Phonology, Orthography, and Reading Process

Chang H. Lee

Pusan National University, Korea
chleehoan@pusan.ac.kr

Increasing amount and types of studies have recently provided evidence for phonological recoding in word processing. This paper reviews three main hypotheses on the role of phonology in word recognition. A piece of experimental evidence supporting the role of phonology were summarized. Based on these previous research reviewed, the strength of the phonological recoding hypothesis is discussed as compared to other competing hypotheses.

Since the beginning of experimental research on reading, the majority of studies have concentrated on what is unique to reading: how do we access the meaning of a printed word? The main purpose of the study of word recognition is making a model based on empirical phenomena. There are numerous models, and the criterion of a good model depends on the degree of its explaining power about the empirical phenomena. One of the main issues in making a model is whether the phonological components in a word mediate the access to the meaning of a word when a reader processes a printed word. Of course, the orthographic input is necessary to convert letters into the phonological form of the word. The point is whether phonology mediates the access to the meaning or whether the initial orthographic input is directly associated with the meaning.

Ever since Rubinstein, Lewis, and Rubinstein (1971)'s seminal paper showing phonological interference in the lexical decision task, the role of phonology in word recognition has been debated. Although many previous studies argued that a word is processed only on a visual basis, the current trend of debate on this topic concerns whether phonological mediation is “universal” or “limited” (e.g., Lukatela & Turvey, 2000; Lukatela, Eaton, Lee, Carello, & Journal of Cognitive Science 5: 245 - 263, 2004. © 2004 Institute for Cognitive Science, Seoul National University.
A universal phonology supports the phonological mediation hypothesis, in which the access to the meaning of a word is mediated by the phonology of the word. In contrast, a limited phonology supports the limited phonology hypothesis, in which only some of the words are processed phonologically, not all words.

The major purpose of this paper is to review the evidence which supports the role of at least some phonological processing on word recognition. After briefly reviewing the hypothesis that supports only visual processing (hereafter “the visual hypothesis”), the evidence related with the two kinds of phonological hypotheses are reviewed: the evidence supporting the absolute role of phonology in accessing the meaning of a word (hereafter “the phonological recoding hypothesis”), and the evidence limiting the role of phonology (hereafter “the limited phonology hypothesis”). Finally, the discussion about all three hypotheses was followed.

1. Visual Mediation Hypotheses

Word recognition was traditionally assumed to be achieved on a purely visual basis (e.g., Baron, 1973; Becker, 1980; Bower, 1970; Cattell, 1986; Evett & Humphreys, 1981; Humphreys & Evett, 1985; Humphreys, Evett & Quinlan, 1990). The visual hypotheses assume that phonology plays no role in accessing the meaning of a word. Various types of visual processing have been proposed.

The earliest assumption about visual processing was based on the view that word perception is holistic (e.g., Cattell, 1886; Huey, 1968; Taylor, Miler, & Juola, 1977). In other words, the whole word pattern or shape is the processing unit, rather than the individual letters. For example, Cattell’s (1986) seminal study showed that a short familiar word can be identified as rapidly (or even faster) as any of its constituent letters. He concluded from this that we can not recognize a word by recognizing its letters, that we must instead be using the whole pattern or shape of the word as the unit of word recognition. Related to the holistic view, the template matching model was proposed. This model was based on the notion that there are stored templates for each word in our brain (Neisser, 1967; see Rayner & Pollatsek, 1987, for a review). The match between the input and the template was believed to determine the meaning
assigned to the input. There is, however, a serious defect in the template model. Many templates would be required for each word in our lexicon, for any word can appear in a variety of forms. So in order for this model to be operational, we would need to have numerous templates for each word, necessitating a huge memory load. A contrasting notion was pursued in which the whole word pattern was assumed to play a minimal or no role, and the letters were the basic processing unit. The fully-developed letter-based models of word recognition were the activation-verification model of Becker (1980) and the Interactive Activation model of McClelland & Rumelhart (1981). Specifically, Becker (1980) proposed an activation-verification model. He argued that the input of a letter string activates several candidate words which are visually similar to that letter string. Then these activated candidate words are compared with the letter string in sensory memory until the target word is recognized. High frequency words are assumed to be compared earlier than low frequency words, and this comparison is done in the verification stage. This is because words are assumed to be stored in the order of frequency of a word in the lexicon. This model assumed no role for phonology in either the activation or the verification stages. Secondly, the original interactive activation (McClelland & Rumelhart, 1981) model suggests that there are three basic processing units: features, letters, and words. Each is represented as layer of interconnected nodes. In particular, the different types of node layers are interconnected hierarchically. The adjacent interconnected layers excite or inhibit each other to produce the desired output. For example, interconnected units in the letter layer send excitation or inhibition to the units in the word layer, and the word layer sends excitation to the letter layer. The word node which receives the most activation from the letter nodes is activated. After activation, the activated word node inhibits other word units which received partial activation. This model argues that phonological processing does not take place until the word is recognized; instead, only visual processing takes place.

