult, native readers of Turkish who were undergraduates at the Eastern Mediterranean University. Each participant received course accreditation for participating in the experiment.

Materials/Apparatus/Procedure

The target word stimuli were the same as in Experiment 6, i.e. 20 high-frequency (e.g. ANNE) and 20 low-frequency (e.g. AVUÇ) words which were presented mixed with 40 longer letter filler words (e.g. AÇIKLAMA meaning explanation and AĞLAMAK meaning to cry) of average frequency (see Appendix 3 for a full set of practice and experimental stimuli). The apparatus and the procedure were the same as in the previous experiment. The experiment commenced after ten practice trials.

7.10.3 Results and Discussion: Experiment 7

(see Appendix 5 for details of RTs for subjects)

Table 7.10.1 Experiment 7: Mean RTs (in ms) and their corresponding standard deviations (SD) for high- and low-frequency Turkish words and longer letter filler words, along with the Error % for subjects

Type of stimuli	Mean	SD	Error %
High-frequency words	728	52	1
Low-frequency words	745	55	1.6
Difference	17		
Longer-letter word fillers	814	71	1.2

As can be seen in Table 7.8.1, a difference of 17ms between RTs to high- and low-frequency words was found. Formal analyses showed a null effect for frequency in the analysis for subjects $F1\ (1, 14) = 4.01$, $p = 0.07$, $MSE = 541$; and for items $F2\ (1, 38) = 0.30$, $p = 0.59$, $MSE = 8738.16$. This finding was argued to be due to the impact of the longer naming words on the time criterion whereby RTs to fast stimuli, i.e. high-frequency words, are generally slowed down, thus reducing the difference between RTs to high- and low-frequency words. Moreover, as increased letter length is assumed to have a direct impact on the operations of the nonlexical route (i.e. longer RTs) it is then plausible to explain the finding from Experiment 7 as follows: Since all the experimental stimuli are words there is no reason to expect the involvement of the nonlexical route. However, the increased RTs to the longer letter word fillers suggest otherwise. Therefore, the explanation offered here is that both the lexical and the nonlexical routes must operate in parallel yet in an interactive manner as recently proposed by Coltheart et al. (1993).

7.11 Discussion of Results: Experiments 3 to 7

The results of Experiments 3 to 7 collectively lead to the conclusion that single-word naming in Turkish is influenced by a time criterion factor not the shut off or de-emphasis of the lexical route in response to filler stimuli. The inclusion of nonwords does affect the position of this criterion whereby the processing speed of nonwords is also an important factor. That is, when nonwords are fast, i.e. speed-matched with words, there is indeed no influence on the frequency effect but when they are slow, e.g. matched on initial phoneme, number of letters and number of syllables, it does affect word frequency. When words are read in the presence of slow, longer words this also has an impact on frequency similar to slow nonwords. Based on this evidence, it is concluded that both the lexical and the nonlexical routes must operate in parallel as both word and nonword stimuli are named successfully. Lack of evidence for strategic control further suggests that the two routes do not operate in an independent manner rather their operations are interactive Thus, it appears that neither the lexical nor the nonlexical route is under the strategic control of Turkish readers and that data is best explained by a time criterion position. This is contrary to a recent report by Rastle and Coltheart (1999) who acknowledged that data from English is at a tangle whereby both the strategic control and Lupker et al.'s (1997) time criterion can equally account for the pattern of results. Rastle and Coltheart (1997) based their observation on evidence that first-position irregular words are named slower than third-position irregular words. The authors' conclusion summarises the current state of affairs as "According to Lupker et al. (1997), because first-position irregular words are named so slowly, they drag down the naming latencies of both the regular-word targets and the nonword targets. Of course, this is the same prediction given by the dual-route account and is what we reported. Thus, it is difficult using these data to disentangle the two theories" (p494). Therefore, whilst it remains to be seen which account will eventually help untangle evidence from English, findings from Experiments 3 to 7 of the present thesis, however, show a clear indication that the time criterion position rather than the strategic control over the use of the routes accounts for single-word naming in Turkish.

This also makes sense on logical grounds in that the highly transparent nature of Turkish orthography may indeed encourage the use of both the lexical and nonlexical route, since they are both highly efficient in deriving the correct phonology from print. Thus during the course of their development, contrary to English and other scripts where linguistic dichotomies exist, there is no need to strategically shut off or de-emphasise the nonlexical route. This could subsequently lead to a more interactive operation between the routes rather than two functionally independent procedures which can be strategically shut off or de-emphasised depending on task demands, as reported for English (Monsell et al., 1992) or Persian (Baluch & Besner, 1991).

8 Chapter 8: Semantic Effects in Single-Word Naming in Turkish

8.3 Preface

According to the dual-route model generation of phonology can take place via two qualitatively distinct routes: namely the lexical and the nonlexical route (e.g. Baluch & Besner 1991; Coltheart et al., 1993; Coltheart & Rastle, 1994). What characterises these two routes is that while the nonlexical phonology can be generated via GPCs prelexically, as discussed earlier, assumptions about generating phonology via the lexical route is twofold: One way to generate lexical phonology is assumed to be via the direct, orthography-to-phonology route where words' orthographic and phonological representations are activated. A second way of generating lexical phonology is assumed to be via the orthography-to-semantics route (semantic route) where words' meaning are activated for the purpose of generating phonology which is postlexical in nature (see Figure 1). Some dual-route theorists have argued that the dual-route model is in effect a three-route model, whilst, it is generally assumed that the impact of the semantic route on single-word naming in skilled readers is minimal (e.g. Besner, 1999; Besner & Smith, 1992). This is because the general consensus, within the dual-route framework in terms of speed, is that attaining phonology from print via the semantic route is the slowest of the two routes. It is further assumed that the involvement of the semantic route is only maximised when words' semantic characteristics such as imageability is manipulated. However, it must be highlighted that systematic investigation of effects of imageability in single-word naming is not a widely explored issue in English and to-date with one exception, namely Persian (Baluch & Besner, 1999), it has not been the subject of direct investigation in other writing systems. Nevertheless, the aim of this Chapter is to provide an overview of how imageability came to play an important role in providing evidence for the psychological reality of the indirect route from orthography-to-semantics. Moreover, the issue of whether the involvement of the semantic route is universal or script-specific will be reviewed in light of evidence from English and from Persian with a view of exploring these effects in transparent Turkish.

8.4 Imageability in Single-Word Naming

Controversies, however, exist regarding the extent of the contribution that a semantic route may make to the production of a word's pronunciation. Some researchers have taken the strong stand that as far as skilled reading is concerned access to a word's semantic information is essentially "phonologically mediated", thus by definition semantic information can never play any role in deriving "prelexical phonology" (Van Orden, Pennington & Stone, 1990; see also Frost, 1998 for an extensive debate on the role of phonology in visual word recognition).

Others have argued that the role of a semantic route in deriving phonology is evident only in conditions when phonological processing is slow and error prone (Strain et al., 1995). Using word imageability as a semantic variable, Strain et al. (1995) reported significant imageability effects for low-frequency exception English words (i.e. the words that usually produce the longest RTs in oral naming). High-imageability low-frequency exception words (e.g. SOOT) were named significantly faster than matched low-imageability low-frequency exception words (e.g. SCARCE). Strain et al. (1995) concluded that readers of English benefit from consulting the semantic properties such that "If a word's semantic characteristics can have any influence on the process of naming it, this influence might be observed chiefly on words in which orth-to-phon translation is somewhat inefficient, slow, or error prone" (p1141). The latter interpretation could suggest the existence of an orthography-to-semantics route in naming and also be interpreted within the connectionist accounts of reading (e.g. Plaut et al., 1996). Indeed, the view that semantic information may contribute to naming is very much in agreement with the connectionist modelling of reading. According to the most recent versions of the model (Plaut et al., 1996) and the logic of "division of labour", in the course of training and with increased specialisation the model gradually builds up a putative semantic pathway. This pathway would relieve the "normally" utilised orthography-to-phonology pathway to be more specialised for regular words (or high-frequency exception words) and the semantic pathway to be specialised for low-frequency exception words. Thus both the localised multi-route model and the connectionist modelling of reading are in agreement that semantic information may be involved in reading English when translation from orthography to phonology is slow or noisy.

8.5 Baluch and Besner's (1999) study on Persian

In a very recent study Baluch and Besner (1999) examined whether imageability effects could also be found for opaque and transparent Persian words. As mentioned previously, the salient aspect of written Persian is the co-existence of both transparent and opaque words in adult scripts. In this respect, this within-script manipulation of transparency and imageability provides a unique environment for examining imageability effects in relation to orthographic transparency. Using Persian transparent and opaque words the following predictions were made by Baluch and Besner (1999): based on evidence reported by Strain et al. (1995) imageability effects may be limited only to words when translating orthography-to-phonology is slow and error prone (i.e. low-frequency irregular English words). Opaque Persian words fit into this category. As noted by Baluch

(1988) opaque Persian words (both high- and low-frequency) were named significantly slower (and with greater error) relative to high- and low-frequency transparent Persian words. Thus, it follows that because the translation of orthography-to-phonology is slow and error prone for a consonantal string irrespective of frequency, both high- and low-frequency opaque words would benefit from the interaction of semantic representations in accessing phonology. Such a finding may suggest that the factor contributing to the effect of semantic variables in naming is indeed the degree and ease of orthography-to-phonology translation. In a single-word naming task Baluch and Besner (1999) presented 20 subjects with 80 transparent (40 high- and 40 low-frequency) and 80 opaque words (40 high- and 40 low-frequency). High- and low-frequency words were then split into 20 high- and 20 low-imageability words. Thus in the transparent and opaque categories there were 20 high-frequency, high-imageability words, 20 high-frequency, low-imageability words, 20 low-frequency, high-imageability words and 20 low-frequency, low-imageability words.

Baluch and Besner (1999) reported that high-frequency words, in both opaque and transparent scripts were generally named faster than low-frequency words, with the effect more noticeable for opaque than transparent words. However, more importantly was the greater imageability effects found for opaque words compared to transparent words. There was a +30ms advantage for the imageability factor for high-frequency opaque words and a +49ms advantage for low-frequency opaque words, whilst these effects were minimal for transparent words. A significant main effect was reported for script (i.e. transparent and. opaque); for frequency (i.e. high and low), and for imageability (high and low). Moreover, a significant interaction between script and frequency was also found, indicating the greater frequency effects found for opaque relative to transparent words. There was also a significant script by imageability interaction, indicating the greater imageability effects for opaque than transparent words. Indeed the imageability effect was evident for both high- and low-frequency opaque words.

In summary, Baluch and Besner's (1999) results showed an interesting pattern of findings: whilst there was a significant imageability effect on naming opaque words, such effects on naming transparent words were minimal. Baluch and Besner (1999) concluded that the findings could be accommodated by both localised dual-route models of naming incorporating the indirect, orthography-to-semantics route (Besner, 1999) and connectionist models (Seidenberg & McClelland, 1989; Plaut et al., 1996). Both make strong predictions regarding the involvement of an orthographic-to-semantic processing in generation of the phonological code, especially when translations of orthography-to-phonology are slow and error prone. For transparent words, such processing is not necessary as the connections between orthography-to-phonology and/or nonlexical are fast and reliable. For opaque words assembling prelexical phonology from a string of consonants seems an impossible task. Moreover, the direct, orthography-to-phonology route may produce greater lexical noise. Thus the most logical possibility is to attain phonology from semantics for opaque Persian words.

8.6 Semantic Effects: Universal or Script Specific?

One possible explanation for the above findings on English and Persian is that perhaps the involvement of an orthography-to-semantic route could be evident only for low-frequency irregular English and high- and low-frequency opaque Persian words. Because translations of orthography-to-phonology are argued to be slow and error prone for such words they may benefit from a semantic factor, namely imageability, when they are presented for naming. The question, however is whether on the basis of these observations one would ever expect to find effects of semantics on naming the transparent

Turkish orthography. One prediction is that arguably transparent Turkish words, high- or low-frequency could be named similar to regular English words and transparent Persian words, hence no effects for imageability. There is, however, another reason to suspect possible involvement of imageability even for naming transparent Turkish; this is by taking participants level of skill into account. Neither Strain et al. (1995) nor Baluch and Besner (1999), however, examined their data in relation to participants' level of skill. The reason for this interest in level of skill is two-fold: First, if imageability has its greatest impact on single-word naming when processing is slow and error prone, this might also be demonstrated when less skilled or poor readers are asked to name high- and low-frequency words manipulated factorially with imageability. Second, based on a connectionist model of single-word naming (Plaut et al.,1996) both the orthography-to-phonology and the orthography-to-semantic pathways become strengthened with growing reading skill. Plaut et al. (1996) speculate that, "Presumably, the mapping between semantics and phonology develops, in large part, prior to reading acquisition, as part of speech comprehension and production. By contrast, the orthography-to-semantics mapping, like orthography-to-phonology mapping, obviously can develop only while learning to read. In fact, it is likely that the semantic pathway makes a substantial contribution to oral reading only once the phonological pathway has developed to some degree ... We will assume that the strength of the semantic contribution to phonology in reading increase gradually over time.." (p95). Thus presumably very skilled readers should show a greater degree of semantic effects in naming than less skilled readers. These two positions need not be mutually exclusive. In other words whilst there is expectation that either imageability effects are evident for very skilled or for poor readers, it could affect readers on both ends of the skill continuum.

8.7 Experiments 8 and 9: Imageability as a Function of Level of Skill

8.7.1 Aims

The aims of the two experiments reported here were to examine the effects of imageability on naming of very skilled as compared to skilled adult Turkish readers (Experiment 8) and on previously skilled (poor) readers (Experiment 9).

