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Phonological Processing of Japanese Kanji Characters

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THESIS APPROVAL

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ABSTRACT

An abstract of the thesis of Randy L. Evans for the Master of Arts in Teaching English to Speakers of Other Languages presented January 29, 1998.

Title: Phonological Processing of Japanese Kanji Characters

The purpose of this study was to investigate the lexical access of Japanese kanji characters, particularly the access of *on*-readings and *kun*-readings, which are different pronunciations that kanji may realize in different contexts. A modified Stroop experiment was used, using drawings instead of colors, in which subjects were to call out what they saw in the drawings while ignoring written distractors. The following three conditions were used:

1. A Kunyomi condition, which offered a distractor that is graphically and phonologically identical to the character that represents the object in the drawing,
2. An Onyomi condition, which offered a distractor that is graphically identical but phonologically incongruent, and

3. An Incongruent condition, in which the distractor was both graphically and phonologically incongruent.

Subjects were 30 native Japanese speakers attending Portland State University in Portland, Oregon, who had completed at least secondary education in Japan. All subjects should be considered proficient readers of kanji.

The following hypotheses were posed:

1. There would not be a significant difference between the Onyomi condition and the Incongruent condition, suggesting a weak role for visual processing in kanji recognition.
2. The Kunyomi condition would be significantly faster than both the Onyomi condition and the Incongruent condition, suggesting a strong role for phonological processing in kanji recognition.

These hypotheses were not realized. The Onyomi condition did not demonstrate a significant difference from either the Incongruent condition or the Kunyomi condition. In fact, though both differences were non-significant, the Onyomi data were more similar to the Kunyomi data than the Incongruent data, contrary to the hypothesis.

The fact that the Kunyomi condition was significantly faster than the Incongruent condition suggests that there is a strong role for phonological processing in kanji recognition. Unfortunately, the data suggest nothing statistically concerning visual processing. However, the direction of the data leads one to conjecture that visual processing may also play a role in kanji recognition, though less powerful.

PHONOLOGICAL PROCESSING OF JAPANESE KANJI CHARACTERS

by

RANDY L. EVANS

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This work is

DEDICATED

to the memory of

SACHIKO AOKI

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A work of this size is rarely completed by a single person, and this study is no exception. I would like to take this opportunity to thank those people without whose contributions this work could not have been completed. I will make no attempt to make this page interesting, rather I will simply jump in with a list that is in no particular order.

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CHAPTER 1

INTRODUCTION

Statement of the problem

There has been a long-standing debate in reading research on whether words are recognized visually, or if there is an intermediate phonological step necessary for word recognition. Over the last 30 years, this issue has been of great interest to psychologists, (psycho)linguists, and reading educators.

Many researchers support what is referred to as a "direct visual access" model of word recognition, which states that phonological recoding is not necessary to arrive at the meaning of a word. In fact, this model holds that meaning must be accessed in order to arrive at a phonological representation. In contrast, many researchers believe that phonological processing plays a larger role in word recognition, though few actually believe that a phonological representation is <u>necessary</u> to access meaning.

In short, pretty much everyone agrees that both visual processing and phonological processing occur in skilled reading. The debate is over the <u>order</u> of these processes. Specifically, does phonological processing take place <u>before</u> an entry from the lexicon is accessed (pre-lexical access) or <u>after</u> (post-lexical)?

This issue had been investigated by means of different interference tasks over the last 30 years, one such paradigm being the Stroop effect. This refers to the difficulty in ignoring written words when tasked with a conflicting visual identification exercise. Stroop (1935) originally asked his subjects to name the color of ink in which a word was written, rather than reading the word itself. If the ink was blue, he found a quicker response time if the word written is also "blue" than if it is "green." It has been demonstrated that this holds true even when using homophonous nonwords such as "bloo" and "grene" (Gough & Cosky, 1977).

This debate takes on a slightly different nature in the field of education. Researchers here are more concerned with providing support for either whole-word recognition models of reading instruction or phonics-based models. Golinkoff and Rosinski (1976) performed a different Stroop-like experiment in which they presented simple drawings to schoolchildren, and asked them to name the objects shown in the drawings. Written on the drawings as distractors were simple English words or nonwords, which the students were to ignore as they named the objects in the pictures.

Again, response times were quicker when the distractor matched the drawing (e.g., drawing of a cat with the word "cat" written on it) than when it did not (drawing of a cat with the word "dog", or a nonword such as "lig", written on it).

Gough and Cosky (1977) support a theory that English speakers read phonetic segments sequentially, "letter by letter" so to speak. In the case of nonalphabetic scripts, it is obviously not possible to read "letter by letter". Indeed, many researchers have raised the question of how the phenomenon discussed above might operate in the processing of different orthographic systems.

The world's writing systems can be broadly divided into three categories; alphabet, syllabary, and logography. This study will specifically be concerned with the processes involved in reading a logographic orthography. Unlike alphabetic and syllabic characters, which represent a unit of sound and carry no meaning, logographic characters represent a unit of meaning (the morpheme) and have no analytically phonological basis (Gleitman & Rozin, 1977; Taylor, 1987). The only known logograms used in the modern world are Chinese characters. These logograms are used exclusively in Chinese, extensively in Japanese, and moderately in Korean (Taylor, 1987; Tzeng & Wang, 1983).

The point where this logographic script differs most from English is the semantically-based nature of the characters. In

Chinese, for example, the semantic quality of each character is consistent across dialects, even though the different dialects are phonologically so dissimilar that speech is often mutually unintelligible.

In the case of Japanese, one character can actually realize one of several pronunciations, depending on its context (this will be discussed further later). As in the case of Chinese dialects, the consistent element of each character is its meaning. In Korean the characters realize one pronunciation of Chinese origin. Even across these languages the semantic quality of the characters remains largely the same.

Due to the nature of logographic script, many researchers postulate that it is not processed phonologically (Feldman & Turvey, 1978; Koda, 1987; 1990; Sasanuma, 1975). They argue that the meaning of a logographic character is accessed first, and that the pronunciation is processed secondarily. On the other hand, other studies provide evidence that suggests there is some phonological recoding involved in the processing of logographic characters (Erickson, Mattingly & Turvey, 1977; Mou & Anderson, 1981; Shwedel, 1983). The very nature of logographic script throws a new twist on the ongoing argument concerning lexical access in reading.

Studies involving Stroop or Stroop-like effects, similar to those done with English readers, have also been performed with readers of logographic scripts (Biederman & Tsao, 1979; Fang, Tzeng & Alva, 1981; Hung, Tzeng & Tzeng, 1992). Hung, Tzeng and Tzeng conducted a Stroop-like experiment similar to that done by Golinkoff and Rosinski (1976), but using Chinese materials and Chinese subjects. They presented subjects with drawings on which written distractors were superimposed. They created seven test conditions, using distractors that varied in visual and phonological similarity to the character which represents the object in the drawing, creating conditions where the characters were visually similar, phonologically similar, both, or neither. Their seven conditions were 1. Completely Congruent, 2. Completely Incongruent, 3. Similar Graph/Same Sound, 4. Similar Graph/Different Sound, 5. Different Graph/Same Sound, 6. Different Graph/Different Sound, and 7. Psuedo-Character (these conditions will be explained more fully in Chapter 2).