2. Phonological Recoding Hypotheses

In contrast to the visual mediation hypothesis, the phonological recoding hypothesis proposes that the phonological form of a word is automatically assigned to a word upon perceiving a word, and it mediates access to the
word’s meaning. Recently, studies using priming techniques have supported
the phonological mediation hypothesis (e.g., Lee & Turvey, 2003; Lukatela &
Turvey, 1993, 1994a, 1994b; Lukatela, Frost, & Turvey, 1999; Lukatela, Eaton,
Lee, Carello, & Turvey, 2002). The priming is the experimental task in which
two words are presented subsequently, and one of the words is the target for a
lexical task. The other word is called a prime that is usually manipulated by a
lexical variable. The results of these studies provide stronger evidence for the
role of the phonological route in accessing the meaning of a word, in that they
showed that the processing of the non-word and the word are similar in various
aspects. Here the term “route” means the pathway from the input of the
letterstring to activation of meaning of the letterstring or to the goal of the
output (e.g., naming). The similar processing across both types of stimuli
indicates that the word and the non-word are processed by the same route, the
phonological route, given that the processing of the non-word can only be done
by the phonological route. Lukatela and Turvey (1993) showed that the
pseudohomophone (the non-word of which pronunciation is same as a word)
and the word are affected to the same degree by a memory load. Specifically,
when there was a memory load of recalling digits in the naming task, the
reaction time of naming was decreased to the same degree for the
pseudohomophone (e.g., FOLE, HOAP) and its counterpart (e.g., FOAL,
HOPE). This indicates that the pseudohomophone and the word are processed
similarly, and, according to the researchers, it is phonologically. Lukatela and
Turvey (1994a) used semantic priming to demonstrate the role of phonology.
Semantic priming means that the prime and the target are semantically related
and that the processing of the target is supposed to be facilitated because of
their semantic relatedness (e.g., TOAD - frog). According to these researchers,
the assumption of automatic phonological mediation would predict that the
homophone of the prime (i.e., TOWED) would facilitate the processing of the
target frog. Their prediction was borne out: only the identical and the
homophonic primes facilitated processing the target, and no orthographic
priming occurred. In addition, a pseudohomophonic prime (e.g., TODE - frog)
facilitated the processing of a target more than did the graphic prime. This
pseudohomophonic prime has the same phonological form as the word, in this
case, TOAD. Thus, the facilitation by this prime indicates the role of
assembled phonology: TODE activated /tod/ which facilitated processing frog.
More importantly, the degree of facilitation was almost the same as that by a homophonic prime (similar RT and error rates). The experimenters argued that this similar degree of priming by both kinds of primes (e.g., TOWED and TODE) indicates the exclusive role of the common processing route of the dual route in priming: the phonological route which assembles each phoneme obtained from the application of the GPC (Grapheme Phoneme Conversion) rule. Subsequently, Lukatela and Turvey (1994b) designed a direct priming study. It showed that a homophonic prime (e.g., TOWED) facilitated the processing of the target (e.g., toad) more than did a graphic prime (e.g., TOLD) or the control prime. Also, the identical prime facilitated the processing of the target (e.g., TOAD - toad). This effect of phonological priming remains constant across three stimulus onset asynchronies (SOAs) (30, 60, and 250ms).¹ The manipulation of the SOAs reflects the timecourse of lexical processing. The shorter the SOAs, it is more likely to reflect the early locus (i.e., prelexical stage) of lexical processing. Lukatela, Eaton, Lee, Carello, and Turvey (2002) showed that the phonological priming for pseudohomophones (e.g., HOEZ-hoze versus HOGZ-hoze) was similar in degree with the phonological priming for words (e.g., KNOWS-nose versus KNEES-nose). These results are contrasted with those by Rastle and Coltheart (1999), in which the phonological priming including a word was better in facilitating the target than the phonological priming including only non-words in the priming task. The similar performance across the word and the non-word is supporting the phonological recoding hypothesis as described above.