8.7.2 Method

Participants in Experiment 8

Participants were all adult native speakers of Turkish (n = 44) who were either first year undergraduate or foundation level students at the Eastern Mediterranean University, Northern Cyprus, who received course accreditation for their participation. This group were further divided according to level of skill as explained below into two groups of very skilled (n =16) and skilled (n =28) readers. The method used to determine level of skill was based on the distribution of RTs and error rates for a pool of 100 words (see Appendix 4 for a full set of experimental stimuli). It has been argued previously (e.g. Posner, 1970; and Fitts & Posner, 1976) that using RTs in conjunction with error rates is an appropriate determinant of language skill. Thus, prior to the main experiment, 78 students were asked to name as rapidly as possible 100 words of mixed frequency (not used in the main experiment) presented on the computer screen. The overall RTs mean for 78 students was 851ms, (SD = 277). Participants' RTs were standardised and consequently used to identify two levels of skill, i.e. very skilled and skilled. Participants whose RTs fell beyond 1.3 standard deviation higher than the mean, i.e. slow, were classified as skilled (n = 28).

Participants whose RTs were 0.9 standard deviation below the mean were classified as very skilled readers (n = 16).

Participants in Experiment 9

Twenty four adult male and female native Turkish speakers who have lived in the UK for approximately ten years and who claim to have little daily activity in reading Turkish materials although Turkish is maintained as the main spoken language.

Materials

Imageability ratings for 300 words (from a list of 433, see Appendix 6 for a full set of list) were obtained from 60 highly literate native Turkish speakers on a 7-point scale ranging from 1 = "high-imageability" to 7 = "low-imageability", as there are no readily available imageability ratings in Turkish. Words were then rated as either high- or low- on imageability according to their mean rating scores. A mean score of 2 was the maximum acceptable for high-imageability, and a mean score of 6 was the minimum acceptable for low-imageability for words. Experimental stimuli consisted of four categories with 20 words each: 20 high-imageability high-frequency, e.g. İNSAN meaning (human); 20 high-imageability low-frequency e.g. İNCİR meaning (fig); 20 low-imageability high-frequency, e.g. İZLEM meaning (observation) and 20 low-imageability low-frequency, e.g. İBLİS meaning (devil) (see Appendix 4 for a full set of experimental stimuli).

As in previous experiments, data were omitted from analysis if the participants' mean response time exceeded 1000ms for the onset of high-frequency word articulation for skilled readers in Experiment 8, whereas this was raised to 1500ms in case of previously skilled readers in Experiment 9. An error rate of maximum 10% was maintained as a second criterion for data omission, otherwise error responses were replaced by the mean for that item.

Apparatus/Procedure

The 80 experimental trials were presented randomly in one mixed-block. The apparatus and the procedure were the same as in previous experiments. The experiments commenced after 20 practice trials (see Appendix 4 for a full set of practice and experimental stimuli).

8.7.3 Results of Experiment 8

(see Appendix 5 for details of RTs for subjects)

Table 8.7.1 Experiment 8: Mean RTs (in ms) with their corresponding standard deviations (SD) for high- and low-frequency and high- and low-imageability words, along with the Error % for subjects

Very Skilled readers			Skilled readers		
	Imageability			Imageability	
	High	**Low**		**High**	**Low**
Frequency			Frequency		
High			**High**		
Mean	626	633	Mean	810	814
SD	90	92	SD	138	149
Error %	1.6	1.7	Error %	3	3.1
Low			**Low**		
Mean	675	705	Mean	901	891
SD	104	94	SD	164	161
Error %	2.9	3	Error %	3.4	5.1

As can be seen in Table 8.5.1, very skilled readers are faster in naming all four types of words in the task than skilled readers.

As in previous experiments, ANOVAs were performed on RTs using both Subjects (F1) and Item (F2) means. The two variables included in the initial ANOVA conducted on RTs were frequency (high vs. low) and imageability (high vs. low). These variables were treated as repeated measures (within-subjects) in the analysis by Subjects and independent groups (between-subjects) in the analysis by Items. Overall, participants were significantly faster in naming high-frequency words (745ms) than low-frequency (821ms) ones; a significant main effect for frequency F1 (1, 43) = 70.05, $p < 0.001$, MSE = 3579.59; but not in naming words high (781ms) vs. low (785ms) imageability; F1 (1, 43) = 0.66, p = 0.42, MSE = 1210.63. There was also no significant interaction between frequency and imageability F1 (1, 43) = 0.02, p = 0.89, MSE = 908.62. Item analysis also showed a significant effect for frequency F2 (1, 76) = 46.976, $p < 0.001$, MSE = 2255.60 but not for imageability F2 (1, 76) = 0.07, p = 0.79, MSE = 2255.60. There was also no significant interaction between frequency and imageability F2 (1, 76) = 0.03, p = 0.88, MSE = 2255.60.

However, analyses of RTs yielded different results when level of skill was taken into consideration. Formal analyses of skill (very skilled vs. skilled) by frequency (high vs. low) and imageability (high vs. low) for subjects showed a significant main effect for level of skill F1 (1,42) = 22.66, $p < 0.001$, MSE = 67849.53; and for frequency F1 (1,42) = 60.28, $p < 0.001$, MSE = 3534.39; but non-significant effect for imageability F1 (1, 42) = 1.90, p = 0.18, MSE = 1122.83. A 2-way, skill by frequency interaction F1 (1, 42) = 1.55, p = 0.22, MSE = 3534.39 and a frequency by imageability interaction were also non-significant F1 (1, 42) = 0.19, p = 0.66, MSE = 840.73; whilst a 2-way skill by imageability interaction was significant F1 (1, 42) = 4.36, $p < 0.04$, MSE = 1122.83 as well as a 3-way interaction for skill by frequency by imageability F1 $(1, 42) = 4.47$, $p < 0.04$, MSE = 840.73. Post-hoc analyses conducted on the data showed that the latter interaction is a result of faster naming of low-frequency high-imageability words by very skilled readers than low-frequency low-imageability words t $(15) = 3.05$, $p < 0.008$. A 3-way factorial ANOVA was conducted in the analyses for items which showed a significant main effect for frequency F2 $(1, 76) = 53.32$, $p < 0.001$, MSE = 3834.41 and level of skill F2 $(1, 76) = 366.51$, $p < 0.001$, MSE = 3834.41; whilst there was no main effect for imageability F2 $(1, 76) = 0.117$, $p = 0.73$, MSE = 3834.41. Both the 2-way and 3-way interactions were also non-significant in the item analysis.

8.7.4 Results of Experiment 9

(see Appendix 5 for details of RTs for subjects)

Table 8.7.2 Experiment 9: Mean RTs (in ms) and their corresponding standard deviations (SD) for high- and low-frequency and high- and low-imageability words, along with the Error % for subjects

Type of stimuli	Mean	SD	Error %
High-frequency High-imageability words	911	153	3.4
High-frequency Low-imageability words	923	160	4.2
Low-frequency High-imageability words	1011	175	7.1
Low-frequency Low-imageability words	1019	184	5

As can be seen in Table 8.5.2, participants were significantly faster in naming high-frequency words than low-frequency words. Formal repeated measures ANOVA for subjects was significant for frequency (high- and low), $F1\ (1, 23) = 63.163$, $p < 0.001$, $MSE = 3633.875$ but not for imageability (high- and low) $F1\ (1, 23) = 1.757$, $p = 0.198$, $MSE = 1355.542$. There was also no significant interaction, $F\ (1, 23) = 0.138$, $p = 0.714$, $MSE = 638.415$. For items a significant frequency effects was observed, $F2\ (1, 76) = 21.757$, $p < 0.001$, $MSE = 7602.851$ whilst imageability was nonsignificant, $F2\ (1, 76) = 0.474$, $p = 0.5$, $MSE = 7602.851$ and also there was no interaction $F2\ (1, 76) = 0.139$, $p = 0.711$, $MSE = 7602.851$. Single-word naming in previously skilled readers of Turkish is clearly influenced by frequency but not by imageability of words.

A Methodological Issue

It is important to note here that a combined statistical analysis was not conducted for Experiments 8 and 9 on methodological grounds. This is because the two samples of participants, skilled vs. previously skilled, came from two different populations. Whilst the selection of skilled participants for Experiment 8 was from a population of undergraduates in Cyprus who were later differentiated to two subgroups, i.e. very skilled and skilled, according to their performance prior to the main experiment, the previously skilled readers were selected from a sample of native Turkish speakers who resided in the UK approximately for ten years and had little daily contact with the script. The main distinction is thus whilst the former group, regardless of degree of performance, is in regular contact with the Turkish orthography the latter is not.

8.8 Discussion of Results: Experiments 8 and 9

The results of Experiments 8 and 9 showed an interesting pattern of findings: in Experiment 9 only frequency was found to be significant, although a similar pattern was also found in Experiment 8, i.e. there was only a significant main effect for frequency; there was, however, a significant 2-way interaction of skill by imageability and a 3-way interaction of skill by frequency by imageability. Further analysis showed that this was due to i) very skilled readers showing more imageability effects than skilled readers and ii) the effect of imageability being significant for low-frequency words. High-imageability low-frequency words were named 30ms faster by very skilled readers than matched low-frequency low-imageability words. A straightforward implication of the findings is that imageability effects are "universal" in terms of being reported on naming a truly transparent writing system. Moreover, like English (Strain et al., 1995), these effects are limited to low-frequency words. However, these results differ from Strain et al.'s data in two ways: Firstly, imageability effects were only observed when testing carefully selected very skilled Turkish readers. If very skilled or skilled readers were not differentiated one might have found no effects of imageability. Secondly, the effects of imageability were found for low-frequency Turkish words, which is a transparent orthography, whilst Strain et al. (1995) found effects of imageability for low-frequency irregular words not for low-frequency regular words. Some of the controversy may be resolved if semantic effects are also reported for very skilled readers responding to low-frequency transparent Persian words or low-frequency regular English words. In the absence of such data at present one could entertain at least two accounts for the pattern of results reported here: according to one account imageability interacts with both opaqueness/irregularity of the stimuli as well as level of skill of the participants. When average university students are tested such imageability effects are observed for very slow processing words (low-frequency irregular or opaque words). When a cohort of very skilled readers are tested there is greater impact of imageability extending to regular or transparent words. Another possible account for why Turkish low-frequency words show an effect of imageability, yet there is no evidence that it affects low-frequency regular English words, could be the manner in which reading skill develops in a particular orthography. For all scripts both routes (namely, orthography-to-phonology and orthography-to-semantics) may develop in parallel with the degree of involvement and specialisation of a particular route depending on the peculiarities of the writing system. For readers of English or Persian, the "division of labour" may take place according to the regularity of the stimuli being read. Thus the orthography-to-semantics route may become more specialised for irregular words or opaque words and orthography-to-phonology route used more frequently for regular/transparent words. For readers of a transparent writing system like Turkish, however, both routes may develop but the orthography-to-phonology route tends to dominate at all times as this is an efficient route to name all types of words. An orthography-to-semantics route could be involved as a backup when naming is generally slow via the orthography-to-phonology route, e.g. low-frequency words. In this respect skilled readers may benefit more as this "back-up" process is more elaborate and functions more efficiently for such readers.

It is also noteworthy that the categorisation of participants into very skilled and skilled readers was not based on conventional reading and spelling tests, rather the selection was based on RTs (and error data) in naming a cohort of words in the Turkish language. Thus whilst participants in experimental studies such as the one reported here may be classed as "skilled adult readers", a finer classification into very skilled and skilled based on their RTs and naming accuracy may provide a different pattern of results.

Moreover, an earlier finding by Baluch (1996) on previously skilled readers of Persian reported a nonsignificant frequency effect which is contradictory to the evidence reported here for previously skilled Turkish readers. Two reasons are offered for such a discrepancy: One is the manner in which previously skilled readers are selected in the two studies. Second, the differences in the two orthographies, that is Persian and Turkish, could manifest themselves in the degree of “graphic surprise” this group of previously skilled participants may face. For Turkish readers who live in the UK and are exposed to the English orthography the surprise may be minimal since both scripts have shared letters and sounds, and words that resemble each other, e.g. İNSAN (human) in Turkish and INSANE in English. For Persian readers, however, the direction of reading and differences in the two scripts may create a total graphic surprise under experimental tasks, particularly more so if readers have no regular contact with the script.

9 Chapter 9: General Discussion

The present thesis aimed to examine the following issues in relation to single-word naming in Turkish:

- First, the debate between the orthographic depth and universal hypotheses.
- Secondly, a critical evaluation of evidence reported in relation to Baluch and Besner's (1991) claim of strategic control of processing routes, and the re-examination of their claim in relation to reading Turkish.
- Finally, an examination into the possible involvement of an orthographic-to-semantic route in single-word naming in Turkish.