As might be expected, the Completely Congruent condition yielded the quickest response times and the lowest error rate, and the Completely Incongruent condition yielded the longest response times and the highest error rate. These results suggest some phonological processing of logographic characters for Chinese speakers. It appears that the pronunciation of the characters created interference in the picture naming task.

How would this phenomenon operate in Japanese speakers' processing of these characters? Such a research question would be more than simply a replication with a different subject population, due to major differences in how the script operates in Japanese.

As mentioned earlier, one very interesting difference in the character script as used in Japan is the number of pronunciations that the characters may realize. In the Chinese system, one character will realize only one pronunciation (in each dialect). The same is true of the characters' use in Korea (in Korean the characters realize Sino-Korean pronunciations). In such a system, it is obviously impossible to create a condition such as "Same Character/Different Sound", but this is possible with Japanese orthography, where the characters can realize multiple pronunciations.

In Japanese, many Chinese pronunciations (called *on*-readings, or onyomi in Japanese) were borrowed along with the characters themselves, with native Japanese pronunciations (called *kun*-readings, or kunyomi) also retained. This has led to a system where one character, though retaining its semantic representation, will realize different pronunciations in different contexts.

For example, the character 魚, which means "fish", is pronounced /sakana/. The phonological representation /sakana/ is a free morpheme, the character realizes this pronunciation in isolation, and also in some compounds such as the word 魚屋 "sakanaya" (fish store). However, in most compounds the character will be realized as the bound morpheme /gyo/, as in a combination such as the word

魚類 "gyorui" (kinds of fish). The character retains its semantic representation (see Table 1).

Table 1

Multiple pronunciations of a single kanji character

Characters	Pronunciation	Meaning	pronunciation of 魚
魚	/sakana/	fish	魚 = /sakana/
魚屋	/sakanaya/	fish store	魚 = /sakana/
魚類	/gyorui/	kinds of fishes	魚 = /gyo/

Therefore, if two-character Japanese stimuli are used, it is possible to retain the visual and semantic representations of a character while radically altering its phonological representation. This kind of variation on the previous research can throw further light on the nature of phonological and semantic processing of logographic characters.

Purpose of this study

The purpose of this study is to examine the extent to which the recognition of Chinese logograms, used as Japanese kanji characters, is phonologically mediated. Many previous studies have explored this phenomenon in Chinese speakers, utilizing different kinds of interference tasks in the naming or recall of Chinese logograms. As mentioned above, Hung, Tzeng and Tzeng performed a picture-naming task with seven test conditions, involving characters that are visually and phonologically similar and dissimilar.

The nature of Japanese orthography allows for a complete change in the pronunciation of a character without affecting its semantic properties. Using this ability to manipulate the pronunciation, this study implements the same test design as Hung, Tzeng and Tzeng, and Golinkoff and Rosinski. It will involve three test conditions utilizing Japanese materials with Japanese subjects.

What effect would the nature of Japanese kanji orthography have on the performance of this kind of task? By using two-character kanji compounds, it is possible to completely change the phonological representation of kanji characters (by changing the environment in which they appear). Given that, it would be possible to create a condition wherein the first character of a compound would be graphically identical, but phonologically incongruent to the character that represents the object in the drawing! In Hung, Tzeng, and Tzeng's terms, this is, essentially, "Same Character/Different Sound".

This study proposes a design with three conditions (seen in Figure 1). One condition could be a "Kunyomi condition", where the first character of the compound would represent the object in the drawing, both semantically and phonologically (even though the lexical

Figure 1

Test Condition 1 - the Kunyomi Condition

First character matches the object semantically and phonologically

魚 - /sakana/ - "fish"
屋 - /ya/ - "store"
魚屋 - /sakanaya/ - "fish store"

Test Condition 2 - the Onyomi Condition

First character matches the object semantically but not phonologically

魚 - /sakana/ - "fish"
類 - /rui/ - "variety"
魚類 - /gyorui/ - "kinds of fishes"

Test Condition 3 - the Incongruent Condition

Neither character matches the object, semantically or phonologically

歯 - /ha/ - "tooth"
形 - /kata/ - "shape"
歯形 - /hagata/ - "teeth marks"

item presented, being a compound, will be a little different, compare "dog" and "doghouse"). An example of this is the lexical item "sakanaya". A second condition could be an "Onyomi condition", where the first character of the compound would represent the object in the line drawing semantically but not phonologically, as in "gyorui". A third condition could be an Incongruent condition, where both characters of the distractor would be completely unrelated, both semantically and phonologically, to the object in the drawing. The level of interference will be measured by the time it takes to complete the task, in seconds. Since the Onyomi condition and the Kunyomi condition are distinguished phonologically, a greater amount of interference in the Onyomi condition would suggest that character recognition is phonologically mediated.

Research Question

This study is designed to investigate the extent to which phonological mediation affects the reading of Japanese kanji-compound words by native speakers. Specifically, the following research question is addressed:

Research Question

Are Chinese characters, as used in Japanese, phonologically mediated when read by native speakers?

To answer this question, this study will present subjects with sets of kanji characters and line drawings. Subjects will be asked to name the object in the drawing, and to ignore the printed word. Three different test conditions will present three different kinds of distractors. The Kunyomi condition will present a character that realizes both the same phonological representation and the same semantic representation of the character that represents the object in the drawing. The Onyomi condition will present a character that realizes the same semantic representation of the word for the object in the drawing, but a completely different phonological representation. The Incongruent condition will a present a character that realizes completely different representations, both semantically and phonologically.

Based on the large corpus of previous research, it is expected that the Kunyomi condition and the Incongruent condition will demonstrate a significant difference, suggesting that phonological (and/or visual) representation have an effect on character recognition. Since the Onyomi condition and the Kunyomi condition differ only in their pronunciation, a difference in response times for these two conditions should demonstrate a dependence on phonological representation in reading, and a lack of difference between the Incongruent condition and the Onyomi condition should suggest the same conclusion. I expect that the Kunyomi condition shall produce times that are much faster than either the Onyomi condition or the Incongruent condition, and that the times for the Onyomi condition and the Incongruent condition will be very similar. This will suggest a strong role for phonological mediation in kanji recognition.

Summary

Of all the orthographies used in the modern world, logograms of Chinese origin comprise the script that is the most different from English orthography (an alphabet). There is some controversy concerning how much phonological processing is involved in reading characters such as these. However, the manner in which they are used in Japan suggests that there must be at least some phonological processing in that the characters can be pronounced differently depending on their context in kanji compounds. If there were no phonological processing involved, then readers would never know how to pronounce these words when reading them. The question now becomes when this processing takes place, before or after the meaning of the word is accessed.

This study investigates the issue of phonological mediation through an interference task. A high degree of interference in the Onyomi condition will suggest a high degree of mediation. Exploring this phenomenon in the use of Chinese logograms in Japanese orthography can only deepen our understanding of phonological mediation involved in reading logographic characters, and will further relate to a much more general issue about phonologically mediated reading in any language.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Introduction

There exists in the field of reading research a long-standing debate on whether silent reading is phonologically mediated. That is, do we understand the meaning of a word upon sight, without any phonological mediation, or is it necessary to reach a phonetic representation of the word to access its meaning? The former is often called the "direct visual access" (print-to-meaning) hypothesis, and the latter the "phonological mediation" hypothesis.