Van Orden (1987, 1988) argued that we need to use a lexical task ensuring semantic processing. Thus, he used the semantic categorization task to study phonological mediation, due to the uncertainty of lexical access in naming. The main procedure of the semantic categorization task is to judge whether an exemplar (e.g., rose) belongs to a certain category (e.g., flower) or not. Thus, this task ensures access of meaning, and using the data on positive responses

¹ In the same study of Experiments 4-7, a pseudohomophone prime (e.g., TODE) facilitated the processing of a following target more than did an orthographic prime or a control prime. This trend was also consistent in various SOA conditions. The degrees of priming (i.e., RT, error rates) by pseudohomophones were almost the same as those by the homophonic primes.
will reveal the characteristics of early lexical processing. Van Orden used a homophone (e.g., ROWS) as a critical stimulus and compared the false positive ratio for the homophone versus that of the spelling control (e.g., ROBS). The idea is that the possible phonological processing of the homophone will activate the meaning of real exemplar (i.e., rose), as well as that of the foil homophone. If this is so, the rate of saying “yes” for the foil homophone (i.e., ROWS) would be significantly higher than that for the spelling control (e.g., ROBS). He showed a higher false positive ratio for the foil homophone, as predicted, and argued that the mediation of phonology is rapid. Another result, similar to that of the priming studies, is that the rate of false positives was not affected by the frequency of foil homophones. In other words, high and low frequency homophones were phonologically activated to the same degree. Based on this result, Van Orden argued that phonological activation is universal for all types of words. He conjectured that the statistical regularity between orthographic features and phonological features would determine the speed of conversion from orthography to phonology. In turn, the phonology can be connected with the meaning. Thus, Van Orden’s proposed process is slightly different than the phonological route of the dual-route hypothesis because it does not assume the rule-based phonology conversion. However, the assumptions are basically the same in the sense that the calculated phonology based on the relation between the orthography and the phonology mediates lexical access.

In a subsequent study, Van Orden, Johnston, and Hale (1988) consolidated the result of the first study. They showed that a pseudohomophone foil (e.g., BRANE) also produced a higher false positive ratio than the control foil in semantic categorization (e.g., Is it a part of the human body?). Furthermore, the false positive ratio was almost the same as that for the word homophone (e.g., HARE, for the question, “Is it a part of the human body?”). In addition, the latency to say “yes” for these pseudohomophones and homophone foils was the same as the latency for the real exemplars. Based on these results, he argued that phonology is activated through a kind of assembly process; the equal performance across different lexicalities serving as evidence for the same process of phonological assembly.