9.3 The Search For Universality in Single-Word Naming: Experiments 1 and 2

The present series of experiments began with the initial inquiry of whether naming of transparent Turkish is primarily achieved via the lexical route, or the nonlexical route for naming is preferred in view of the reliable and invariant letter-sound correspondences that exist in this alphabetic writing system. The main aim was to search for the universality of reading processes in view of the literature discussed in depth in Chapters 3 and 4. The agreed assumption is that if the lexical route is used for naming, the process should be sensitive to "lexical" factors such as word frequency. However, if the nonlexical route is used its operation should not be influenced by any lexical factors. The universal position, as outlined by both the dual-route and single-route advocates, maintains that in all writing systems the lexical route dominates. This is assumed to be irrespective of the differences in the manner in which a particular orthography encodes the phonology of the spoken language (cf., Baluch & Besner, 1991; Seidenberg, 1985a). Experiment 1, which was aimed at examining the latter position, found a strong and significant word frequency effect, thus suggesting that the lexical route must have been used for naming Turkish. A wider implication of the finding, as argued by Raman, Baluch and Sneddon (1996; see Appendix 7 for the published article based on data from Experiments 1 and 2), is that "If readers of a shallow orthography such as Turkish make prime use of the lexical route, the same should be true for readers of other shallow orthographies and, of course, for readers of deep orthographies" (p224). To this end, both the dual-route and single-route models are in some kind of agreement. What, however, is a major source of controversy between dual-route and single-route advocates, is whether the nonlexical route is (ever) involved in naming (single-route models) and whether its involvement may depend on task demands (dual-route models). The widely cited work of Baluch and Besner (1991) has been taken as evidence that whilst the lexical route is expected to dominate in reading in all writing systems there is also a tendency for readers (of all writing systems) to strategically switch to the nonlexical route in response to the presence of "filler" nonwords. Baluch and Besner's (1991) claim, based on Persian, was also tested on transparent scripts such as Italian (Tabossi & Laghi, 1992) and Spanish (Sebastián-Gallés, 1991). Moreover, the dual-route supporters, e.g. Baluch and Besner (1991), rejoicing from the effects of nonword fillers on naming target words concluded that a single routine PDP model cannot account for the presence and absence of word frequency (and semantic priming) with the same items and that two or more qualitatively different routes underline the oral reading of words. The general paradigm adopted in all the aforementioned studies (i.e. Persian, Italian and Spanish) is to create a set of pronounceable nonwords by matching them with words on initial letter, number of letters and syllables and perhaps on their word "likeness". Adopting exactly the same paradigm as in parallel studies on Persian, Italian and Spanish in Experiment 2, the significant word frequency effect observed in Experiment 1, was no longer significant in the presence of nonword fillers. The argument put forward was that because there is no evidence of word frequency effect, a nonlexical route must have been in operation for naming the target words. It may thus follow that as suggested by Raman et al. (1996) "… reading is a very flexible process. When subjects in an experiment are encouraged to use the nonlexical strategy they do indeed make use of this strategy" (p226). Whilst the result of Experiment 1 seems promising news as to the role and degree of involvement of the lexical route in reading different writing systems, there are, however, a number of reasons to doubt the credibility of an account which maintains a strategic switch to a nonlexical strategy in response to the nonword fillers (i.e. Experiment 2). Acknowledging that Turkish readers had used an entirely nonlexical strategy for naming in Experiment 2 (hence no word frequency) is equivalent to arguing that either the lexical route was never involved (perhaps completely shut off) or that if it was involved it was heavily overshadowed by the faster nonlexical route! Both the issues of shutting-off the lexical route or a lexical route that loses its race to a nonlexical route, insofar as skilled readers are concerned, are at odds with the general consensus from the literature (see e.g. Paap & Noel, 1991; Paap et al., 1992). Indeed, even if it is true that a nonlexical route is under strategic control (e.g. not used in Experiment 1 of the present thesis when all stimuli are words) there is little evidence that its rival, the lexical route, could also conveniently (and completely) be turned off. Paap et al. (1992) thus suggested that "The routine for addressing phonology was assumed to be more automatic, while the routine for assembling phonology was assumed to be more controlled. The two routes were also assumed to differ on the intentional-obligatory dimension with assembled phonology more easily influenced by strategic factors" (p310). Perhaps one line of defence is that this latter argument, i.e. the obligatory aspect of a lexical route in naming, applies to English, because in principle a lexical route cannot be completely turned off. In transparent writing systems, and in particular Turkish, as analogised with the alien dilemma (as explained in Chapter 4) a nonlexical strategy of naming could happily plod along and take over the lexical route with no lexical support. Even with these lines of defence to justify the results of Experiment 2, there is yet another problem raised by the notion of a complete switch-off of the lexical route. This is because, assuming that a lexical route is turned-off and a nonlexical route is completely in operation in naming Turkish, why is it that there is a significant word/nonword effect (difference of 14 ms)? Indeed Baluch and Besner's (1991) experiment 3b also showed a 21ms difference between transparent Persian words and nonwords used for naming, whilst in the same experiment the word frequency effect was not significant. Therefore the very fact that a word frequency effect was not found in Experiment 2 is not solid evidence that a lexical route is completely shut off in naming Turkish (or other scripts), even when nonword fillers are added to the list. It is, therefore possible that both lexical and nonlexical routes will be in operation in naming (Turkish or other scripts), regardless of the inclusion of the filler stimuli. Therefore one might need to explore an explanation that is different to a complete changing of route account in the presence of nonword fillers in single-word naming. A different approach to a changing route account of naming is one offered by Jared (1997) and Lupker et al. (1997), in their experimental work on English formulated in their time criteria hypothesis (as explained in Chapters 6 & 7). In essence, the latter researchers have argued that the disappearance of word frequency effect in the presence of nonword fillers could be explained by this simple statement "when fast things (words) are mixed with slow things (nonwords) the fast get slower and the slow get faster" (Lupker et al., 1997). Thus when words (fast things) are mixed with nonwords (slow things) words are named slower, compared to a situation when they are not mixed with nonwords. This re-adjusting of time criteria to accommodate all stimuli accounts for lack of frequency effects not changing routes. Thus whilst one may observe a "nonlexical effect" in the format of lack of word frequency in the presence of nonword fillers, the time criteria account does not account for a complete shut off of the lexical route. The advantage of this account, if found to be true for naming Turkish, is that it could also account for the presence of lexical factors (word vs. nonwords) and at the same time for the lack of frequency effect when filler items are included. Moreover, it tallies with the issue of "automaticity" and lexical dominance in reading different writing systems.

9.4 Changing Routes or Time Criteria?

The claim by researchers such as Baluch and Besner (1991), is that when readers are faced with naming nonwords embedded in a list of words they optimise their performance by relying on a nonlexical route - hence there is little or no word frequency (or semantic priming). One of the wider implications of such a claim is that perhaps the operations of the two routes are to a large extent independent of one another. This is because, according to the latter argument, it is possible for the reader to completely switch off the activation of one route (in this case the lexical route) and to attend entirely to nonlexical processing when deriving phonology from print. At odds with the independence of routes account is experimental data from Hebrew (Frost 1995) and the need for stress assignments for transparent Italian (e.g. Carello, Lukatela, & Turvey, 1994; Colombo & Tabossi, 1992) that suggests the impossibility of avoiding some "lexical shaping" in production of nonlexical phonology in different writing systems. But whilst the idea that lexical and nonlexical routes could operate independently could well be an illusion in almost all orthographies, the claim here is that Turkish is an exception to such impossibility. Midgley-West's (1980) hypothetical "alien" knowledgeable in letter sound correspondences in Turkish is perhaps able to derive nonlexical phonology with no need for lexical shaping. Thus if claims of changing routes and switching off the lexical involvement in naming, such as that of Baluch and Besner (1991), had ever a context to flourish this would have been a well-founded context in single-word naming of Turkish. With these thoughts in mind, and in view of the outcome of Experiment 2, the context was set to examine if indeed the absence of word frequency effect was truly a reflection of changing routes. In the interim, prior to a direct examination of these issues, there was a need to resolve some design aspect of Experiments 1 and 2 which, as will be argued in the follow-up section, may be crucial to any further research on the changing route dilemma.

9.4.1 The Impact of Mixed vs. Mixed-Block Design on Naming: Experiment 3

One of the design features adopted in Persian (Baluch & Besner, 1991) and in Experiment 2 of the present thesis was that in all of these studies researchers have used a design in which the high- and low-frequency words are mixed with nonwords (mixed design). Assuming that readers do indeed respond to "task demands" such as inclusion of nonword fillers, it may also be true that some simple aspects of design change e.g. "predictability" (Midgley-West, 1980); "list composition" and "list effect" (Jared, 1997) may also contribute in having an impact on readers performances. When high- and low-frequency transparent words and nonwords are all mixed and presented to subjects for naming, it may be argued that the balance of stimuli to be named is more shifted towards a tendency to use a nonlexical strategy. This is because not only are all the nonwords presumably named via a nonlexical strategy but also the low-frequency words may equally favour eliciting a greater use of the latter route. If so, the mixed nature of the experimental design may (also) contribute to (the magnitude of) some of the effects reported in single-word naming in the literature and in particular Experiment 2 of the present thesis. It has also been noted that Lupker et al.'s (1997) design, of naming high- and low-frequency regular words when mixed with nonword fillers was not one of a mixed design rather a mixed-block design. In Lupker et al.'s mixed-block, high- and low-frequency words were separated and each category was mixed with an equal number of nonword fillers. Thus in one block there was only high-frequency words and nonwords, which may be argued that there was a greater tendency to name words via the lexical route as 50% of stimuli to be named were high-frequency words. In the low-frequency words and nonwords block there may be equally a greater tendency to name all stimuli via the nonlexical strategy. This is because all stimuli were either low-frequency or nonwords. Would this change of balance affect the route used, and hence, the magnitude of frequency effects, as compared to a condition when all stimuli are mixed and hence there is a tendency to name 75% of the stimuli using the nonlexical route? If so the magnitude of word frequency should be greater in a mixed-block (as there is a greater tendency to use a lexical route for high-frequency block) as compared to a mixed condition. If, however, the presence of nonword stimuli, irrespective of the nature and composition of high- and low-frequency words and nonwords in the list of stimuli to be named, induces a nonlexical strategy the magnitude of word frequency should be the same (i.e. disappear) in a mixed-block as compared to a mixed condition. Such a finding would imply that at least a mixed vs. mixed-block design feature had no bearing on the pattern of the results found in Experiment 2. As the mixed-block design (and pure-block) was also used in the series of experiments by Lupker et al. any further testing of their claims would have required that evidence for the role of nonword fillers be examined with both a mixed and mixed-block design. Using a mixed-block design in Experiment 3, a nonsignificant difference of 9ms was found between high- and low-frequency words as compared to a 3ms difference in Experiment 2 when a mixed design was used. Notable is the null effect for frequency with both of the designs adopted, although the magnitude may seem slightly larger in the mixed-block, it still does not approach a level of significance. Hence, the idea that mixed vs. mixed-block might have contributed to some of the results was ruled out.

9.4.2 Naming Target Words with Nonword Fillers Matched in Speed: Experiments 5 and 6

Two key issues were addressed in Experiments 5 and 6 in an attempt to examine why frequency effects disappear in the presence of nonword fillers: i) the notion of emphasis or de-emphasis of a particular route due to the mere presence of nonword fillers ii) the notion of time criteria being imposed as a result of perceived difficulty of items in the reading list. As argued in Chapters 3 and 7, the time criteria and the changing routes accounts based on evidence from English is currently in a tangle. For example, Rastle and Coltheart (1999) reported a slowing down in naming target stimuli (regular words and nonwords) when first-position irregular fillers were present, compared with naming target stimuli when third-position irregular fillers were present. The position of the irregularity represents graded difficulty in using the nonlexical route. Rastle and Coltheart (1999) argued that the difficulty in using the nonlexical route has perhaps led to a slow down or a de-emphasis in using the nonlexical route, which is how one should explain the pattern of results found in their study.

According to Lupker et al.'s (1997) time criterion account however, because first-position irregular words are named so slowly, they drag down the naming latencies of both the regular-word targets and the nonword targets, i.e. it is the effect of mixing the slow and fast stimuli that leads to slower processing of the fast stimuli. As acknowledged by Rastle and Coltheart "it is difficult using these data to disentangle the two theories" (p494). Two points however, are important here: first, as Lupker et al.'s (1997) account did not specify whether the stimuli perceived as "difficult" were necessarily a word or a nonword, a time criteria account should hold for the presence of such fillers regardless of its word/nonword status. Evidence from English on the subject of the presence of “fillers” on naming target stimuli incorporates both nonwords (Monsell et al., 1992) and irregular words as fillers (Coltheart & Rastle, 1994; Rastle & Coltheart, 1999). All these studies, however, have shown that fillers do impose an effect on how target stimuli (words or nonwords) are named, but of course the data could be interpreted within both the time criteria account and the de-emphasis of routes position. Secondly, based on evidence from an “opaque” script such as English, one cannot effectively untangle the controversy of whether, in the presence of nonword fillers, it is the switching off (or de-emphasising) of a particular route that accounts for “null” word frequency effects or changes in the time criteria for articulation.

In Experiments 2 and 3 of the present thesis, and that of Baluch and Besner (1991), the claim is that null frequency effects are perhaps an indication that the lexical route is shut off (or de-emphasised) when nonword fillers are included in the naming list. Lupker et al.’s point, however, is different. They maintain that it is not shutting off a particular route that accounts for the reported data, rather the null effect could be interpreted within a time criterion account outlined above. The testing ground is thus straightforward either the mere presence of nonword fillers could account for null frequency effect or it is the perceived difficulty of nonword fillers. If the latter is true making nonwords to be named as fast as matched target words should not affect the “normally” adopted time criterion to initiate articulation, thus word frequency effects should prevail. If, however, the strategic account of shutting down the lexical route in the presence of nonword fillers holds, the speed with which nonwords are named should have no impact on the magnitude of word frequency effects i.e. the mere presence of nonword fillers in a list of stimuli to be named should encourage a complete nonlexical processing- hence no word frequency effects. Indeed due to the nature of Turkish such a shift in processing route should be an entirely effective way to name all stimuli (words and nonwords) with little or no need for “lexical shaping”. Experiment 4 aimed to create and validate speed-matched nonwords i.e. nonwords that are named as fast as high- and low-frequency words. The results of Experiments 5 and 6 using the target words and filler speed-matched nonwords compiled in Experiment 4, however, showed strong evidence that word frequency effects persist when fast naming nonword fillers are embedded in the naming list. Experiment 5, however, was a mixed-block design and found a significant frequency effect, i.e. a 38ms difference between high- and low-frequency words. In neither the high nor the low-frequency block were the nonwords named slower than their matched target words. The same predictions listed above were tested in the follow-up experiment when all the stimuli were mixed (similar to Experiments 2 and 3). Although a small reduction of 12ms in the magnitude of word frequency was observed, the robust effect for frequency nevertheless prevailed. This finding was further indication that perhaps the adoption of a mixed-block vs. a mixed condition was not having a significant differential effect on the pattern of results.