Furthermore, there has been a great deal of research done investigating how the world's different languages are written, and how these different writing systems are read by skilled readers of those languages. This has led to the hypothesis that different kinds of scripts must require different kinds of cognitive processing (Hung & Tzeng, 1981). Of particular interest is the Chinese script, comprised of visually complex characters that are based on meaning rather than sound. Since there is no analytic connection between the characters and their phonetic representations, it has been postulated that they must necessarily be processed from print directly to meaning. However, many researchers disagree with this theory. This chapter discusses the issue of word recognition in English, offers an overview of the world's orthographic systems in general, and of the Chinese character script in particular (with an emphasis on its use in Japanese), studies of Japanese dyslexic aphasia patients, and the issue of phonological mediation in the reading of Chinese logograms.

Word recognition in English

As mentioned above, there are two theories that represent two extremes of the lexical access issue. The direct visual access theory holds that words are recognized holistically, accessed directly from the written word to the lexical representation, i.e., to meaning. Under this model, the meaning of a word must be understood in order to arrive at the pronunciation. In contrast, the phonological mediation theory claims that words are recognized after accessing a phonological representation from the printed word. It is necessary to arrive at a phonological representation in order to arrive at meaning. Some researchers support a dual-route hypothesis, holding that both these processes play a role in word recognition.

Direct visual access theory

Several researchers believe that words are processed directly from print to meaning, without any phonological mediation. A very early version of this theory is provided by Smith (1973), who argues that sentences (either read or spoken) cannot be decoded word-for-word, and therefore cannot be read letter-by-letter. He provides as evidence for this the case of homophones, saying that if we gathered meaning from sound, rather than sound through meaning, we would not be able to recognize the mischosen homophones in the following sentence:

> The none tolled hymn she had scene a pare of bear feat inn hour rheum. (p. 72)

He claims that our ability to understand the misuse of the above words shows that we gather the meaning of written words from their visual properties, and that in fact it is necessary to come to an understanding of the meaning to produce a phonological representation.

Smith also offers the following as evidence that meaning facilitates reading:

1. Words are recognized faster when in a meaningful context.

2. In the case of sentences with the same underlying meaning (for example, passive and active constructions), neither individual sentence enjoys a closer realization to the "actual meaning".

3. The correct pronunciation of homographs, words pronounced differently yet spelled the same (e.g., "wind", "bow", etc.), must be gleaned from context.

While much has changed since Smith's work in 1973, some researchers today still support a less extreme version of the direct visual access model. Cunningham and Cunningham (1978), investigating the direct visual access hypothesis in fluent readers, conducted an experiment with forty-seven fifth and sixth graders and fourteen graduate students. They presented the subjects with a passage about six imaginary fish. Half of each group were given a passage with pronounceable nonsense words as the names of the fish: Mintex, doffit, pontud, dulment, pemtad and mastib. The other subjects were given a passage in which the fish were given unpronounceable names: Mnitxe, dfofti, pnotdu, dlumte, pmetda, and msatbi (these nonsense words are, more specifically, violations of the phonographic rules of English). Cunningham and Cunningham postulated that if the lexical hypothesis holds true, there would be no effect on rate or recall of reading. However, this did not prove to be the case. Both rate and recall were significantly slower in the groups who were presented with unpronounceable words. This seems to support the phonological mediation hypothesis. However, Cunningham and Cunningham do not abandon the direct visual access hypothesis. Instead, they suggest that the effect is due to phonological coding involved in short-term memory storage (to be discussed later).

Rossmeissl and Theios (1982) presented subjects with letter strings and asked them to identify the first letter. Recall was better when the string was a word or pronounceable nonword than when it was an unpronounceable string of letters. This provides evidence for direct visual access in that letters that appeared after the target symbol affected the recall of the letters that appeared initially in the string. This seems analogous to the way we read *$4* in reversed order, as "four dollars". They also found that single letters were named fastest in isolation.

Other arguments for lexical retrieval concern Chinese writing, and the congenitally deaf (Rozin & Gleitman, 1977). In Chinese writing, characters represent the meanings of words, rather than their sounds. It is taken for granted that these characters are necessarily processed visually, and do not involve any phonological mediation. As for the case of readers who are born deaf, the fact that they have learned to read at all demonstrates that phonology is not necessary to understand written text. However, Rozin and Gleitman report that congenitally deaf readers, as a group, read very poorly.

Phonological mediation

In opposition to direct visual access is the theory of phonological mediation, i.e., that meaning is accessed through the phonological representations of words. Thinking back to Smith's example sentence of mischosen homophones (without looking, please!), ponder what version you recall best. Is it the collected meaning of the list of mismatched words, or is it the meaning of the homophonous sentence represented? I will hazard a guess that most people remember the homophonous (and meaningful) sentence rather than the meaningless list of actual written words. This is clearly a case of meaning gleaned from the sound of words, and not their written representations (however, this is not as simple as presented here, as I will address later in my discussions of short-term memory and chunking).

Apparently, very few, if any, researchers support a pure, extreme model of the phonological mediation hypothesis. Most support for this theory seems to merely assert that such mediation exists (in contrast to direct visual access theorists who claim that it does not), rather than saying that it exists exclusively.

Such support is usually in the form of what Rayner and Pollatsek (1989) call the regularity effect and the pseudohomophone effect. The former involves comparing response times of regularly or irregularly spelled words, and the latter deals with using homophonous nonwords as experimental foils (such as "grean"). Examples of such research are Seidenberg (1985), who found that lower-frequency English words are named faster if they have regular spelling, and Van Orden (1987), who conducted a semantic classification test with homophone foils. He found the homophone foils were often misclassified (e.g., the word "rows" being classified as a flower).

Rayner and Pollatsek claim that the results of studies concerning the regularity effect have been inconsistent. The pseudohomophone effect, on the other hand, has produced pretty consistent results. However, they present two points on which this research has been criticized. The first is that while the pseudohomophone effect does provide evidence for phonological processing in deciding the lexicality of words, it does not establish that it plays a role in the lexical access of real words. The second argument is that the pseudohomophone effect may in fact be a visual phenomenon, in that pseudohomophones look very much like the real words. However, Van Orden (1991) presents data showing that nonhomophonous nonwords that look just as similar as homophonous nonwords do not induce proofreading errors (Van Orden's study will be discussed in more detail later).

Dual-route theory

Coltheart (1978) explains the theory that a reader's knowledge of the words of his language is stored as an internal lexicon. He claims that this lexicon contains the reader's knowledge of each word that he knows, including information such as spelling, pronunciation and meaning. Coltheart asserts that there are at least two lexicons, one for phonological information and one for semantic information. Processing is done on a whole-word level.

Many researchers embrace such a dual-route hypothesis of reading. They hold that there are two independent routes with which to read. One, phonological mediation, involves reading words analytically, by means of the grapheme-phoneme correspondence rules. This strategy is assumed to be used in early stages of reading acquisition and in skilled readers when confronted with unfamiliar words (Bosman & De Groot, 1995; Rozin & Gleitman, 1977). The lexical route is where words are recognized holistically on sight.