Methods other than priming have also supported phonological mediation. First of all, eye movement studies provided evidence of the early activation of
phonology (Henderson, Dixon, Peterson, Twilley, & Ferreira, 1995; Lee, Binder, Kim, Pollatsek, & Rayner, 1999; Pollatsek, Lesch, Morris, & Rayner, 1992). The main technique of eye movement studies is monitoring eye movements by an infrared light. Thus, the researcher can detect where the eye is landing on the text and how long it is fixating on a certain position. For example, Pollatsek, Lesch, Morris and Rayner (1992) found that when a homophone (e.g., SENT) of the target word (e.g., CENT) was on the parafoveal region before a subject would fixate on the target word, the fixation duration on the target word was shorter than when a visually similar word was in the parafovea. Thus, the preview of phonological components before actual processing of the target word is beneficial in processing. Secondly, Luo (1996) designed a semantic discrimination task. In this task, there are an experimental pair (e.g., lion-BARE) and a control pair (e.g., lion-BEAN). One word (e.g., lion) is the target and the other word is the distractor. The distractor in the experimental pair is the homophone of a word semantically related to the target in the experimental pair, and the distractor in the control pair is the graphemic control. The test item (e.g., WOLF) is semantically related to the target (e.g., lion), and the subject decides which word in the pairs relates to the test item. Luo hypothesized that if phonology is activated, the homophone in the experimental pair will interfere with performance, eliciting longer response times or higher error rates in the experimental pair trials. The results confirmed Luo’s hypothesis. Luo interpreted this result to mean that phonology mediated the access of meaning. Finally, Ziegler and Jacobs (1995) showed that the detection of a letter is not good when the stimulus is the pseudohomophone, as compared to the detection of a letter in a normal pseudoword or a word. For example, detecting the letter “I” in pseudohomophones like BRANE or TAIP was hard because their homophones include that letter (i.e., BRAIN) or not (i.e., TAPE). The subject produced more false alarms for a stimulus like BRANE, and more misses for a stimulus like TAIP. This indicates that the processing of the pseudohomophone was done on a phonological basis; it activated the phonologically matching real word.

3. Limited Phonology Hypotheses

Some compromising models (e.g., Coltheart, 1978; Rastle & Coltheart,
1999; Seidenberg & McClelland, 1989) adopt assumptions from both the phonological and visual mediation models. These models are based on the notion that most word recognition is direct, but allow for the fact that the skilled reader can make use of phonological recoding for reading very low frequency words and non-words. From this view, both types of processing, visual and phonological, contribute to lexical access, but visual processing predominates. It might be said that this hypothesis is a watered down version of the visual mediation hypothesis; phonology plays only a limited role in word recognition.

One of representative models of this kind, the dual route hypothesis can explain the role of phonology only for recognizing low frequency words and non-words (Carr & Pollatsek, 1985; Coltheart, 1978; Coltheart, Curtis, Atkins, & Haller, 1993; McCusker, Hillinger, & Bias, 1981; Paap & Noel, 1991; Tousman & Inhoff, 1992). Proponents of the dual route hypothesis argue that two routes are responsible for accessing the lexicon: the visual route (also called the direct route), and the phonological route (also called the indirect route). Different types of words are held to be processed by each route. A non-word (e.g., BLIKE) can only be processed by the phonological route, because the processing of the phonological route is done by the GPC rule application, not lexical activation. For example, b is converted to /b/, l is converted to /l/, and so on. An exception word (e.g., SHOE) can only be approached in the lexicon by the visual route, because applying the GPC rule would produce the wrong phonological form. One important assumption in the dual route hypothesis is that the processing speed of the visual route is faster than that of the phonological route. This indicates that most words are processed by the visual route, and that no phonological mediation occurs for these words. In contrast, only low frequency words are processed by the phonological route, and phonological mediation is limited to these words.

One of the primary pieces of evidence for the limited role of phonology was found in the limited regularity effect (e.g., Andrews, 1982; Coltheart, 1978; Gough & Cosky, 1977; Seidenberg, 1985; Seidenberg, Waters, Barnes, & Tanenhaus, 1984; Waters & Seidenberg, 1985; Waters, Seidenberg, & Bruck, 1984). The regularity effect refers to the phenomenon of exception words being processed slower than regular words. Specifically, a regular word (e.g., BRAIN) whose correct phonological form can be attained by the GPC rule
shows faster reaction time in its processing than an exception word (e.g., COLONEL), whose correct phonological form depends only on the addressed route. This is because a regular word elicits no conflict between the phonological form produced by the assembled route and the one by the addressed route, whereas only the addressed route can produce the right phonological form for an exception words. Here, we cannot depend on the phonological route to process the exception word because the wrong phonological form by the assembled route interferes with the correct processing of an exception word. Thus, the slower processing for the exception word indicates that the phonological route is playing a role. In this sense, the regularity effect is often used as evidence for phonological mediation. One important fact about the regularity effect is that only low frequency words elicit regularity effects in lexical tasks. This limited range of the regularity effect supports a minor role for phonological processing in word recognition. In addition, a greater degree of phonological interference for low frequency words is also compatible with the assumption of the dual route hypothesis. Low frequency words allow the GPC rule to be more active because low frequency words take more time to process than do high frequency ones.