9.4.3 Naming Target Words with Filler Slow Naming Words: Experiment 7

As argued earlier, Lupker et al. (1997) did not specify whether the stimuli perceived to be difficult necessarily needed to be nonwords or words. This issue of impartiality of the nature of filler stimuli is also echoed by Rastle & Coltheart, (1999, p494) “simply put, when fast things are mixed with slow things, those fast things slow down”. Thus if the stimuli perceived to be difficult (slow things) are words they should equally slow down naming of the faster target stimuli (words). In Experiments 5 and 6 of the present thesis the stimuli manipulated for perceived difficulty were all nonwords. However, if the principles of time criterion hold then it should also follow that if these fast things (high-frequency words) are mixed with slow things (words that are longer in length, hence taking more time to articulate) they should get slower, and perhaps these slower naming words should speed up the naming of low-frequency words that are shorter in length! Thus according to the time criterion account if naming speed for high-frequency words slows down, and perhaps for low-frequency words speeds up this may nullify the word frequency effect. However, based on the changing route account there is a change of routes only when filler stimuli are nonwords. There is no reason to predict a change of route when all stimuli are words. If so, the word frequency effect should prevail even with the slower naming words. These predictions were tested in Experiment 7 in which high- and low-frequency target words were named mixed with words that were longer in length (hence take more time to be pronounced). Thus whilst filler items were perceived to be more difficult than targets (because they were longer in length) they were nevertheless all words. Contrary to a changing route account word frequency effects disappeared when the filler stimuli were words taking more time to be named than their matched target words. These results thus suggest that for a cohort of Turkish bi-syllabic words perhaps there is a time criterion set that is adhered to and is only disrupted if filler items are included that are named via the lexical and nonlexical routes slower than the set time criterion.

9.4.4 Some Caution in Generalisability

Whilst evidence of strategic change in routes is not fully entertained here, it is equally plausible to argue that the time criteria account is best applicable to naming performance of a transparent writing system, but not more so for readers of opaque scripts. Readers of English, Persian or Hebrew, or non-alphabetic scripts such as Japanese, may be more inclined to use both the lexical and nonlexical routes “strategically” in their course of naming. This is because readers of such scripts, by the nature of their orthography, may have to deal with both lexical and nonlexical routes in their course of reading development. English readers must use a lexical route to read exception words. Persian readers must use a similar strategy to deal with a string of consonantal spelling. Japanese readers have no other choice but to use the lexical route in reading the logographic Kanji. In contrast, at least in principle, the regular words of English, transparent words of Persian and Japanese Kana, can be read via the nonlexical route. Thus, the fact that different strategies in principle are applicable, depending on the different spelling structures of ones' own language may encourage readers of such scripts to be more strategic readers. For (skilled) Turkish readers, however, using both lexical and nonlexical strategies could effectively apply to all words and perhaps this efficiency of using both routes becomes an integral part of their reading process. Perhaps for this reason one may argue that because Turkish readers in their course of reading development have no basis to strategically switch between different routes depending on the spelling structure, they may learn to be less of a strategic reader. Thus it is plausible that for skilled Turkish readers, both routes may operate in parallel and possibly in a complementary, interactive manner (see Section 9.4). If so, there is little reason to expect in the short period of time imposed in an experimental setting for readers to learn to engage in a strategic switching in processing routes. Therefore, the note of caution is that whilst the model that will be proposed for naming Turkish (see Section 9.4) may be one of (automatic) processing of both lexical and nonlexical routes that does not incorporate a flexible switching mechanism, it does not generally follow that it may apply to other more opaque scripts. In this respect, whilst factors such as the presence and absence of nonword fillers, type of blocking and instruction, may indeed impose 'task demands' on readers of deep or opaque orthographies such as English and Persian and encourage them to change routes, it is not conceivable to expect the same for readers of transparent Turkish who have never had to face the type of linguistic dichotomies of the former orthographies. Thus, neither the presence and absence of nonword fillers nor blocking have the same impact on single-word naming in Turkish as in deep or opaque scripts, i.e. there is no change in the processing routes for Turkish readers because they are not accustomed to altering routes. One could speculate further by assuming that the peculiarities of English, e.g. regular vs. irregular words, and Persian, e.g. presence vs. absence of vowels, may demand that readers attend to a particular strategy that would provide the most efficient and successful phonology early on in the process. In the absence of such linguistic dichotomies in Turkish, it is not surprising that there is no impact of such experimental manipulations, i.e. "task demands", but the impact of perceived difficulty of filler items on naming since readers have previously never faced such "task demands" under normal circumstances. One could argue here that the impact of the perceived difficulty of the filler items takes its toll later on in the process, prior to articulation hence the effect on the time criterion.

Of course, a more universal account would be that even on the subject of strategic processing what applies to Turkish is also true in all writing systems regardless of their orthographic transparency. This is perhaps a subject for further research along the lines of "task demands" placed upon readers of both transparent and opaque orthographies.

9.4.5 Implications of the Findings for the Dual-Route and Single-Route Models

The bulk of evidence from Experiments 5, 6 and 7 suggest that the criteria account is more favoured in accounting for the effects of nonword fillers upon naming target words, insofar as reading a transparent orthography is concerned, than the route shift account. The point, however, is that if evidence is found that implicated readers' greater use of a particular route depending on task demands this could be used as strong support for a dual-route framework. It is in response to this type of evidence that single-route connectionist models have always been on the offensive, as maintained on a number of occasions in their article Plaut, et al. (1996) admit that stimulus blocking effects (Baluch & Besner, 1991) and pseudohomophone effects (Fera & Besner, 1992) are problematic for their model (p102). The problematic finding involves demonstrations that readers' performance is sensitive to the context in which orthographic stimuli occur. "Neither of these sets of phenomena is handled particularly well by Seidenberg and McClelland's 1989 implementation model" (p105). Although evidence from Turkish may bring more promising news for the single-route connectionist model, as it offers a different interpretation of strategic change in processing routes, one contradictory issue arises immediately: namely, the effect of letter length on naming latencies. The finding that RTs increase as a direct function of increased letter length for both words and nonwords can only be explained by means of a procedure which functions serially rather than interactively. Thus whilst the presence of a nonlexical route is not ruled out in the present series of experiments, nevertheless the issue of strategic control and independence between the two routes cannot be entertained. The model that perhaps accounts best for the present series of results is that of Rastle and Coltheart's (1999) DRC model. Within the general architecture of the DRC model, two distinct ways to attain phonology are maintained. In this respect Rastle and Coltheart (1999) argue that "the model has both a dictionary-lookup (lexical) procedure for converting print to speech and a rule-based (nonlexical) procedure for such conversion" (p482) whilst the lexical procedure is assumed to be functionally similar to McClelland and Rumelhart's (1981) interactive activation model, the functioning of the nonlexical procedure is assumed to be serial. The latter assumption is fuelled by findings that increased letter length in both words and nonwords has a direct impact on RTs (e.g. Frederiksen & Kroll, 1976; Weekes, 1997). As Coltheart and Rastle (1999) maintained "because the DRC model does not make any explicit predictions about whether strategy effects do occur in reading at all, the absence of a strategy effect would not be incompatible with the DRC model" (p492). However, as the series of experiments by Coltheart and Rastle (1994); Rastle and Coltheart (1999) has shown the presence of filler stimuli (irregular words and nonwords) does impose an effect on naming target stimuli (words or nonwords), which is an indication that the two routes do operate interactively. The Turkish model proposed here is one in line with the DRC model, however, whether the lexical route of the model is a localised one in line with connectionist modelling is perhaps made more clear once the results of Experiments 8 and 9 are discussed.

9.5 Evidence for Orthography-to-Phonology via Semantics? Experiments 8 and 9

The question of how skilled readers of an alphabetic script read single-words aloud has been dominated by the debate as to whether there are one or more non-semantic routes of converting print representations. Perhaps because of this, remarkably little work addresses the issue of whether intact skilled readers of an alphabetic script ever utilise the orthography-to-semantics to phonology pathway. Moreover, if the orthographic transparency has an effect on naming routes it may also impose an effect on the degree and the nature of involvement of a semantic to phonological route in naming opaque and transparent orthographies. This suggestion could be inferred from recent work by Strain et al. (1995) who reported an imageability effect only when naming irregular English words but no significant imageability effect was found on naming regular English words. The immediate question is would Turkish words also behave like regular English, i.e. if so, then there will be no reason to find an imageability effect in naming a transparent orthography? In other words, an orthographic-to-semantic route may only develop for readers of deep/opaque scripts, or are there some "universalities"? Evidence from a recent paper by Baluch and Besner (1999) suggests that the former might be the case. This is because imageability effects were found on naming opaque Persian words but not for naming transparent words. Indeed the interesting aspects of Baluch and Besner's (1999) results are that the effects of imageability were significant (31ms difference) even for high-frequency opaque words. As Strain et al. (1995) argued, when the process of generating phonology is slow and error prone, the semantic route has more time to influence processing. This is certainly the case for low-frequency exception English words and consonantal spelling of Persian. Thus, if orthographic transparency is to have a noticeable effect on whether or not semantic effects are involved in naming this should be less evident in transparent Turkish. Another issue that needs further examination insofar as semantic effects on naming is concerned is the possible effects due to participants level of reading skill. If semantic involvement has to have an effect in naming it is more likely to be a function of level of reading skill i.e. very skilled readers should show greater semantic effects than skilled readers. This is because both localised and connectionist models (in particular the latter) maintain that the link between orthography and semantics develops as readers progress in their reading competence. However, equally plausible is the account that perhaps semantic effects are greatest when testing poor readers for which processing is slow and error prone (it is the understanding of the author that similar effects have also been found for English - Eamon Strain, 1999, personal communication). However, it was also noted that Strain et al. (1995) did not take into account participant's level of skill when reporting the results of their experiments. The two experiments reported in Chapter 8 examined semantic effects on naming amongst the very skilled vs. skilled, and previously skilled Turkish readers. The results showed an interesting pattern of findings: whilst there was a significant main effect for frequency in both experiments there was no significant main effect for imageability in either. There was, however, a significant 2-way interaction of skill by imageability and a 3-way interaction of skill by frequency by imageability in Experiment 8. Further analysis showed that this was due to i) very skilled readers showing more imageability effects than skilled readers and ii) the effect of imageability being significant for low-frequency words. High-imageability low-frequency words were named 30ms faster by very skilled readers than matched low-frequency, low-imageability words. A straightforward implication of the findings is that imageability effects are universal as they are also found for naming in a transparent writing system. Moreover, as in English (Strain et al., 1995), these effects are limited to low-frequency words. However, these results differ from Strain et al.'s (1995) data in two ways: First, imageability effects were only observed when taking into account participants level of skill. If level of skill was not taken into account one might have found no effects of imageability. Secondly, the effects of imageability were found for low-frequency Turkish words, which is a transparent orthography, whilst Strain et al. (1995) found effects of imageability for low-frequency exception words only in English, an opaque orthography. Strain et al. (1995) argued that the reason for this is that generation of a phonological code is more error prone and slower for low-frequency exception words relative to low-frequency regular words. One may argue that perhaps these two positions, i.e. the impact of level of skill, and speed and ease of phonological generation on semantic involvement in naming may not be mutually exclusive. For opaque scripts, one may expect imageability effects for all readers on the cohort of words that are difficult to generate "prelexical" phonology. For transparent scripts it is harder to find such an effect, nevertheless when very skilled readers are examined they show evidence for semantic processing. Thus, orthographic-to-semantic processing is a possibility that may manifest itself directly when ease of phonological generation is manipulated and perhaps also observed in relation to all orthographies when level of skill is also taken into account.

The issue, however, that needs further discussion is the manner in which semantic information may enter in single-word naming. There are at least two positions here:

Position 1: The lexical route makes contact with phonology which may in turn activate semantics which then may feedback to phonology.

Position 2: The lexical route makes direct contact with semantics which then activates phonology.

So what in the present data, and those reported in parallel studies on other writing systems, helps to distinguish between the two positions?

Baluch and Besner's (1999) finding is perhaps more in line with position 2 as they have found significant imageability effects for high- and low-frequency Persian opaque words but not for transparent Persian words. This is more in line with position 2 because it may imply that perhaps early on in lexical processing the fact that some words are opaque is recognised by the system and may activate the use of the semantic route for naming. A recent study on Japanese (Derek Besner, personal communication) and English, Hino and Lupker (1996), however, seems to support position 1. Manipulating another semantic variable, namely polysemy (number of meanings), Hino and Lupker (1996) found a polysemy effect in naming English words. That is, words with multiple meanings (e.g. RIGHT) were named faster than words with fewer meanings (e.g. TENT). However, this effect was restricted to only low-frequency words, i.e. a polysemy by frequency interaction. Hino and Lupker (1996) concluded that this interaction in a naming task "… would be facilitated for low-frequency ambiguous (polysemous) words due to feedback from semantic units" (p1351). Similarly the same was found to be true for naming Japanese polysemous words. In the Japanese study, the polysemy effect was the same size for words printed in a familiar script (Katakana) which must be read via phonology. So the argument was made that in the case of Japanese reading the polysemous effect seen for script in which it normally appears must interact with semantics via phonology. Perhaps the same applies to English and to Turkish? Maybe Persian is the exception here, with its peculiar nature of consonantal and transparent orthography? Thus, whilst one may talk about some "universalities" in semantic effects for naming different writing systems, namely, it is evident in all writing systems - the nature of underlying processes may differ as a function of orthographic transparency and level of skill. Currently, on the basis of the present data from Turkish, there is not much that one could say about "universality" or script specific aspects of how semantics affect naming. Perhaps future research could shed light on these issues.