Golinkoff and Rosinski (1976) even suggest that the two skills are separable. They presented a set of decoding tasks and picture-word identification tasks to third and fifth grade children. The decoding tasks consisted of presenting schoolchildren with short words and non-words and timing how long it took to read them. Both groups (skilled readers and unskilled readers) read nonwords more slowly, and unskilled readers read all stimuli more slowly than skilled readers. However, there was a significant relationship between the non-word condition and the unskilled group. The unskilled group had considerably more difficulty with the nonwords. Golinkoff and Rosinski conclude that unskilled readers have weak decoding skills.

In the identification tasks, the children were shown simple drawings with one of the words or nonwords from the decoding test written on the drawings. The students were to ignore the written words as they named the objects in the pictures. Response times were quicker when the distractor matched the drawing (e.g., drawing of a cat with the word "cat" written on it) than when it did not (drawing of a cat with the word "dog", or a nonword such as "lig", written on it). This effect held true for all students (both the skilled and unskilled groups). Based on these results, Golinkoff and Rosinski conclude that reading proficiency does not effect the ability to obtain the meaning from written words (they also conclude that phonological decoding is not essential for comprehension).

Rayner and Pollatsek (1989) describe Coltheart's model as a "horse race", where the phonological route and the direct route try to outrace each other to produce lexical recognition. The horse race model accounts for the regularity effect in that the regularity effect is seen much more frequently when subjects are presented with low-frequency words, which is presumably when the direct visual access route, which favors high frequency words, is slowed down. It also accounts for the pseudohomophone effect in that pseudohomophones will activate a lexical entry through the rule system but not the lexical system, whereas other nonwords will not. This would account for the longer response times to reject pseudohomophones.

Rozin and Gleitman (1977) characterize both the phonological access model and the direct visual access model as extreme. They introduce the concepts of "chunking", "automatization", and "parallel processing". Chunking describes the strategy of organizing clusters of smaller (e.g., phonemic or alphabetic) units into larger units (e.g., syllables or words). In the case of Smith's "homophone" sentence (see p. 15), it could be that the meaningful nature of the homophonous counterpart is more amenable to chunking. Automatization refers to activities that have become so ritualized that their component processes no longer require any volitional thought. Parallel processing refers to tasks that are done simultaneously. For example, we might perform letter identification and word identification at the same time. Rozin and Gleitman support the concept of phonologically mediated reading, though they do not discount a parallel role played by whole-word recognition in fluent reading.

Bosman and De Groot (1995) presented Dutch First-graders and University students with first-letter naming tasks, following Rossmeissl and Theios (1982). The results were largely the same. The first letter of a string of words could be named faster if the string was a word or "legal" non-word than if it was an "illegal" non-word. In contrast to Rossmeissl and Theios, however, Bosman and De Groot suggest that the automaticity of reading creates a hindrance in naming the first character to begin with, and "illegal" strings merely provide a greater interference. As support for this, they point to the other part of Rossmeissl and Theios' experiment where the subjects named letters in isolation fastest.

Baron and Strawson (1976) find that words that have a regular spelling-to-sound correspondence (such as sweet) are named faster than irregularly spelled words (such as sword), which would suggest an advantage for words that conform to regular "rules" of English orthography. However, orthographically legal nonsense words were also named significantly slower than regularly spelled words. Nonsense words, by their very nature, must be read according to orthographic rules, or they could not be pronounced at all. That they were slower than regular words suggests perhaps a familiarity effect, which suggests a lexical mechanism to reading.

In a second experiment, Baron and Strawson (1976) found that words with mixed case (e.g., sWeEt, sWoRd) caused more interference in words that do not conform to regular spelling than in those that do. This implies an interference in the lexical reading mechanism caused by breaking up familiar whole-word patterns. In light of their results, they suggest that we seem to use both a lexical mechanism and an orthographic mechanism. They state that the concept of utilizing both mechanisms is not surprising, in that we apparently use the orthographic mechanism when faced with unfamiliar words, and the lexical mechanism when faced with lexical representations such as "lb.", $, &, etc.

When does phonological processing occur?

Many researchers tend to dismiss evidence that seems to support phonological processing in light of short-term memory studies. In the field of psychology, there is a lot of convincing evidence that short-term memory requires speech recoding (Baddeley, 1966; 1970). This refers to the mechanism that translates linguistic information into inner speech, which is defined as a speechlike mental representation (Banks, Oka & Shugarman, 1981). The concept here is that a speech representation is heavily involved in remembering linguistic elements, such as utterances, words, or letters, even when such information was not received by means of speech, e.g., reading (Crowder, 1976). This confuses the lexical access issue somewhat. In the case of many reading research studies, it is difficult to ascertain whether certain effects involving phonological processing are due to the nature of reading processes or to coding related to short-term memory. Many researchers claim that much evidence that seems to support phonological mediation is the result of phonological coding into short-term memory in order to give a response. It could be due to short-term memory processing that we remember Smith's sentence (see above) as its meaningful, homophonous counterpart.

Liberman, Shankweiler, Liberman, Fowler and Fischer (1977) report a study in which children were asked to recall letters of the alphabet, that were grouped in clusters of either rhyming characters (B C D G P T V Z) or non-rhyming characters (H K L Q R S W Y). Phonetic similarity caused greater deterioration in immediate recall for all the children, but the effect was much greater for those children who were highly skilled readers (even though the skilled readers showed fewer errors overall). They suggest that the better recall of the skilled readers is due to their more efficient use of phonetic recoding, a strategy that is usually advantageous, but not in the case of rhyming strings. However, in light of studies in short-term memory encoding, it is not clear whether the phonological processing actually takes place during the reading process, or later for short-term memory storage.

This leads to what many researchers consider the real question of phonological processing: Not <u>if</u> it happens but <u>when</u> it happens.

Hu and Catts (1993) state, "Researchers generally agree that speech sound codes are automatically generated while reading alphabetic scripts. Disagreement, however, still remains as to whether or not this activation takes place pre- or post-lexically" (p. 325). In other words, does phonological coding occur before or after the meaning of the word is accessed?

Banks, Oka and Shugarman (1981), in their nine experiments involving list scanning and incorrect homophones, provide evidence that speech recoding is part of short-term memory encoding, and takes place after lexical retrieval. They take a strong stand against any non-visual model of word recognition.

Van Orden (1991) refutes these claims, conducting more experiments using homophone foils, this time involving the proofreading of short English texts. The proofreading foils would be either homophonous foils such as SLEAT for SLEET, or non-homophonous foils, such as SPEET. Words were categorized as low- or high-frequency words. For every low-frequency set, a similarly-spelled high frequency set was also constructed. For example, the corresponding set to the low-frequency SLEET was the high-frequency GREEN (the foils being GREAN and GRELN). They compared the proofreading misses (i.e., the failures to detect the misspellings) on the basis of low- vs. high-frequency words and homophone vs. non-homophone foils. They found a significantly greater number of proofreading misses in the homophone foils of low-frequency words. Nonhomophonous foils, though just as similar visually, did not create this effect. Van Orden concludes that the homophonous misspellings are activating lexical representations of the story-words.

In English word recognition, the dual-route theory, which holds that both whole-word direct visual access and phonologically mediated access occur in silent reading, seems to be gaining the most support. There is considerable support for a wholly direct visual access model, in which researchers hold that lexical recognition is pre-lexical, and necessary for arriving at a phonological representation. There is very little support for a "pure" phonological mediation model, which would hold that a phonological representation must be derived analytically from the text before the reader can retrieve a lexical representation.