Another evidence can be found, based on the existence of two different types of dyslexics: the surface dyslexic and the deep dyslexic. Coltheart (1978) found that the surface dyslexic can read regular words and nonwords correctly, but reads exception words incorrectly. The deep dyslexic can read some exception words well, although they don’t read well in general. It was assumed for the surface dyslexic that the phonological route can process both regular word and pseudowords well, but that the orthographic route, which can process the exception word, is impaired. In contrast, the deep dyslexic person is assumed to have an impaired phonological route, sparing the orthographic route. The existence of the two types of dyslexia supports the dual route hypothesis in the sense that it shows the double dissociation of the two routes. However, the distinction between the performances of the two types of dyslexic is not clear cut. In other words, some surface dyslexics can process some exception words correctly, and some deep dyslexics can process regular words correctly (Humphreys & Evett, 1985). Thus, it is difficult to infer that the two routes are dissociated precisely. Furthermore, the performance of the
dyslexic cannot readily be generalized to the normal reader: there is no indication that the processing of the word by the normal reader is the same as that of the dyslexic.

Evidence of the existence of two independent routes for word reading in our brain is noteworthy. Specifically, the visual mediation hypothesis does not assume the existence of the phonological route. Likewise, the phonological mediation hypothesis argues that there is no convincing evidence for the existence of the visual route (Van Orden, Pennington, & Stone, 1990). Although the very existence of the two routes does not directly implicate the involvement of both routes in word recognition, the evidence that shows the existence of the two routes weakens the two extreme positions and provides grounds for the role of both phonological and orthographic processing. Recently, double dissociation of the processing of the two routes, demonstrated by different kinds of regularity effects, indicated the existence of two routes (Bernstein & Carr, 1996; Herdman & Beckett, 1996; Paap & Noel, 1991; Pugh, Rexer, & Katz, 1994). Specifically, the regularity effect disappeared when a phonological task (i.e., digit memorization) was imposed as the interference task. The phonological task was argued to interfere with the assembly process by the phonological route. Subsequently, a lack of competition between the orthographic route and the phonological route elicited faster processing for exception words. In contrast, a visual task (i.e., dot pattern memorization) requirement elicited more regularity effects, compared to the baseline condition. This indicated that greater involvement by the phonological route impairs the correct processing only for the exception words, because it produces an incorrect phonological form. These results suggest that both routes in the dual route hypothesis actually exist in our brains and emerge through the interference tasks. In addition, the different degrees of phonological processing due to the memory load indicates the flexibility of phonological processing.

Finally, Jared and Seidenberg (1991) conducted a study similar to Van Orden’s (1987). They compared the false positive error rates for pseudohomophones (e.g., BARE) and normal words (e.g., BEAT) in semantic decision for a category (e.g., living thing). Jared and Seidenberg (1991) argued that there were serious defects in Van Orden’s study (1987, 1988), and that a revised study was necessary. First of all, they argued that the first study used narrow categories which can elicit preactivation for candidates. That is, the
categories in Van Orden's study were so small that they activate its members before the actual target process. For example, the category, part of a horse's harness, can induce a subject to preactivate potential targets (e.g., bit, rein). Thus, this preactivation of phonological forms might affect the false positive ratio for subsequent foil homophones (e.g., RAIN). Jared and Seidenberg (1991) used the categories (i.e., living thing, object) which include a broad range of members, in order to minimize such preactivation.

Another important criticism of Van Orden's study by Jared and Seidenberg was that the first study did not control the frequency of exemplars. The high frequency homophone foil usually matched with the low frequency exemplar, and the low frequency homophone foil usually matched with the high frequency exemplar. Thus, foil frequency was confounded with exemplar frequency. Jared and Seidenberg pointed out that phonological activation for the high frequency foil might be due to the possible influence from the low frequency exemplar. The activation of the low frequency exemplar might slow down the processing of the high frequency foil.