9.5.1 Individual Differences in Level of Skill and Single-Word Naming Experiments

It is also noteworthy, that the categorisation of participants into very skilled and skilled readers in Experiment 8, was not based on conventional reading and spelling tests, rather the selection was based on RTs (and error data) in naming a cohort of words in the Turkish language. Thus whilst participants in experimental studies such as the one reported here may be classed as "skilled adult readers", a finer classification into very skilled and average skill was based on their RTs and naming accuracy may provide some different pattern of results. The literature generally does not make this finer distinction when a cohort of "skilled university" students act as participants. Since the pioneering work of Posner (1970), it is evident that speed and accuracy in dealing with simple RTs tasks (e.g. judging whether two letters are the same or different) is a good predictor of information processing skills. When literature on visual word recognition makes reference to different levels of skill it is often the distinction of those readers with no known reading deficits as opposed to those having observable problems in reading. Similarly from a developmental perspective skilled readers are usually adult readers who have mastered their reading and spelling abilities, whilst less skilled are generally referred to as beginner readers yet to master their skill. The issue of selecting a finer grain of skilled participants based on their

RTs and accuracy on a cohort of words may have some appeal for models of reading. Within a dual-route account of reading a skilled reader is defined as one who normally has mastered the ability to use both lexical and nonlexical routes, and perhaps makes greater use of the lexical route in the normal course of reading. According to the connectionist view the level of reading performance is a direct function of reading competence. If this were true within a cohort of "skilled" readers there ought to be significant individual differences in their nature of reading performance. Perhaps a good indicator of how this finer distinction is made will not be a conventional test of reading and spelling (e.g. National Adult Reading Test, NART) rather a test of speed in RTs and accuracy to a cohort of reading materials. The conventional tests do not place participants under time constraints. The participant is merely asked to spell or correctly read a cohort of words with no time limit. Thus whilst two readers may score equally high on this test they may nevertheless differ in their RTs to the same cohort of words. It is this finer distinction that is argued to account for how participants may respond in word naming tasks like the ones outlined in the present study. Of course one may argue that the problem may also apply to all the experiments reported in the present thesis. The point, however, made here is that this finer classification of subjects in different skill categories is perhaps more crucial when examining more controversial issues in word recognition such as the role of semantics in naming rather than more robust effects such as word frequency.

9.6 Proposing a Model for Single-Word Naming in Turkish

The model proposed for how transparent Turkish is named is one in which both the lexical route and the nonlexical routes operate in parallel and automatically and that initiation of articulation depends on activation of information from both routes. The fact that lexical information is involved in naming is inferred from Experiments 1, 5 and 6. The fact that a nonlexical route is also used in parallel was also inferred whereby manipulations to nonword stimuli in terms of letter length was shown to have an effect on target word naming (Experiments 2, 3, 4, 5, 6 & 7). The issue that either the lexical route or the nonlexical route can be shut off in response to task demands, i.e. inclusion of nonwords (Experiments 5 & 6), mixed-block vs. mix (Experiments 2 & 3) and list effects suggests that perhaps the operation of the two routes is more automatic than under strategic control. The evidence reported here, however, suggests that once the balance of lexical and nonlexical processing is affected by inclusion in the naming list words or nonwords that take longer to articulate this also affects the timing of articulation of target words. One may argue here that perhaps for a large cohort of Turkish words the system learns to set a time criteria for initiation of articulation for each word which may be based on a harmony of processing speed of both lexical and nonlexical routes. Of course for high-frequency words this timing is different than for low-frequency words because the speed of both lexical and nonlexical routes differs for high- and low-frequency words. Once, however, in an experimental setting subjects are exposed to naming filler stimuli (words or nonwords) for which the operation of nonlexical route (or lexical route) for these filler items is achieved significantly slower than the set time criteria for naming the target words, the system makes adjustments to the time criteria for articulation. This is more at the expense of slowing down the time criteria for fast naming high-frequency words and perhaps speeding up of low-frequency words.

The dual-route model provides a plausible explanation in that the nonlexical route is involved in the naming of such stimuli, whilst the single-route models are yet to provide an explanation for this phenomenon. Moreover, the involvement of the nonlexical route, particularly with the longer letter word fillers, suggests a serial processing of GPCs in line with the nonlexical procedure of the DRC model. In addition, the failure to find evidence for strategic control suggests that the two routes operate in an interactive fashion rather than independent of each other. Finally, the impact of imageability on word naming reported for highly skilled readers only is also in line with the connectionist approach. Thus, it appears that single-word naming in Turkish is best accounted for by a model that is a hybrid of both the single-route and the dual-route models of oral naming. Inferences about the organisation of the mental lexicon is considered next.

9.6.1 Localised or Interactive Lexicon?

Based on present evidence from naming Turkish, drawing conclusions regarding to the nature of lexical processing is hard to come by. However, in view of evidence from Experiment 8 suggesting a link between level of skill and development of an orthographic-to-semantic route, one may find more scope within a connectionist model of reading (Plaut et al., 1996) than a localised model. This is because the connectionist view holds that the strength of the weights between connections increases with developing level of skill. In short the model proposed for naming Turkish is perhaps one more in line with Coltheart et al. (1993), Coltheart and Rastle (1994) and Rastle and Coltheart's (1999) DRC model with the exception that a strategic emphasis and de-emphasis of the routes is not incorporated. Rather evidence from Turkish suggests that the operation of the two routes are more interactive than independent. Whether the model proposed here is applicable to reading a transparent script or is one that could be generalised to other scripts is perhaps the subject of further investigation.

9.7 Future Quests in Research on Turkish - Universality of Visual Word Recognition?

The present thesis examines the extent to which orthographic transparency affects the route use in oral naming. Whilst this is a quest for possible universality in the context of routes in oral naming, yet another dilemma is whether orthographic transparency affects the nature of codes involved in lexical access (e.g. McCusker et al., 1981). According to DeFrancis (1989) and Mattingly (1992) all writing systems are phonological in nature and meant to convey the phonological structure of the words regardless of the nature of orthographic structure. As maintained by Frost (1998) "The main implications of this characteristic is that writing systems were not designed (and in fact could not have been designed) to transcribe units of meaning directly without some reference to their phonological form " (p74). So the view is that "prelexical" phonology is perhaps computed as an integral part of reading processes and is present at all times when reading words. In line with this view, Frost (1994) reports that "All alphabetic orthographies may make some use of prelexically derived phonology for word recognition" (p117). The general consensus, however, based mainly from research on English, is that prelexical phonology is always lagging behind visual coding as the latter is always faster at least for skilled readers (e.g. Dennis & Newstead, 1981; Seidenberg et al., 1984; Seidenberg, 1985a). The debatable issue is therefore whether in some writing systems prelexical generation of a phonological code in view of transparency could bypass the visual coding. Thus lexical access (at least) in transparent scripts may be argued to be almost always phonologically mediated. Evidence from lexical decision tasks on bi-alphabetic script of Serbo-Croatian (e.g. Feldman & Katz, 1983; Lukatela et al., 1978; Lukatela et al., 1980) as briefly reviewed in Chapter 4 is in line with the latter position. The point, therefore, is that one could further pursue whether the nature of the code(s) used in lexical access is affected by orthographic transparency. If in transparent orthographies the "prelexical" generation of phonology (computed via a set of conversion rules or computational processes) is faster and more efficient it may bypass orthographic/visual processing in lexical and semantic access whilst the same may not be true for deep orthographies. Alternatively one may account for some "universality" in which one type of code dominates in visual word recognition in all writing systems. To this end there is not much research on other writing systems (e.g. Baluch, 1993; see also Frost, 1998 for a comprehensive review). Clearly whether prelexical phonology is important in visual word recognition, and whether this is more salient in transparent than opaque scripts, could be demonstrated in tasks that do not explicitly involve the phonological properties of the stimulus. From word naming tasks one could infer evidence as to the processes involved in generating pronunciation from print, from non-verbal tasks such as lexical decisions one could infer evidence of lexical access without necessarily encouraging phonological coding. Thus, only if in such "non-verbal" tasks there is evidence that phonological properties of the words affect decisions regardless of whether they were needed or not, may imply their (mandatory) presence in visual word recognition. Whether lexical access in Turkish is mediated via a phonological or visual code is a subject that could be tested more effectively in tasks involving non-verbal performance such as lexical decisions. However, because of the regular nature of its orthography, and absence of such features as vowelised-unvowelised spellings or bi-alphabetic presentations, many experimental manipulations that have been carried out on other orthographies (lexical decisions to regular-irregular English words, e.g. Andrews, 1982,1989; Seidenberg et al., 1984; bi-alphabetic letter strings of Serbo-Croatian, e.g. Lukatela et al., 1978, 1980; pointed vs. unpointed Hebrew, e.g. Frost, 1994; or transparent vs. opaque words of Persian, Baluch, 1993) are not possible with Turkish. Thus the mere fact that one could devise a non-verbal task in Turkish, in which phonological manipulations are conducted in a lexical decision task, is in itself a challenge. However, as a starting point, perhaps one could begin by conducting a lexical decision task along the same parameters as the classic study of Frederiksen and Kroll (1976) who demonstrated that whilst factors such as letter length and syllabic structure affect naming they do not affect lexical decisions in English. Frederiksen and Kroll thus concluded that "phonemic recoding is not a prerequisite for lexical retrieval" (p361). The point however, is whether the same may be found to be true for Turkish? Letter length was found to affect naming in Turkish (Experiment 4) if the same is true in lexical decisions perhaps it is greater indication that phonological coding is necessary for lexical access. If so, this would please those supporting a mandatory role for phonological mediation in visual word recognition (e.g. Lukatela et al., 1978, 1980; Lukatela & Turvey, 1998; Van Orden, 1987, 1988). Alternatively lack of such effects in Turkish may set researchers to examine whether i) indeed phonological recoding is not necessary in all writing systems in spite of transparency or ii) the presence and absence of phonological effects are artefacts of experimental manipulations and task demands!

The conclusions based on evidence from the present thesis for Turkish are thus:

i) Single-word naming in transparent Turkish is achieved via the parallel and interactive processing of both the lexical and the nonlexical routes.

ii) The idea that processing of these routes is under strategic control and may be influenced by factors such as the inclusion of filler stimuli (words or nonwords) and blocking cannot be entertained insofar as evidence from Turkish is concerned. Instead there is evidence that any inclusion of filler stimuli (words or nonwords) may act in changing the time criterion for initiation of articulation.

iii) The fact that semantic effects first reported on naming English are also evident in naming Turkish suggest universalities in the involvement of this "lexical route" in oral naming. However, as outlined in the present thesis, there could be different accounts of how semantics may be involved in single-word naming of different writing systems.

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Appendices

Appendix 1

The following is the written instructions in Turkish and the corresponding translation in English, that participants were given on the screen when naming word stimuli only for all the experiments reported in the current thesis. This was the same for both the practice and experimental trials.

Açıklamalar
Ekranda sunulacak olan Türkçe kelimeleri seslendirmeniz rica olunur. Bu bir test veya sınav değildir. Deneyde kesinlikle kandırmaca veya aldatmaca yoktur. Ancak sunulan kelimeleri elinizden geldiği kadar süratle seslendirmeniz gerekmektedir. Deney süresince konuşmamanız, yalnız ekranda gördüğünüz kelimeleri seslendirmeniz önemle rica olunur.

Instructions
You are required to name the words that will be presented on the screen. This is not an examination or a test. However, you are required to call out the words as fast and as accurately as possible. It is also very important that you do not talk during the experiment but only call out the words on the screen.

Instructions were altered as follows to indicate to the participants that nonwords were also presented as part of the stimuli set:

Açıklamalar
Ekranda sunulacak olan harf dizilerini seslendirmeniz rica olunur. Bu dizilerin bazılarını daha önce hiç görmemiş olabilirsiniz. Ancak sunulan tüm dizileri Türk dili harf-ses kurallarına uyarak elinizden geldiği kadar süratle seslendirmeniz gerekmektedir. Bu bir test veya sınav değildir. Deneyde kesinlikle kandırmaca veya aldatmaca yoktur. Deney süresince konuşmamanız, yalnız ekranda gördüğünüz dizileri seslendirmeniz önemle rica olunur.

Corresponding translation in English:
Instructions
You are required to name letter strings that will be presented on the screen. Although you may have never seen some of these strings before you should attempt to name them as accurately and as fast as possible by employing letter-sound correspondence rules in Turkish. This is not an examination or a test. There are no tricks in this experiment. It is very important that you do not talk during the experiment but only call out the words on the screen.