The world's orthographic systems

The debate concerning phonological mediation is not limited to the reading of English. In fact, this study concerns itself with the reading of a radically different script. There are several different scripts used to write the world's written languages. The scripts used are categorized into three basic types: Alphabet, syllabary, and logography (Downing, 1973; Henderson, 1982; Hung & Tzeng, 1981;

Koda, 1987).

Alphabet

In an alphabet, each symbol (roughly) represents a phoneme. This is, of course, the system used in English, as well as other languages (the Roman alphabet). Other examples are the Cyrillic, Arabic and other alphabets. Sometimes, as is the case with English, there may not always be a direct one-to-one correspondence between the written symbols and the phonemes they represent. Even so, the characters represent only a phonological representation of the words, and do not relate to meaning (Downing, 1973; Gleitman & Rozin, 1977).

Syllabary

In a syllabary, each character represents a syllable. Examples of this are Japanese kana characters (to be discussed below) and Cree-Eskimo. Characters such as these are also phonological representations, and do not carry any meaning themselves (Downing, 1973; Gleitman & Rozin, 1977).

Logography

In a logography, characters called logograms represent a morpheme. They are lexical representations with little analytical representation of the phonetic qualities of words. Actually, there are logograms that are used in the English language: Arabic numerals (1, 2, 3), mathematic symbols (+, =, ÷) and the ampersand (&) are all examples of logograms (Downing, 1973; Gleitman & Rozin, 1977). A completely logographic system will be discussed in depth in the following section.

Chinese characters

Chinese characters appear to be the only completely logographic system in use today.[1] They are used as the sole script in Chinese, the main script in Japanese, and as a supplementary script in Korean (Coulmas, 1989; Taylor, 1987; Tzeng & Wang, 1983). Coulmas (1989) and Tzeng and Wang (1983) point out that the characters were also used for several centuries in the Annam region of present-day Viet Nam. However, use of the characters there has been discontinued, and I am only concerned here with those languages which currently utilize logographic script.

Much of the literature argues that Chinese characters are not "pictograms", nor even "ideograms". These researchers describe "true" pictograms and ideograms as word-level characters that are

[1] DeFrancis (1989), however, claims that the term "logographic" is meaningless, describing English as much as it describes Chinese, in that English also has derived frames, i.e., words. He uses the term "morphosyllabic" to describe Chinese characters.

more or less visual representations of the things they signify.[2] They hold that modern Chinese characters are logograms, which represent the smallest meaningful unit in language, the morpheme (Chao, 1968; Coulmas, 1989; Downing, 1973; Erickson, Mattingly & Turvey, 1977; Henderson, 1982; Lee, Stigler & Stevenson, 1986; Leong, 1989; Miller, 1967; Perfetti, Zhang & Berent, 1992; Seidenberg, 1985; Taylor, 1987; Tzeng & Hung, 1980; Tzeng & Wang, 1983).

Chinese characters are written in predetermined strokes, with a specific order in which the strokes are to be made for each character. Using the correct order becomes very important in the case of handwriting. Incorrect stroke order will lead to illegible handwriting.

A small number of strokes can make any of several recurring elements, each of which may or may not be a character itself. These elements can also play specific functions. For example, 214 such elements comprise the historical radicals. These radicals broadly classify the characters by meaning. For example, the characters that mean "star" 星, "bright" 明, and "sunny (weather)" 晴 all contain an element representing the character meaning "sun" 日. This is the system under which characters are categorized in dictionaries (Leong, 1989; Paradis, 1989; Wang, 1973).

This kind of system makes learning the characters easier than

[2] This terminology should not be confused with the term "pictographic" as used to categorize characters, and which refers to the characters' historical origins.

might be guessed. Readers of this script need not learn thousands of discrete, unique characters, but rather a much more manageable system of smaller components (strokes, the smallest components) that cluster together into larger elements (radicals, and other elements) that make the characters (Leong, 1973; Wang, 1973).

Use in Chinese

Chinese text is composed completely of these logographic characters, with no spaces written between words in a sentence. Even "function words" such as sentence particles are represented by logograms (Lee, Stigler & Stevenson, 1986). In Chinese, many characters also contain a phonetic element, similar to the radical, which provides an approximation to the pronunciation of the character (Chao, 1968; Coulmas, 1989; DeFrancis, 1989; Erickson, Mattingly & Turvey, 1977; Henderson, 1982; Hung, Tzeng & Tzeng, 1992; Ju & Jackson, 1995; Lee, Stigler & Stevenson, 1986; Leong, 1989; Paradis, 1989; Perfetti, Zhang & Berent, 1992; Seidenberg, 1985; Wang, 1973). These characters also contain a radical, which provides an approximation of the character's meaning (see above). The simple fact that such phonetic elements exist supports a theory of phonological processing of the logograms as used in Chinese (Seidenberg, 1985). However, where some researchers (Hung, Tzeng & Tzeng, 1992; Ju & Jackson, 1995; Leong, 1989; Tzeng & Wang, 1983) say that between 80% and 90% of characters contain a phonetic element, others (Lee, Stigler & Stevenson, 1986; Perfetti, Zhang & Berent, 1992) downplay the phonetic elements, saying that they operate in only a limited number of characters. Perfetti and Zhang (1991) and Ju and Jackson (1995) suggest that such elements play a minor role in word recognition in their backmasking studies, though there are a number of ways to interpret their results (discussed later). Other languages that have come to use Chinese logograms make little use of the phonetic elements.

As suggested earlier, it is a mistaken assumption to think that there is a character-to-word correspondence in Chinese. This kind of assumption led Rozin and Gleitman (1977) to claim that even Chinese scholars will learn to read only around 4000 words in their lifetime - the number of characters they can recognize. While single character words do exist in Chinese, most words are written using two or more of these characters (Chao, 1968; Coulmas, 1989; Lee, Stigler & Stevenson, 1986). Once this is understood, it can be seen that a knowledge of 4000 characters means an ability to read tens of thousands of words.

Each character is monosyllabic (Chao, 1968; Paradis, 1989), and realizes only one pronunciation in one dialect (Hatano, 1986). Across dialects, the phonological representation varies so widely that they are mutually unintelligible. It is the meaning of the characters that remains consistent, making the written form of the language understandable to all, regardless of dialect. Smith (1973) compares this to the universal nature of Arabic numerals in the world's languages. Everyone knows the meaning of the symbol "2" even though speakers of different languages will pronounce it differently. Chinese logograms enjoy this same level of consistency. Undoubtedly, this uniformity of the writing system is one of the cultural and sociopolitical reasons that the different dialects are all regarded as the same language (Chinese).

Use in Korean

In Korean, Chinese logograms are a supplement to the Korean alphabet, called Hangul. Hangul, called an alphabetic syllabary by Taylor (1980), is an unusual script. It is like an alphabet in that there is a unique symbol for every phoneme in the language. These phonemic symbols are clustered into blocks, each of which represents a V, VC, CV, CVC, or CVCC syllable. These compound characters are the units of reading and writing, and in this way Hangul is like a syllabary. Taylor (1980) also compares Hangul to logographic systems, pointing out that some of the syllabic characters represent morphemes by themselves. For example, he points out that the Korean word for "hen" is realized as one character, in much the same way that there is one Chinese character representing the Chinese word for "hen". However, while such a character-to-morpheme correspondence is indisputably a characteristic of a logogram, it must be noted that the symbol can still be analyzed into phonemic components. If it is indeed logographic, it seems to me that it is only accidentally so. If we accept Hangul syllables as logograms, we could just as easily say that the English word "I" is a logogram.