Jared and Seidenberg's study corrected the defects in the first study, and revealed that phonological activation did not prevail. Specifically, the false positive ratio was higher than the spelling control only for the low frequency homophone foil (e.g., BAWL-child's toy). The high frequency homophone foil (e.g., BREAK-car part) did not show substantial false positive ratio. They interpreted this result as indicating that phonological mediation is not predominant, but is very limited with only low frequency words processed by the phonological route.

4. Discussion

The presence of the role of phonology in many studies can not be explained by the visual hypothesis. Specifically, proponents of the visual hypothesis commonly argued that the orthographic information is activated first for all types of words, and then phonological information follows. For example, for the processing of the homophone TOWED, as the prime in the previous priming tasks, the orthographic form of the prime is activated first, and accesses the meaning of the word towed. Subsequently, the phonological forms of TOAD and TOWED are activated together. Finally, the phonological form
of TOAD activates the corresponding targets (i.e., toad or frog). The visual hypothesis predicts that there would be no performance difference between the phonological manipulation and the orthographic manipulation in the fast time scale priming studies. Taft and Graan (1998) proposed an interesting variation of the visual hypothesis. They suggested that there can be automatic phonological activation which does not access the meaning of a word. Instead, orthography directly accesses the meaning. They argued that activated phonology just rebounds to provide another orthographic form rather than accessing the meaning unit ("Orthography → Phonology → Orthography" (O → P → O) as Taft & Graan described). For example, if the phonological form of the target break is activated in the semantic tasks, then the phonological form rebounds to activate the homophone of the target, brake. This is why there is confusion in semantic categorization and semantic discrimination for the processing of homophones. Likewise, if the phonological form of the prime TOWED is activated in the priming task, then the phonological form rebounds to activate the orthographic form of the homophone of the prime, TOAD. If the homophones are activated rapidly by this mechanism, then it is possible to explain the results of the priming tasks. Thus, Taft and Graan’s model can explain most of the evidence for phonological recoding including the evidence for the limited phonological recoding. However, this model has major limitations. First, it is an ad hoc explanation to accommodate the evidence supporting the phonological recoding hypothesis. A phonological form is rebounded to another orthographic form without connecting to its semantic node is just an interesting idea with no evidence to prove it. Their experiments based on the null effect of regularity effects can also be explained by the traditional visual hypothesis that does not include the concept of rebounding phonology. Thus, until there is a serious evidence for this new model, adhering to the former contrasting hypotheses is legitimate without introducing a new hypothesis.

Secondly, the limited phonology hypothesis also has a difficulty in explaining the role of phonology in many studies. Specifically, the horserace model, one of the main limited phonology hypotheses, can not explain the results either. It allows that the two horses of the phonological route and the orthographic route are activated at the same time when we perceive a word. Here, the speed of the orthographic route horse is assumed to be faster than the
other one. Thus, the influence of the phonological route horse is effective only when the orthographic route horse is slow, such as if processing very low frequency words. The performance for most frequency range of stimuli in many previous studies should show indications of visual processing if the horserace model is correct. However, consistently better processing for the phonological condition than for the orthographic condition in the previous studies using high frequency words is contrary to the prediction of the horserace model. In order to explain the result of the previous experiments, the characteristics of orthographic and phonological horses in the horserace model should be reversed.