Appendix 2
Stimuli used in practice trials and in Experiments 1 and 2

Stimuli used in practice trials in Experiment 1

High- and low-frequency words
deniz
ipek
belge
bilimsel
esnek
müjde
yurt
müracaat
zihin
ev

Stimuli used in practice trials in Experiment 2

High- and low-frequency words	Matched nonwords
deniz	domap
ipek	inke
belge	bolgu
bilimsel	beteberi
esnek	enkey
müjde	mapsa
yurt	yalo
müracaat	mesetire
zihin	zapın
ev	ep

Appendix 2 continued

Experimental stimuli, high-frequency Turkish words, used in Experiments 1 and 2 and their corresponding translations in English

High-frequency Turkish words	Corresponding translation in English
insan	human
giysi	clothes
yalan	a lie
bilgisayar	computer
fırtına	storm
yosun	moss
yazı	writing
oyun	game
bilgi	information
tekme	kick
ayı	bear
salak	clumsy
deprem	earthquake
ters	opposite
genç	young
su	water
indirim	reduction
tüfek	gun
yalancı	liar
müddet	time
mutfak	kitchen
heyecan	excitement
estetik	aesthetics
albay	colonel
kıyaslama	comparison
özel	special
güvercin	pigeon
zengin	wealthy
serseri	footloose
isim	name
izahat	explanation
çapraz	criss-cross
elveda	farewell
evlenme	marriage
millet	nation
körfez	gulf
güven	trust
nizamsız	without order
munafık	tell-tale
cüretli	courageous

Appendix 2 continued

Experimental stimuli, low-frequency Turkish words, used in Experiments 1 and 2 and their corresponding translations in English with matched nonwords used in Experiment 2 only

Low-frequency Turkish words	Corresponding translation in English	Matched nonword fillers
iblis	devil	ignör
gedik	hole	gisye
yaver	assistant	yumin
bilasebep	without reason	burkatakar
feragat	abandonment	firako
yazgı	destiny	yanoç
yeis	sadness	yusi
obur	greedy, obese	oroy
bulgu	finding	böglö
tümce	sentence	takef
ati	future	abü
sıfat	adjective	selek
dehliz	hidden tunnel	derkit
tunç	bronze	tark
gürz	metal war tool	gülç
us	mind, reason	sö
intizam	order	imidre
türbe	tomb	tilme
yarıçap	radius	yamarzi
mahkum	prisoner	mekküt
mahzun	sad	marfat
hıyanet	treachery	hirifay
eflatun	purple	ermikit
ablak	dull person	aylap
kalıtsal	genetic	katıkala
önek	prefix	ölez
gergedan	hippopotamus	gicerven
zakkum	oleander	zikrum
serüven	adventure	söfsöfi
ilim	science	irel
izmarit	cigarette end	iratak
çıngar	dispute	çorkaz
evliya	saint	enzeve
entrika	intrigue	esmeva
menzil	firing range of a gun	mektil
külfet	inconvenience	kefröz
güveç	earthware pot	gataf
nezaret	observation	nuratkız
mutabakat	correspondence	mukanık
canavar	monster	caratlı

Appendix 3
Stimuli used in practice trials and Experiments 3 to 7

Experimental stimuli, high- and low-frequency Turkish words, used in Experiments 3, 4, 5, 6 and 7 with their corresponding translations in English

High-frequency	Corresponding translation in English	Low-frequency	Corresponding translation in English
açık	open	avuç	palm
aç	hungry / to open	ay	moon
anne	mother	ayran	yoghurt drink
bahçe	garden	baston	walking stick
biber	pepper	berber	barber
cami	mosque	cila	varnish
çiçek	flower	çilek	strawberry
dünya	world / earth	dümen	driving wheel
erkek	man	esnek	flexible
fırın	oven	fener	lantern
göz	eye	gaz	gas
güzel	beautiful	gündüz	daytime
halı	carpet	havan	pestle-mortar
insan	human	incir	fig
kan	blood	kaygan	slippery
kilit	lock	küp	large earth-pot
mavi	blue	maske	mask
para	money	peçe	veil
saç	hair	saz	stringed folk inst.
tepsi	tray	türbe	tomb

Stimuli used in practice trials in Experiment 3

High-frequency words and matched nonwords in mixed-block	Low-frequency words and matched nonwords in mixed-block
ayna	arpa
daìre	damar
dosya	damla
hasta	hamam
kapı	kıyı
akiç	avve
dafun	deple
dıplı	dakut
hular	henet
keye	kuka

Appendix 3 continued

Stimuli used in practice trials in Experiment 4

High-frequency words	Low-frequency words	Three-letter nonwords	Four/five letter nonwords
ayna	arpa	ars	apran
daìre	damar	dan	deset
dosya	damla	düç	darun
hasta	hamam	hit	hıpat
kapı	kıyı	kej	kipat
okul	obur	ofu	orat
oyun	otel	osu	oyus
tarak	tören	til	teley
uyku	uyuz	uka	uvay
yatak	yokur	yup	yulat

Stimuli used in practice trials in Experiment 5

High-frequency words with three-letter nonwords in mixed-block	Low-frequency words with four/five-letter nonwords in mixed-block
ayna	arpa
daìre	damar
dosya	damla
hasta	hamam
kapı	kıyı
ars	apran
dan	deset
düç	darun
hit	hıpat
kej	kipat

Appendix 3 continued

Stimuli used in practice trials in Experiment 6

High- and low-frequency words mixed with three- and four/five letter nonwords
ayna
daìre
dosya
arpa
damar
ars
dan
düç
apran
deset

Stimuli used in practice trials in Experiment 7

High- and low-frequency words mixed with longer letter word
ayna
daìre
dosya
arpa
damar
arzulama
dolmalık
abanoz
donmuş

Appendix 3 continued

Matched nonword filler stimuli used in mixed-blocks with high- and low-frequency word stimuli in Experiment 3

Matched nonword fillers used with high-frequency words	Matched nonword fillers used with low-frequency words
alıf	apuk
ab	aj
aruy	apran
bıkaf	botkan
banım	berzik
cava	cuto
çiren	çifre
dopul	deset
eknez	evsol
fıran	fazur
gep	gaj
gıcar	genzit
hosu	hesel
inser	ircin
kof	kenyip
kitel	küç
meyu	merki
pese	pepi
sef	süp
teley	tapul

Appendix 3 continued

Three and four/five-letter nonword stimuli created and validated in Experiment 4, also used in Experiments 5 and 6

Three-letter nonwords	Four/five-letter nonwords
ako	alif
anu	apuk
api	aruy
bap	bikat
bet	banim
cum	cava
çip	çiren
dof	dopul
elk	evsol
fey	firan
gat	gavar
gep	gacir
hul	hesel
ira	inser
kof	kenip
kuz	kıya
mis	meyu
pap	pesit
sem	sıptak
tes	teley

Appendix 3 continued

Longer-letter word fillers used in Experiment 7 and their corresponding translations in English

Longer-letter words	Corresponding translations in English
açıklama	explanation
ağlamak	to cry
ayrılık	separation
bılezık	bracelet
bisiklet	bicycle
biricik	unique, only
boşanma	divorce
cahillik	ignorance
çingene	gypsy
çocuksu	childish
dalgalı	wavy
dondurma	ice-cream
duygusal	emotional
efsane	legend
erimiş	melted
esrarlı	mysterious
felsefe	philosophy
ferıbot	ferry-boat
fukara	poor
gecelik	nightdress
gereksiz	needless
gezegen	planet
gönüllü	volunteer
güvence	security
hareket	movement
hazırlık	preparation
horultu	snoring
ihtiyar	old person
ileride	further (away)
kilise	church
kuruluğ	establishment
menekşe	violet
pastırma	sausage/dried meat
portakal	orange
sıkıntı	stress
söylenti	rumour
tanıtma	introduction
ticaret	trade
üzüntü	sorrow
yapışkan	glue

Appendix 4
Experimental stimuli used in the pilot experiment prior to Experiment 8 and their corresponding translations in English

Turkish words	Corresponding translation in English	Turkish words	Corresponding translation in English
ayak	foot	kabak	marrow
av	hunt	kaçamak kahvaltı	sneak around breakfast
ayrıntı	detail	kamçı	whip
balta	axe	kanat	wing
beyaz	white	karamsar	pessimist
beygir	horse	kelebek	butterfly
bunalım	depression	köy	village
bütün	whole	lokum	Turkish delight
büyüteç	magnifying glass	lodos	south-westerlıes
can	life	lokanta	restaurant
cimri	scrooge	makas	scissors
cumhuriyet	republic	marangoz	carpenter
çadır	tent	nane	mint
çakmak	lighter	nezle	cold/flu
çalıntı	stolen	oda	room
çorap	sock	odun	chopped wood
dalga	wave	oğlan	boy
derece	degree, extent	olgun	mature
dil	language	olumlu	positive
durum	situation	ortaklık	partnership
ebe	midwife	oya	embroidery
emekli	retired person	ödül	prize
eskici	person dealing with second-hand goods	öğrenci	student
		ölgün	lifeless
felsefe	philosophy	paket	packet
fesleğen	basil	pamuk	cotton
fincan	cup	pancar	beet-root
gazeteci	journalist	parlak	shiny
gebe	pregnant	petek	honey-comb
gece	night	pusu	set up
gemici	sailor	ramazan	ramadan
gevşek	loose	resim	picture
gezegen	planet	saç	hair
gök	sky	sağanak	shower (rain)
gözlem	observation	sağlam	strong, durable
hafif	light in weight	sakal	beard
halay	a type of folk dancing	sakınma	prevention
hamur	dough	saldırgan	aggressive
hazırlık	preparation	sergi	exhibition
hırsız	thief	sorun	problem
huzursuz	restless	sözlük	dictionary
ırgat	labourer	şaka	joke
ısırgan	nettle	şişman	fat
ığın	light beam	tabak	plate
içki	drink	terlik	slipper
ikiz	twin	uçak	aeroplane
ilişki	relationship	üretici	manufacturer
ilkel	primitive	varsayım	hypothesis
imren	envy	yetenek	talent
kabadayı	rogue	zırıldama	whinging

Appendix 4 continued

Stimuli used in practice trials in Experiments 8 and 9

High-frequency High-imageability	High-frequency Low-imageability	Low-frequency High-imageability	Low-frequency Low-imageability
açık	avuç	arzu	aruz
aç	ay	an	ar
ayna	ayva	armut	ayar
bìber	berber	berbat	bulgu
camì	cìla	cani	cìn

Appendix 4 continued

Experimental stimuli used in Experiments 7 and 8 and their corresponding translations in English

High-frequency High-imageability	Corresponding translation in English	Low-frequency High-imageability	Corresponding translation in English
anne	mother	ayran	yoghurt drink
ateş	fire	arpa	barley
bardak	glass	balkon	balcony
bahçe	garden	baston	walking stick
çiçek	flower	çilek	strawberry
dünya	earth	düğme	button
göz	eye	gaz	gas
güneş	sun	gitar	guitar
insan	human	incir	fig
kan	blood	kaygan	slippery
kardeş	brother	kukla	puppet
kilit	lock	kumar	gamble
kitap	book	küp	water butt
mavi	blue	maske	mask
para	money	peçe	veil
saç	hair	saz	musical inst.
sigara	cigarette	sevinç	joy
tava	frying pan	tepe	hill
tarak	comb	türbe	monument
yatak	bed	yokuş	uphill

Appendix 4 continued

High-frequency Low-imageability	Corresponding translation in English	Low-frequency Low-imageability	Corresponding translation in English
artik	leftover	ablak	dull person
ayip	shame	ayar	timing
bencil	selfish	bellek	memory
biçim	shape	buhran	depression
çözüm	solution	çi□ir	era
duygu	emotion	doyum	content
gizli	secret	göç	migration
güç	power	gönül	heart/mind
inat	stubborn	ilim	science
kayit	register	kavram	concept
kibar	polite	kisir	infertile
lisan	language	lasan	seedling
mantik	logic	menzil	firing range
onur	honour	oruç	fasting
önlem	prevention	ölçek	scale
sanat	art	sürgün	exile
tarih	history	tekel	monopoly
tasa	anxiety	töre	custom
yalan	lie	yazgi	destiny
yemin	vow	yorum	interpretation

Appendix 5

Mean RTs and corresponding SD for subjects are reported in Appendix 5 for Experiments 1 to 8. Number of participants is indicated as n.

Experiments reported in Chapter 6

Experiment 1

High-frequency words	Low-frequency words
830	832
869	904
874	905
756	816
833	841
727	811
775	872
680	744
835	904
823	896
813	909
645	647
732	761
640	673
705	805
820	887
714	767
688	755
761	810
717	758
693	739
821	852
878	938
Mean = 767 SD = 74 n =23	Mean = 818 SD = 78 n =23

Appendix 5 continued

Experiment 2

High-frequency words	Low-frequency words	Matched nonword fillers
712	714	723
770	771	803
694	700	709
838	859	899
766	767	773
749	750	764
770	769	780
723	726	730
767	768	777
745	747	780
833	835	842
699	700	703
865	874	875
839	842	844
792	794	805
850	849	878
Mean = 776 SD = 54 n =17	Mean = 780 SD = 57 n =17	Mean = 793 SD = 60 n =17

Appendix 5 continued

Experiments reported in Chapter 7

Experiment 3

High-frequency words Experiment 3	Low-frequency words Experiment 3	Nonword fillers with high-frequency words	Nonword fillers with low-frequency words
855	851	636	725
721	725	807	761
689	688	753	838
768	785	534	591
728	757	787	857
845	855	771	815
637	632	823	864
709	706	745	770
783	671	797	893
851	841	871	809
656	786	878	815
699	699	755	874
749	753	818	831
652	660	761	790
625	684	749	837
Mean = 731ms SD = 76 n =15	Mean = 740ms SD = 72 n =15	Mean = 766 SD = 86 n =15	Mean = 805 SD = 74 n =15

Experiment 4

Three-letter nonwords	High-frequency words	Four/five-letter nonwords	Low-frequency words
652	650	738	720
675	647	757	699
668	708	758	747
698	545	736	610
531	600	586	690
678	673	748	720
502	628	554	678
605	635	679	680
Mean = 626 SD = 73 n =8	Mean = 636 SD = 49 n =8	Mean = 695 SD = 81 n =8	Mean = 693 SD = 41 n =8

Appendix 5 continued

Experiment 5

High-frequency words	Speed-matched nonwords	Low-frequency words	Speed-matched nonwords
575 669 650 681 706 767 707 676 689 678 643 748 698 850 578	607 660 592 643 612 671 455 735 845 675 706 752 662 776 701	607 818 675 784 778 851 720 672 755 718 717 787 650 800 563	665 692 619 702 747 714 509 751 852 723 754 769 731 826 720
Mean = 688 SD = 69 n =15	Mean = 673 SD = 85 n =15	Mean = 726 SD = 81 n =15	Mean = 718 SD = 82 n =15