Most people in modern Korea, especially younger people, tend to write exclusively in Hangul. However, newspapers still use the Chinese logograms, mixed with Hangul (Coulmas, 1989). Chinese characters in Korean realize one Sino-Korean pronunciation (Hatano, 1986; Park & Arbuckle, 1977).

Use in Japanese

In that this study addresses the use of these characters in Japanese, a much more in depth description of their use in Japanese is warranted. In the case of Japanese, the Chinese logograms are called kanji (漢字, literally "Chinese characters"), and are supplemented by two syllabaries called hiragana (ひらがな) and katakana (カタカナ). The two syllabaries, collectively referred to as kana (in hiragana, かな, and in katakana, カナ), are completely redundant of each other. A kana symbol realizes a V or CV syllable, plus one character that represents a syllable-final nasal consonant. Any Japanese word can be written in either syllabary, as seen in the alternate representations of "kana" above (Backhouse, 1984; Erickson, Mattingly & Turvey, 1977; Gleitman & Rozin, 1977). In modern Japanese, hiragana are traditionally used for morphological inflections, function words such as case particles, and some words of Japanese origin. Katakana are used for foreign loanwords, and stylistically for emphasis. Kanji are used only to represent lexical items (Backhouse, 1984; Besner & Hildebrandt, 1987; Chao, 1968; Coulmas, 1989; DeFrancis, 1989; Erickson, Mattingly & Turvey, 1977; Gleitman & Rozin, 1977; Henderson, 1982; Paradis, 1989; Sasanuma, 1975; Taylor, 1987).

DeFrancis (1989) claims that in the case of Japanese kanji, the characters do not represent morphemes. To illustrate his argument he examines the Japanese verb 食べる (taberu, "eat"). He points out that the kanji represents only the syllable ta, the syllables be and ru being represented by hiragana symbols. However, the morphemic element of "eat" is tabe, as demonstrated in the past form of the verb: 食べた (tabeta, "ate").

Furthermore, I myself have made the observation that there exist characters in the Japanese system that historically represent two-morpheme words. For example, the character 鶏 (niwatori, "chicken") historically represents two morphemes: Niwa "garden" and tori "bird". However, there is some doubt as to whether modern Japanese continue to recognize this and similar words as two morphemes.

A significant difference between Japanese and the other languages that utilize Chinese logograms is the multiple pronunciations that can be represented by a single character. In Japanese, Chinese pronunciations were borrowed along with the characters themselves, with native Japanese pronunciations also retained. This has led to a system where one character, though retaining its semantic representation, will realize different pronunciations in different contexts.

The pronunciations that are Chinese in origin are called the character's <u>onyomi</u>. This word is written with two kanji characters (and one hiragana character), 音読み. The two kanji mean "sound" 音 and "read" 読. Therefore, the word means to read the kanji by its (original Chinese) sound (Chao, 1968).

Pronunciations that are Japanese in origin are referred to as <u>kunyomi</u> (訓読み). The first character of this word, 訓, means "explanation", that is, its reading "explains" the meaning of the kanji (by providing a representation from the native Japanese lexicon).

In English literature, "onyomi" and "kunyomi" are sometimes translated as "Chinese readings" (or Sino-Japanese) and "Japanese readings" (DeFrancis, 1989; Erickson, Mattingly & Turvey, 1977; Foorman, 1986; Hatano, 1986), which explains what they are historically but does not address the meaning of the characters.

Some refer to them as "semantic readings" and "phonetic readings" (Foorman, 1986; Hatano, 1986), which more closely approximates the meaning of the characters. However, considering the debate being addressed by this paper, these terms seem to favor one approach to the issue over the other. Many researchers merely use the terms "*on*-readings" and "*kun*-readings" (Backhouse, 1984; Chao, 1968; Coulmas, 1989; Foorman, 1986; Henderson, 1982; Miller, 1967; Paradis, 1989; Suzuki, 1975, Wydell, Patterson & Humphreys, 1993). This paper shall follow that tradition.

Many characters will have several pronunciations, acquiring at least one, and sometimes a number of (roughly) synonymous *kun*-readings, as well as one or more different *on*-readings. Vastly different *on*-readings were often the result of multiple borrowings from different areas of China, or during different dynasties in history (Coulmas, 1989; Foorman, 1986; Hatano, 1986; Wydell, Patterson & Humphreys, 1993). In most cases, an *on*-reading will function as a bound morpheme, only to be realized when compounded with other characters. Consequently, the pronunciation of a character in isolation will most likely be that character's *kun*-reading (Paradis, 1989). This phenomenon is a powerful influence on modern Japanese, and will have a strong bearing in this research.

Other phenomena of the pronunciation of written Japanese words warrant some attention, even though their influence on the language is negligible compared to the phenomenon of *on*-readings and *kun*-readings. One is the case of kanji clusters that are in no way phonologically analyzable into their component logograms. The words must be recognized as lexical wholes. An example of this is the word oishii 美味しい, which means "tastes good, tasty" (an adjective that describes food). This is written with the character that means "beautiful" 美, which according to the Nelson Character Dictionary (27th printing, 1988) realizes one *on*-reading, BI, and one *kun*-reading, *utsuku(shii)*,[3] and the character meaning "taste (noun)" 味, which has one *on*-reading, MI, and one *kun*-reading, *aji*. None of the customary readings are applied in the case of oishii. A particular pronunciation must be associated, not with the individual characters, but with a particular compound (Paradis, 1989).

Another phenomenon of the pronunciations of Kanji is called ateji, which describes words that are related phonologically, but not semantically, to their component logograms. An example of this is the word hiniku 皮肉, meaning "sarcasm", which is written with the characters HI 皮 "skin" and NIKU 肉 "meat". The meaning of the characters have nothing to do with the meaning of the word (Coulmas, 1989; Miller, 1967; Paradis, 1989).

The use of kanji in names is also sometimes confusing. Last names will sometimes retain archaic pronunciations or kanji forms.

[3] Following custom, *on*-readings are in capital letters, *kun*-readings in italics, and material traditionally written in hiragana are in parentheses.

In the case of given names, almost any name may be customarily written by one of a number of different kanji combinations (e.g., the name "Fumiko" could be written as 文子, 史子 or 富美子). Conversely, one combination of kanji may customarily realize more than one spoken name (e.g., the written form 文子 could be realized phonologically as "Fumiko" or "Ayako"). I know of a case where parents chose a spoken name they liked and a kanji they liked for their daughter's name, even though the kanji and the spoken representation had absolutely no (traditional) relation!

It should be clear by now that the pronunciation of kanji characters must always be derived from context. An example using Arabic numerals and English words can demonstrate how this works. As mentioned above, Arabic numerals are logograms. They are lexical representations, with no analytic relationship between their shape and their pronunciation. Consider the logographic symbols 1, 2, and 3. English speakers will undoubtedly read them as "one", "two", and "three". However, these symbols in conjunction with other symbols, for example, 1st, 2nd, and 3rd, will realize a completely different pronunciation and a slightly different meaning. Nearly every Japanese kanji character derives its pronunciation from context in a similar fashion.