The explanatory power of evidence supporting the phonological mediation hypothesis is stronger than the evidence supporting the limited phonology hypothesis in several aspects. First of all, the parallel distributed processing model and the dual route hypotheses are able to explain the greater regularity effect in low frequency words by assuming that the phonological route/unit plays a role when the visual route/unit is slow. The main defect of explaining the regularity effect in this way is that it is the ad hoc assumption the theories adopted. The theories did not predict this type of regularity effect in advance, but the assumption of theories just fit the empirical phenomenon. Secondly, Berent (1997) challenged the legitimacy of the regularity effect as evidence for limited phonological processing. She argued that the subject can still use a phonological form of the consonants for the words when there is a null effect of the regularity effect for high frequency words. Specifically, most regularity effects arise from the inconsistent relationship between vowels and their phonemes. This tells us that no effect of regularity in the high frequency word only means no phonological mediation for the vowel, not for the remaining part of the word, the consonants (see Frost, 1998 for the concept of “abstract phonology”). Thus, the absence of a regularity effect can not be used as evidence for the absence of the phonological mediation of the whole letter strings. The consonants in a word might depend on the phonological assembly even when there are no regularity effects for high frequency word recognition. In Berent’s experiments, she combined two traditional markers: the regularity effects and the priming effects. The same amounts of significant phonological priming for both regular and exception words were found and at the same time there are no regularity effects in the lexical decision task. This means that the
exception word might be processed phonologically, and consonants in a word are responsible for this phonological assembly. This study indicates that the validity of evidence of the limited phonology hypothesis is significantly weakened: null effects of the regularity effect in high frequency word recognition do not necessarily indicate predominant visual processing; consonants can be still processed phonologically here.

Then, does phonology mediate lexical access for all words? The argument of the absolute role of phonology in the phonology recoding hypothesis would not indicate that all words should be processed phonologically. Like the argument of the limited phonology hypothesis about frequency dependent processing, the phonology mediation hypothesis would also allow a certain degree of orthographic processing for high frequency words. The matter of degree in phonological processing is important. The degrees of orthographic processing in the phonological mediation hypothesis are minimal. Only some portion of high frequency words are processed orthographically, and others are dominated by the phonological processing. In contrast, the limited phonology hypothesis suggests that most high frequency words are processed orthographically, and that only low frequency words are processed phonologically. In addition, the degree of phonological processing could be different according to different types of words. The processing of homophones should depend on the orthographic processing to a certain degree to access the right lexicon. Also, the processing of homographs that have multiple phonology (e.g., bow), or a word that has multiple meaning (e.g., bug), should be somewhat dependent on sentence context. In sum, there is room for orthographic processing or context to play a role in lexical access. However, the phonological recoding hypothesis argues that the role of orthography and context is highly restricted and is supplementary on word recognition.

In sum, the visual hypothesis argues the exclusive role of visual processing for word recognition. However, this hypothesis is disappearing because there are tremendous amounts of evidence that at least some role of phonology is involved in the processing of the word. Thus, the supporters of two phonological hypotheses are competing to develop the evidence to consolidate their arguments. The main difference between the phonological mediation hypothesis and the limited phonology hypothesis is the different ranges of phonological mediation. The phonological mediation hypothesis argues that
phonological mediation occurs for almost all kinds of words, whereas the limited phonology hypothesis argues that only low frequency words or non-words elicit phonological mediation. Thus, testing the range of phonological mediation would provide evidence for either of the two hypotheses. Especially, testing whether the high frequency word is processed phonologically or not can be a criterion to support one of the two hypotheses. Showing the phonological mediation in high frequency word processing is supporting the phonological mediation hypothesis. In contrast, failing to show the phonological mediation in high frequency word processing would indirectly support the limited phonology hypothesis. As argued above, there is substantial and convincing evidence for the role of phonology throughout high frequency ranges, supporting the phonological mediation hypothesis than the limited phonology hypothesis.

However, we need to acknowledge that the types of evidence supporting each hypothesis are too few to draw a firm conclusion. Specifically, the data from the various priming studies, the eye movement study, and the letter identification study supported the phonological mediation hypothesis. Likewise, the seminal semantic categorization study (Jared & Seidenberg, 1991), the double dissociation of the two routes, and the greater regularity effects in low frequency word processing supported the limited phonology hypothesis. Following this reality, a current trend is to try to come up with new idea with a variation of existing lexical tasks. The typical examples are the introducing new stimuli to priming tasks (Lee and Turvey, 2003), semantic discrimination task (Luo, 1996), and the letter identification task (Ziegler and Jacobs, 1995). These effort will provide a converging evidence for the role of phonology.

References


Waters, G. S., & Seidenberg, M. S. (1985). Spelling-sound effects in reading: Time...