Experiment 6

High-frequency words	Low-frequency words	Speed-matched nonwords
684 746 551 676 564 671 663 625 699 667 729 840 793 710 765	728 698 614 688 632 661 706 677 710 730 733 838 795 763 813	667 687 708 775 680 780 719 685 637 690 635 679 632 713 834
Mean = 693 SD = 78 n =15	Mean = 719 SD = 64 n =15	Mean = 702 SD = 58 n =15

Appendix 5 continued

Experiment 7

High-frequency words	Low-frequency words	Longer letter word fillers
672	679	753
728	731	815
842	847	849
704	727	767
764	780	909
651	672	642
708	737	784
716	717	883
705	709	791
765	772	794
806	813	924
678	809	837
684	685	760
767	770	859
720	718	831
Mean = 728 SD = 52 n =15	Mean = 745 SD = 55 n =15	Mean = 814 SD = 71 n =15

Appendix 5 continued

Experiments reported in Chapter 8

Mean RTs to a cohort of 100 words in the pilot study prior to Experiment 8

Mean RTs of 78 subjects			
995	654	992	1093
688	445	764	1276
1092	689	1134	556
1002	700	1456	768
478	569	1283	443
903	800	773	998
870	713	556	1152
448	890	883	1100
387	443	431	662
992	1245	507	1098
412	1523	778	1278
782	448	1082	663
567	776	679	1000
473	1004	1156	1345
620	899	1179	996
400	1102	1085	1001
901	1265	945	891
1003	450	887	562
762	1013	875	972
905	789		
Mean = 851 SD = 277 n =78			

Appendix 5 continued

Experiment 8 – Very skilled readers

High-frequency High-imageability	High-frequency Low-imageability	Low-frequency High-imageability	Low-frequency Low-imageability
541	518	591	574
752	701	914	918
602	614	706	630
737	825	874	791
641	658	636	692
696	725	775	739
611	626	678	615
661	620	652	628
664	670	824	826
700	742	759	758
608	616	616	620
676	700	748	739
499	508	566	555
532	521	544	555
514	531	674	656
618	548	571	598
Mean = 626 SD = 90 n =16	Mean = 633 SD = 92 n =16	Mean = 675 SD = 104 n =16	Mean = 705 SD = 94 n =16

Appendix 5 continued

Experiment 8 – Skilled readers

High-frequency High-imageability	High-frequency Low-imageability	Low-frequency High-imageability	Low-frequency Low-imageability
832	828	830	905
645	696	761	745
864	849	952	981
779	795	902	880
739	742	944	913
607	634	663	679
697	703	750	780
625	660	650	667
1038	1003	1217	1192
900	902	1092	1095
699	733	735	789
915	1096	1102	1165
1053	969	1199	1208
832	802	920	896
722	718	774	773
628	635	850	738
725	701	810	812
677	681	773	746
704	706	736	725
828	849	903	925
899	872	1098	1086
1216	1280	1255	1304
940	995	979	1024
902	905	968	1030
739	778	823	815
779	763	862	903
726	745	840	744
756	747	856	879
Mean = 810 SD = 138 n =28	Mean = 814 SD = 149 n =28	Mean = 901 SD = 164 n =28	Mean = 891 SD = 161 n =28

Appendix 5 continued

Experiment 9 – Previously skilled readers

High-frequency High-imageability	High-frequency Low-imageability	Low-frequency High-imageability	Low-frequency Low-imageability
932	928	930	1005
745	796	861	845
964	949	1052	1081
879	895	1002	980
839	842	1044	1013
707	734	763	779
797	803	850	880
725	760	750	767
1138	1103	1317	1292
1000	1002	1192	1195
799	833	835	889
1015	1196	1202	1265
1153	1069	1299	1308
932	902	1020	996
822	818	874	873
728	735	950	838
825	801	910	912
777	781	873	846
804	806	836	825
928	949	1003	1025
999	972	1198	1186
1316	1380	1355	1404
1040	1095	1079	1124
1002	1005	1068	1130
Mean = 911 SD = 154 n =24	Mean = 923 SD = 160 n =24	Mean = 1011 SD = 175 n =24	Mean = 1019 SD = 184 n =24

Appendix 6

The list of Turkish words used in two separate subjective frequency and imageability ratings on a 1-7 point scale with a rating of one indicating the most frequent and high-imageability whilst seven indicates low-frequency and low-imageability. Appropriate instructions were given to participants indicating whether the rating was for frequency or imageability at the beginning for each rating.

Instructions for subjective frequency rating:
Aşağidaki sözcüklerin sizce ne kadar sık kullanıldıklarını veya rastlandığini belirten numarayi lütfen işaretleyin. Eğer çok sık kullanıldığını sanıyorsanız (1) numarayı ; çok az kullanıldığını sanıyorsanız (7) numarayı işaretleyin

Örnek: **masa**	1	2	3	4	5	6	7

Instructions for subjective imageability rating:
Aşağidaki sözcükleri okuduğunuz zaman sizce ne kadar canlı olduklarını belirten numarayi lütfen işaretleyin. Eğer çok canlı olduklarını sanıyorsanız (1) numarayı ; çok az canlı sanıyorsanız (7) numarayı işaretleyin

Örnek: **kırmızı**	1	2	3	4	5	6	7

1. ablak	1	2	3	4	5	6	7
2. aç	1	2	3	4	5	6	7
3. açık	1	2	3	4	5	6	7
4. aday	1	2	3	4	5	6	7
5. af	1	2	3	4	5	6	7
6. ahmak	1	2	3	4	5	6	7
7. albay	1	2	3	4	5	6	7
8. altın	1	2	3	4	5	6	7
9. anı	1	2	3	4	5	6	7
10. anne	1	2	3	4	5	6	7
11. arı	1	2	3	4	5	6	7
12. aşk	1	2	3	4	5	6	7
13. ateş	1	2	3	4	5	6	7
14. ati	1	2	3	4	5	6	7
15. ayakkabı	1	2	3	4	5	6	7
16. ayar	1	2	3	4	5	6	7
17. ayı	1	2	3	4	5	6	7
18. ayna	1	2	3	4	5	6	7
19. ayran	1	2	3	4	5	6	7
20. azim	1	2	3	4	5	6	7
21. bahçe	1	2	3	4	5	6	7
22. baldır	1	2	3	4	5	6	7
23. balık	1	2	3	4	5	6	7
24. balkon	1	2	3	4	5	6	7
25. bardak	1	2	3	4	5	6	7

Appendix 6 continued

26. barış	1	2	3	4	5	6	7
27. basın	1	2	3	4	5	6	7
28. basit	1	2	3	4	5	6	7
29. baston	1	2	3	4	5	6	7
30. bayat	1	2	3	4	5	6	7
31. baygın	1	2	3	4	5	6	7
32. bayır	1	2	3	4	5	6	7
33. bayrak	1	2	3	4	5	6	7
34. bayram	1	2	3	4	5	6	7
35. bebek	1	2	3	4	5	6	7
36. bela	1	2	3	4	5	6	7
37. bellek	1	2	3	4	5	6	7
38. bencil	1	2	3	4	5	6	7
39. benek	1	2	3	4	5	6	7
40. berbat	1	2	3	4	5	6	7
41. berber	1	2	3	4	5	6	7
42. biber	1	2	3	4	5	6	7
43. biçim	1	2	3	4	5	6	7
44. bilgi	1	2	3	4	5	6	7
45. bilgisayar	1	2	3	4	5	6	7
46. bitkin	1	2	3	4	5	6	7
47. boru	1	2	3	4	5	6	7
48. buhran	1	2	3	4	5	6	7
49. bulgu	1	2	3	4	5	6	7
50. buluş	1	2	3	4	5	6	7
51. bulut	1	2	3	4	5	6	7
52. burç	1	2	3	4	5	6	7
53. cadı	1	2	3	4	5	6	7
54. çalışmak	1	2	3	4	5	6	7
55. cami	1	2	3	4	5	6	7
56. can	1	2	3	4	5	6	7
57. çapraz	1	2	3	4	5	6	7
58. çelik	1	2	3	4	5	6	7
59. çeşit	1	2	3	4	5	6	7
60. çeyiz	1	2	3	4	5	6	7
61. çıban	1	2	3	4	5	6	7
62. çığır	1	2	3	4	5	6	7
63. çilek	1	2	3	4	5	6	7
64. çözüm	1	2	3	4	5	6	7
65. daire	1	2	3	4	5	6	7
66. damar	1	2	3	4	5	6	7
67. damla	1	2	3	4	5	6	7
68. dargın	1	2	3	4	5	6	7
69. defter	1	2	3	4	5	6	7
70. deli	1	2	3	4	5	6	7
71. demeç	1	2	3	4	5	6	7
72. denge	1	2	3	4	5	6	7

Appendix 6 continued

73. dernek	1	2	3	4	5	6	7
74. dikey	1	2	3	4	5	6	7
75. doktor	1	2	3	4	5	6	7
76. dosya	1	2	3	4	5	6	7
77. doyum	1	2	3	4	5	6	7
78. düğme	1	2	3	4	5	6	7
79. dünya	1	2	3	4	5	6	7
80. duygu	1	2	3	4	5	6	7
81. ekmek	1	2	3	4	5	6	7
82. eksik	1	2	3	4	5	6	7
83. erkek	1	2	3	4	5	6	7
84. erken	1	2	3	4	5	6	7
85. eser	1	2	3	4	5	6	7
86. esir	1	2	3	4	5	6	7
87. eşit	1	2	3	4	5	6	7
88. esmer	1	2	3	4	5	6	7
89. esnek	1	2	3	4	5	6	7
90. evcil	1	2	3	4	5	6	7
91. evren	1	2	3	4	5	6	7
92. fare	1	2	3	4	5	6	7
93. felek	1	2	3	4	5	6	7
94. fener	1	2	3	4	5	6	7
95. fikir	1	2	3	4	5	6	7
96. fırın	1	2	3	4	5	6	7
97. fosil	1	2	3	4	5	6	7
98. gayret	1	2	3	4	5	6	7
99. gazete	1	2	3	4	5	6	7
100. gece	1	2	3	4	5	6	7
101. gedik	1	2	3	4	5	6	7
102. gemi	1	2	3	4	5	6	7
103. genç	1	2	3	4	5	6	7
104. gergedan	1	2	3	4	5	6	7
105. gitar	1	2	3	4	5	6	7
106. giysi	1	2	3	4	5	6	7
107. gizli	1	2	3	4	5	6	7
108. göç	1	2	3	4	5	6	7
109. gölge	1	2	3	4	5	6	7
110. gönül	1	2	3	4	5	6	7
111. görev	1	2	3	4	5	6	7
112. göz	1	2	3	4	5	6	7
113. güç	1	2	3	4	5	6	7
114. güdük	1	2	3	4	5	6	7
115. gümüş	1	2	3	4	5	6	7
116. günah	1	2	3	4	5	6	7
117. güncel	1	2	3	4	5	6	7
118. güneş	1	2	3	4	5	6	7
119. gür	1	2	3	4	5	6	7

Appendix 6 continued

120.	gürbüz	1	2	3	4	5	6	7
121.	güven	1	2	3	4	5	6	7
122.	güzel	1	2	3	4	5	6	7
123.	haber	1	2	3	4	5	6	7
124.	halı	1	2	3	4	5	6	7
125.	hamam	1	2	3	4	5	6	7
126.	havan	1	2	3	4	5	6	7
127.	hayal	1	2	3	4	5	6	7
128.	heyecan	1	2	3	4	5	6	7
129.	hilal	1	2	3	4	5	6	7
130.	hisse	1	2	3	4	5	6	7
131.	hizmet	1	2	3	4	5	6	7
132.	hüzün	1	2	3	4	5	6	7
133.	iblis	1	2	3	4	5	6	7
134.	iğne	1	2	3	4	5	6	7
135.	iletişim	1	2	3	4	5	6	7
136.	ilik	1	2	3	4	5	6	7
137.	ilim	1	2	3	4	5	6	7
138.	iman	1	2	3	4	5	6	7
139.	inat	1	2	3	4	5	6	7
140.	ince	1	2	3	4	5	6	7
141.	inci	1	2	3	4	5	6	7
142.	insan	1	2	3	4	5	6	7
143.	ipek	1	2	3	4	5	6	7
144.	irin	1	2	3	4	5	6	7
145.	isim	1	2	3	4	5	6	7
146.	işlem	1	2	3	4	5	6	7
147.	kaba	1	2	3	4	5	6	7
148.	kalıtsal	1	2	3	4	5	6	7
149.	kamışlık	1	2	3	4	5	6	7
150.	kapı	1	2	3	4	5	6	7
151.	karar	1	2	3	4	5	6	7
152.	kardeş	1	2	3	4	5	6	7
153.	kare	1	2	3	4	5	6	7
154.	katı	1	2	3	4	5	6	7
155.	katil	1	2	3	4	5	6	7
156.	kavram	1	2	3	4	5	6	7
157.	kaygan	1	2	3	4	5	6	7
158.	kayıt	1	2	3	4	5	6	7
159.	kedi	1	2	3	4	5	6	7
160.	kibar	1	2	3	4	5	6	7
161.	kilit	1	2	3	4	5	6	7
162.	kin	1	2	3	4	5	6	7
163.	kısır	1	2	3	4	5	6	7
164.	kitap	1	2	3	4	5	6	7
165.	kitle	1	2	3	4	5	6	7
166.	kıyı	1	2	3	4	5	6	7