It seems that such a system may be confusing at times. Indeed, there is a device called <u>furigana</u>, the practice of writing small kana symbols next to unusual kanji combinations, that is used to alleviate ambiguity (Miller, 1967). My friend mentioned above, with the nontraditional name, probably uses furigana. Before the language reform that took place in Japan earlier in this century, use of furigana was rampant and very necessary to understand the written language at all. It was this environment, and not the modern use of furigana, that prompted the often quoted observation by Sansom (1928) below:

> "One hesitates for an epithet to describe a system of writing which is so complex that it needs the aid of another system to explain it. There is no doubt that it provides for some a fascinating field of study, but as a practical instrument it is surely without inferiors." (p. 44)

This is often quoted by researchers who favor more extensive language reform (i.e., the complete abolishment of kanji) in Japan today, but very few of them point out that this quote was written decades ago, and before major language reform. Fewer still point out what Sansom himself said later that same page:

> " . . . with the importation of Chinese words, Japanese has developed in some measure the homophonous quality of Chinese, and the visual aid of the Chinese character is still necessary for understanding a Japanese text . . . It is as difficult to read the kana without the characters as to read the

characters without the kana." (p. 44-45)

I believe this to be true, though it is also true that kana can be mastered in a matter of months, while the Japanese system as it is now takes even native speakers years to master.[4]

Japanese is written using all three scripts (kanji, hiragana and katakana) in the same text, with no spaces between words (Paradis, 1989). Even Roman characters are often used for certain abbreviations such as cm for "centimeter", km for "kilometer", etc. (Backhouse, 1984; Taylor, 1987).

Both the Japanese system and the Korean system utilize a mixed script style of writing, using logograms of Chinese origin and a phonetic script of native origin. Taylor suggests that this may be the ideal kind of script for reading, in that people tend to gloss over function words and fixate on content words. Japanese and Korean present content words as visually complex symbols, and grammatical morphemes as simpler phonetic symbols. Indeed, Sakamoto and Makita (1973) report that Japanese subjects read mixed kanji and kana script twice as fast as all-hiragana script.

Processing of different orthographic systems

There is much compelling evidence that these different

[4] I would like to clarify that I, for one, am not in favor of the abolition of kanji in Japan. However, my defense of the system is not within the scope of this work.

orthographies are processed differently. Rozin and Gleitman (1977) suggests that children (in fact, all readers) access syllables better than phonemes, "because syllables map linearly onto the sound stream, while phonemes are highly encoded in the sound stream (p. 57)." They speak of the <u>blending</u> of sounds in language, and point out that this blending operates more effectively at the level of the syllable rather than the phone. They point out that skilled readers of English confronted with an unfamiliar word do not sound it out on the level of phonemes, but rather as syllables. Liberman, Shankweiler, Liberman, Fowler and Fischer (1977) also report that 4 to 6 year old children can segment words into syllables better than they can segment syllables into phonemic components. In fact, there is evidence (Morais, Cary, Alegria & Bertelson, 1979; Read, Zhang, Nie & Ding, 1986, to be discussed later) that awareness of linguistic units (such as words) as a sequence of phonemes is not something that we acquire naturally.

Rozin and Gleitman's experiment in teaching remedial readers to read at the level of English syllables rather than the characters of the alphabet (and the phonemes they represent) apparently met with success. Though their work was done using English materials, it seems to favor a syllabic system for learning to read (at the very least, it suggests an advantage to learning to read at the level of the syllable).

In Rozin, Poritsky and Sotsky (1971), eight children from a Philadelphia inner-city school who scored low in reading were tutored in reading English sentences represented by Chinese characters. They learned 30 characters. Though their traditional English reading skills did not improve, they did very well in learning the Chinese characters. This cannot be accounted for by the individual attention of the tutoring sessions, for the researchers also tutored the children in alphabetic reading an equal amount of time. This seems to suggest that poor readers of English have low phonological processing skills, but can still perform well in lexical recognition. As discussed above, this is supported by Golinkoff and Rosinski (1976).

Even though there is a lot of agreement that these orthographies are processed differently, there is much more controversy over how it is that the processing differs. One argument is that some orthographies are processed phonologically while others are not. Hung and Tzeng (1981) feel that a difference in orthography affects perceptual reading processes on a bottom-up level (e.g., phonological processing), but not on a top-down level (e.g., direct lexical recognition).

Koda (1987; 1990) believes (as does Hatano, 1986) that kanji are processed visually and kana are processed through phonological recoding. In fact, Koda claims that kana have a more direct phonological link than does the English alphabet, advocating a "meaning code" for processing kanji, a "phonological code" for processing kana, and a "dual process code" for processing English.

Other researchers support such a theory of orthographic processing, and provide evidence. Feldman and Turvey (1980) report that two Japanese subjects named isolated words when written in kana faster than the same words when written in kanji. They postulate that the phonological nature of kana is more easily processed. Besner and Hildebrandt (1987) report that in word identification exercises using words written in katakana, native Japanese speakers identified words normally written in katakana faster than both katakana spellings of words ordinarily written in kanji and nonwords written in katakana. They claim that these results suggest that lexical items are more immediately processed, that phonological recoding is necessary for reading phonographic scripts, and that words are named faster than nonwords because there are no lexical entries for nonwords, and must be assembled. This is parallel to the findings of Seidenberg, Waters, Barnes, and Tanenhaus (1984) that English words are named faster than nonwords.

In a similar study involving Hangul and Chinese characters, Park and Arbuckle (1977) find that Korean subjects living in Montreal perform better in recognition and free recall of Chinese characters than words written in Hangul, but not in paired-associate recall or serial anticipation. They suggest that these results are due to the phonological nature of Hangul, and a more direct link between the logographic characters and meaning.

Other researchers (Grabe, 1987; Paradis, 1989) suggest that we should not categorize orthographies as phonologically processed or not phonologically processed, essentially favoring a dual-route hypothesis for all orthographies. The issue of phonological processing of logograms will be discussed more later.

Aphasia studies

Sasanuma (1975) investigated the case histories of 378 cases of aphasia in Japanese patients admitted to a large rehabilitation center. She reports that different aphasias affected different aspects of language, categorizing the cases by the nature of the impairment: Those whose kana processing was more affected (kana > kanji), those whose kanji processing was more affected (kana < kanji), and those whose kana and kanji processing were equally affected (kana = kanji).

Sasanuma found that kana > kanji patients with milder dyslexia tended to replace certain kana characters with phonemically similar ones, or transpose some characters. Patients with more serious dyslexia replaced characters with phonemically non-similar characters or inserted unnecessary characters. In some extreme cases patients could not produce any kana, but only the appropriate kanji. Hayashi, Ulatowska and Sasanuma (1985) also report of a patient that could not comprehend kana whatsoever, consistently replying "I don't know" whenever asked to identify kana materials.

In the kana < kanji patients, one patient treated kanji as phonetic symbols, producing incorrect, meaningless kanji combinations that could offer the same pronunciation as the target word. Other patients tended to confuse the kanji's *on*-readings and *kun*-readings.

The third group, kana = kanji, had very mild aphasias as a group. Their errors in kana vs. kanji, though more frequent, proportionally mirrored those of non-aphasics. Sasanuma concludes from the differences in aphasias that the different symbols in the language are processed differently, and supports the claim that kana > kanji patients suffered impairment of the phonological aspects of language while the kana < kanji patients suffered impairment of the non-phonological aspects of language.