Appendix 6 continued

167.	kızıl	1	2	3	4	5	6	7
168.	köy	1	2	3	4	5	6	7
169.	kukla	1	2	3	4	5	6	7
170.	kule	1	2	3	4	5	6	7
171.	külfet	1	2	3	4	5	6	7
172.	kumar	1	2	3	4	5	6	7
173.	küme	1	2	3	4	5	6	7
174.	küp	1	2	3	4	5	6	7
175.	kutu	1	2	3	4	5	6	7
176.	kuzu	1	2	3	4	5	6	7
177.	lasan	1	2	3	4	5	6	7
178.	lisan	1	2	3	4	5	6	7
179.	mantar	1	2	3	4	5	6	7
180.	mantık	1	2	3	4	5	6	7
181.	maske	1	2	3	4	5	6	7
182.	mavi	1	2	3	4	5	6	7
183.	menzil	1	2	3	4	5	6	7
184.	merak	1	2	3	4	5	6	7
185.	nefret	1	2	3	4	5	6	7
186.	nehir	1	2	3	4	5	6	7
187.	nerkis	1	2	3	4	5	6	7
188.	obur	1	2	3	4	5	6	7
189.	ok	1	2	3	4	5	6	7
190.	okul	1	2	3	4	5	6	7
191.	önlem	1	2	3	4	5	6	7
192.	onur	1	2	3	4	5	6	7
193.	oruç	1	2	3	4	5	6	7
194.	otel	1	2	3	4	5	6	7
195.	oy	1	2	3	4	5	6	7
196.	oyun	1	2	3	4	5	6	7
197.	özel	1	2	3	4	5	6	7
198.	para	1	2	3	4	5	6	7
199.	parlak	1	2	3	4	5	6	7
200.	peçe	1	2	3	4	5	6	7
201.	peri	1	2	3	4	5	6	7
202.	pul	1	2	3	4	5	6	7
203.	rahat	1	2	3	4	5	6	7
204.	rakip	1	2	3	4	5	6	7
205.	resim	1	2	3	4	5	6	7
206.	rüya	1	2	3	4	5	6	7
207.	sabah	1	2	3	4	5	6	7
208.	saç	1	2	3	4	5	6	7
209.	şafak	1	2	3	4	5	6	7
210.	salak	1	2	3	4	5	6	7
211.	sanat	1	2	3	4	5	6	7
212.	saray	1	2	3	4	5	6	7
213.	sarı	1	2	3	4	5	6	7

Appendix 6 continued

214.	sarışın	1	2	3	4	5	6	7
215.	savunma	1	2	3	4	5	6	7
216.	sayı	1	2	3	4	5	6	7
217.	saz	1	2	3	4	5	6	7
218.	şeref	1	2	3	4	5	6	7
219.	sevda	1	2	3	4	5	6	7
220.	sevinç	1	2	3	4	5	6	7
221.	şiddet	1	2	3	4	5	6	7
222.	sigara	1	2	3	4	5	6	7
223.	şiir	1	2	3	4	5	6	7
224.	simge	1	2	3	4	5	6	7
225.	sınıf	1	2	3	4	5	6	7
226.	sivri	1	2	3	4	5	6	7
227.	siyasi	1	2	3	4	5	6	7
228.	soğuk	1	2	3	4	5	6	7
229.	son	1	2	3	4	5	6	7
230.	soru	1	2	3	4	5	6	7
231.	söz	1	2	3	4	5	6	7
232.	su	1	2	3	4	5	6	7
233.	suç	1	2	3	4	5	6	7
234.	sürgün	1	2	3	4	5	6	7
235.	süt	1	2	3	4	5	6	7
236.	tarak	1	2	3	4	5	6	7
237.	tarih	1	2	3	4	5	6	7
238.	tas	1	2	3	4	5	6	7
239.	tasa	1	2	3	4	5	6	7
240.	tava	1	2	3	4	5	6	7
241.	tavuk	1	2	3	4	5	6	7
242.	tekel	1	2	3	4	5	6	7
243.	tekne	1	2	3	4	5	6	7
244.	tepe	1	2	3	4	5	6	7
245.	tepki	1	2	3	4	5	6	7
246.	tepsi	1	2	3	4	5	6	7
247.	ters	1	2	3	4	5	6	7
248.	top	1	2	3	4	5	6	7
249.	toplum	1	2	3	4	5	6	7
250.	toprak	1	2	3	4	5	6	7
251.	töre	1	2	3	4	5	6	7
252.	tren	1	2	3	4	5	6	7
253.	tunç	1	2	3	4	5	6	7
254.	türbe	1	2	3	4	5	6	7
255.	tutku	1	2	3	4	5	6	7
256.	tutsak	1	2	3	4	5	6	7
257.	uçak	1	2	3	4	5	6	7
258.	ulus	1	2	3	4	5	6	7
259.	umut	1	2	3	4	5	6	7
260.	us	1	2	3	4	5	6	7

Appendix 6 continued

261.	üvey	1	2	3	4	5	6	7
262.	üveyik	1	2	3	4	5	6	7
263.	uyarı	1	2	3	4	5	6	7
264.	uygar	1	2	3	4	5	6	7
265.	uyku	1	2	3	4	5	6	7
266.	uyuz	1	2	3	4	5	6	7
267.	uzman	1	2	3	4	5	6	7
268.	uzun	1	2	3	4	5	6	7
269.	vali	1	2	3	4	5	6	7
270.	vampir	1	2	3	4	5	6	7
271.	vefa	1	2	3	4	5	6	7
272.	verem	1	2	3	4	5	6	7
273.	verim	1	2	3	4	5	6	7
274.	vicdan	1	2	3	4	5	6	7
275.	yalan	1	2	3	4	5	6	7
276.	yalnızlık	1	2	3	4	5	6	7
277.	yasa	1	2	3	4	5	6	7
278.	yaşam	1	2	3	4	5	6	7
279.	yatak	1	2	3	4	5	6	7
280.	yaver	1	2	3	4	5	6	7
281.	yayla	1	2	3	4	5	6	7
282.	yazgı	1	2	3	4	5	6	7
283.	yazı	1	2	3	4	5	6	7
284.	yele	1	2	3	4	5	6	7
285.	yemin	1	2	3	4	5	6	7
286.	yeşil	1	2	3	4	5	6	7
287.	yetim	1	2	3	4	5	6	7
288.	yiğit	1	2	3	4	5	6	7
289.	yoksul	1	2	3	4	5	6	7
290.	yosun	1	2	3	4	5	6	7
291.	yürek	1	2	3	4	5	6	7
292.	yurt	1	2	3	4	5	6	7
293.	zengin	1	2	3	4	5	6	7
294.	zevkli	1	2	3	4	5	6	7
295.	zeytin	1	2	3	4	5	6	7
296.	züppe	1	2	3	4	5	6	7
297.	zurna	1	2	3	4	5	6	7
298.	deniz	1	2	3	4	5	6	7
299.	sendika	1	2	3	4	5	6	7
300.	hizmet	1	2	3	4	5	6	7
301.	uygulamak	1	2	3	4	5	6	7
302.	yeşil	1	2	3	4	5	6	7
303.	müjde	1	2	3	4	5	6	7
304.	örgüt	1	2	3	4	5	6	7
305.	sert	1	2	3	4	5	6	7
306.	tek	1	2	3	4	5	6	7
307.	oyun	1	2	3	4	5	6	7

Appendix 6 continued

308.	belge	1	2	3	4	5	6	7
309.	çerçeve	1	2	3	4	5	6	7
310.	müracaat	1	2	3	4	5	6	7
311.	deprem	1	2	3	4	5	6	7
312.	inat	1	2	3	4	5	6	7
313.	yavaş	1	2	3	4	5	6	7
314.	çocuk	1	2	3	4	5	6	7
315.	ev	1	2	3	4	5	6	7
316.	yazi	1	2	3	4	5	6	7
317.	araba	1	2	3	4	5	6	7
318.	genel	1	2	3	4	5	6	7
319.	devre	1	2	3	4	5	6	7
320.	taklit	1	2	3	4	5	6	7
321.	işlem	1	2	3	4	5	6	7
322.	zihin	1	2	3	4	5	6	7
323.	esnek	1	2	3	4	5	6	7
324.	ölçü	1	2	3	4	5	6	7
325.	dizi	1	2	3	4	5	6	7
326.	boşluk	1	2	3	4	5	6	7
327.	sakat	1	2	3	4	5	6	7
328.	dönem	1	2	3	4	5	6	7
329.	altin	1	2	3	4	5	6	7
330.	yaprak	1	2	3	4	5	6	7
331.	koltuk	1	2	3	4	5	6	7
332.	sınıf	1	2	3	4	5	6	7
333.	kural	1	2	3	4	5	6	7
334.	sabır	1	2	3	4	5	6	7
335.	öncelik	1	2	3	4	5	6	7
336.	sanayi	1	2	3	4	5	6	7
337.	tüfek	1	2	3	4	5	6	7
338.	kale	1	2	3	4	5	6	7
339.	kütüphane	1	2	3	4	5	6	7
340.	taviz	1	2	3	4	5	6	7
341.	islahevi	1	2	3	4	5	6	7
342.	çirkin	1	2	3	4	5	6	7
343.	eylem	1	2	3	4	5	6	7
344.	mahkum	1	2	3	4	5	6	7
345.	kısır	1	2	3	4	5	6	7
346.	denetim	1	2	3	4	5	6	7
347.	örf	1	2	3	4	5	6	7
348.	fakir	1	2	3	4	5	6	7
349.	görenek	1	2	3	4	5	6	7
350.	uyuşturucu	1	2	3	4	5	6	7
351.	evre	1	2	3	4	5	6	7
352.	gereksinme	1	2	3	4	5	6	7
353.	serüven	1	2	3	4	5	6	7
354.	düzey	1	2	3	4	5	6	7

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355.	önlem	1	2	3	4	5	6	7
356.	müddet	1	2	3	4	5	6	7
357.	lodos	1	2	3	4	5	6	7
358.	hiyanet	1	2	3	4	5	6	7
359.	feragat	1	2	3	4	5	6	7
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361.	gevrek	1	2	3	4	5	6	7
362.	istikrar	1	2	3	4	5	6	7
363.	öneri	1	2	3	4	5	6	7
364.	şeffaf	1	2	3	4	5	6	7
365.	şuuraltı	1	2	3	4	5	6	7
366.	beniz	1	2	3	4	5	6	7
367.	sela	1	2	3	4	5	6	7
368.	mutabakat	1	2	3	4	5	6	7
369.	mülkiyet	1	2	3	4	5	6	7
370.	tahrip	1	2	3	4	5	6	7
371.	ihale	1	2	3	4	5	6	7
372.	muhalefet	1	2	3	4	5	6	7
373.	ihtiras	1	2	3	4	5	6	7
374.	entrika	1	2	3	4	5	6	7
375.	nara	1	2	3	4	5	6	7
376.	eflatun	1	2	3	4	5	6	7
377.	istila	1	2	3	4	5	6	7
378.	körfez	1	2	3	4	5	6	7
379.	ihsan	1	2	3	4	5	6	7
380.	sıfat	1	2	3	4	5	6	7
381.	özel	1	2	3	4	5	6	7
382.	boyut	1	2	3	4	5	6	7
383.	somut	1	2	3	4	5	6	7
384.	aşama	1	2	3	4	5	6	7
385.	gelgit	1	2	3	4	5	6	7
386.	köstek	1	2	3	4	5	6	7
387.	bilimsel	1	2	3	4	5	6	7
388.	sakat	1	2	3	4	5	6	7
389.	kriz	1	2	3	4	5	6	7
390.	güngörmüş	1	2	3	4	5	6	7
391.	çağdaş	1	2	3	4	5	6	7
392.	saçak	1	2	3	4	5	6	7
393.	rengarenk	1	2	3	4	5	6	7
394.	parmaklık	1	2	3	4	5	6	7
395.	uçurtma	1	2	3	4	5	6	7
396.	uygarlık	1	2	3	4	5	6	7
397.	evrensel	1	2	3	4	5	6	7
398.	düzey	1	2	3	4	5	6	7
399.	algılama	1	2	3	4	5	6	7
400.	işlev	1	2	3	4	5	6	7
401.	kıyaslama	1	2	3	4	5	6	7

Appendix 6 continued

402.	bağlaç	1	2	3	4	5	6	7
403.	yetenek	1	2	3	4	5	6	7
404.	birey	1	2	3	4	5	6	7
405.	donanma	1	2	3	4	5	6	7
406.	özgeçmiş	1	2	3	4	5	6	7
407.	tezkere	1	2	3	4	5	6	7
408.	intizam	1	2	3	4	5	6	7
409.	kuşatma	1	2	3	4	5	6	7
410.	adil	1	2	3	4	5	6	7
411.	sürgün	1	2	3	4	5	6	7
412.	kasırga	1	2	3	4	5	6	7
413.	zaruret	1	2	3	4	5	6	7
414.	antlaşma	1	2	3	4	5	6	7
415.	miting	1	2	3	4	5	6	7
416.	veznedar	1	2	3	4	5	6	7
417.	gürz	1	2	3	4	5	6	7
418.	serseri	1	2	3	4	5	6	7
419.	kanun	1	2	3	4	5	6	7
420.	zelzele	1	2	3	4	5	6	7
421.	ok	1	2	3	4	5	6	7
422.	sömürge	1	2	3	4	5	6	7
423.	arşin	1	2	3	4	5	6	7
424.	eşya	1	2	3	4	5	6	7
425.	güven	1	2	3	4	5	6	7
426.	kalitsal	1	2	3	4	5	6	7
427.	mağdur	1	2	3	4	5	6	7
428.	neşriyat	1	2	3	4	5	6	7
429.	yarıçap	1	2	3	4	5	6	7
430.	izmarit	1	2	3	4	5	6	7
431.	evliya	1	2	3	4	5	6	7
432.	dehliz	1	2	3	4	5	6	7
433.	diyar	1	2	3	4	5	6	7

Appendix 7

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