Paradis (1989), however, offers alternative explanations for the different performance on kanji and kana. He points out that:

1. Kana are learned earlier, causing a familiarity effect (especially if the patient has a low degree of schooling).
2. Everything can be written in kana (whereas Kanji are limited to lexical morphemes).

3. All kana are relatively simple (whereas kanji are of varying degrees of complexity).

4. All kana are used with relative frequency (whereas kanji are used with varying degrees of frequency).

5. Kanji realize multiple pronunciations, whereas kana do not (with very few exceptions).

This illustrates that there are several variables to consider, suggesting that it may be too simplistic to point to the issue of phonological accessibility as the only explanation for these phenomena.

Phonological processing of logograms

Oddly enough, the debate involving the phonological mediation of logograms is not so very different from the debate concerning phonological mediation in English. Since kanji analytically represent a unit of meaning and not of sound, a model of direct visual recognition is very appealing to many researchers. However, other research has provided evidence that phonological processing does take place in the reading of logographic characters, and many researchers favor a dual-route model of the reading of logographic script.

Direct visual access theory

Many researchers (Biederman & Tsao, 1979; Hatano, 1986; Koda, 1987; Rozin & Gleitman, 1977) take for granted that there is a direct link between Chinese logograms and their meaning, without any phonological mediation. Others (Chao, 1968; Foorman, 1986; Lee, Stigler & Stevenson, 1986; Leong, 1989) believe there is phonological coding involved in reading logograms.

The argument for a direct link between logogram and meaning is especially employed in the case of Japanese kanji, as explained by Hatano (1986):

> "We Japanese think that giving each Kanji a Japanese reading in addition to its Chinese reading has strengthened the association between that Kanji and its meaning. At the same time, this dual "reading" system has weakened the association between a Kanji and either of its readings, as has the fact that many Kanji share the same Chinese reading." (p. 84-5)

He claims that for experienced Japanese readers there are four "internal codes" for a word, which he calls the "kanji code", the "kana code", the "phonetic code", and the "meaning code". His claim is that the "kana code" (e.g., written kana representations) is processed through the "phonetic code", and the "kanji code" (kanji representations) is processed through the "meaning code". He points to the aphasia studies by Sasanuma (1975, see above) to support his paradigm.

Foorman (1986), however, takes issue with Hatano's interpretations. She points out that the "meaning code" proposed by Hatano may not be a cognitive universal, but rather linguistically constrained by the Japanese language. She suggests, "Perhaps the answer is that Kanji allow access to conceptual universals through their prototypal meanings, that is, through their Japanese readings" (p. 119). This seems very plausible. There is a very strong belief among Japanese that *kun*-readings ARE meaning, a belief that probably stems partially from the meaning of the word's first character (see above). Suzuki (1975) even claims that *kun*-readings are "the vernacular, equivalent in meaning to the character in question" (p. 180).

While Hatano merely takes for granted that kanji are processed through a direct visual route, other researchers offer evidence suggesting that logograms are processed graphically (visually) rather than phonologically. Perfetti and Zhang (1991) conducted an experiment in character recall with Chinese subjects, using a process they call "backmasking". That is, subjects would be presented with two characters in rapid succession and asked to recall the first one. The masks were separated into four different conditions: (a) Graphic mask, where the characters shared common strokes (visually similar), (b) phonemic mask, where the characters were homophonous (phonologically similar), (c) semantic mask, where the characters were synonymous (though visually and phonologically dissimilar), and (d) control mask, where the characters were completely dissimilar. Their claim is that only the graphic mask "aided" in character recall. They ran a second experiment without masks, and found substantially higher recall of all the characters. They conclude, "The results confirm the assumption that character identification is not mediated by phonemic processes but also demonstrate that the identification of a printed character immediately causes the activation of its pronunciation" (p. 633).

Ju and Jackson (1995) performed a similar study, claiming that the original study did not take well enough into account the tonal segments of Chinese. They point out that their phonemic masks were based on segmental phonology alone, while the tones were often completely different. They also criticized the graphically similar condition, pointing out that sometimes the shared element was a semantically-based radical and sometimes not. In their experiment they tried to rectify these shortcomings, using these four conditions: (a) Phonetic mask, where the characters were homophonous in both pronunciation and tone (phonologically identical), (b) graphic mask, where the characters shared a graphic component (visually similar), (c) compound mask, where the characters shared a graphic component and were homophonous in both pronunciation and tone (both phonologically identical and graphically similar), and (d) control mask, where the characters were completely dissimilar. They reached the same conclusions as Perfetti and Zhang, that graphic similarity, and not phonetic coding, aids in character recognition. However, in light of the fact that characters without masks were all named faster (Perfetti & Zhang), I suggest that the masks should be considered an interference in the task rather than a facilitator, and that the phonemic masks created a larger interference than the graphic masks. This is supported by other studies that find that lists of phonemically similar words are more difficult to recall than phonemically dissimilar words (Hu & Catts, 1993; Shwedel, 1983; Tzeng, Hung & Wang, 1977).

Koda (1987) replicated the study done by Cunningham and Cunningham (1978, see above) using Japanese learners of English as subjects. The design was the same. One group of subjects received the passage concerning imaginary fish with pronounceable nonsense words as the names of the fish. The other group received a version of the passage where the fish were given unpronounceable names. She expected that the logographic nature of Japanese orthography meant that Japanese speakers did not have to process words phonologically, and that there would be no effect on rate or recall on a written quiz. This held true for recall but not for rate. The passage with unpronounceable names was read faster than the passage with pronounceable names. She provides this as evidence for the theory that kanji are processed directly through meaning. However, she acknowledges the previous research suggesting that phonological coding is necessary for the reading of any orthography, and proposes that different orthographies will foster different word recognition strategies regardless of how it is processed psychologically. Specifically, she states:

> " . . . readers of sound-based orthographies will tend to obtain lexical sounds by direct analysis of phonetic elements whereas readers of meaning-based orthographies will tend to obtain lexical sounds in indirect ways, such as memory search and association" (p. 134).

Koda (1990) conducted a similar study three year later, with four groups of subjects whose native languages were Japanese, Arabic, Spanish and English (for native control). In this study she used two passages, a modified version of the fish passage and a new one about cocktails. With two passages, each group could experience both the control and experimental condition. For the unpronounceable condition she used Sanskrit characters for the names of the fish or cocktails. On a memory comprehension exercise, all subjects performed better on the passage with pronounceable nonsense words, but Japanese students showed significantly less interference with the passages of non-phonological names. Koda suggests that the cause of this is that Japanese speakers are accustomed to processing non-phonological information in the form of logographic kanji characters.

Further evidence regarding this issue is offered by Stroop test results. As explained earlier, a Stroop test involves measuring response times of subjects who are to identify the color of ink in which a color word is written. Subjects tend to demonstrate longer response times when the word and the ink are incongruent. Biederman and Tsao (1979) report significant differences in the performance of Chinese-speaking subjects and English-speaking subjects in Stroop tests. They found that there was a greater Stroop-interference in tests with Chinese subjects utilizing Chinese characters than in tests with English-speaking subjects utilizing English words. In light of their results, they speculate that the extra interference is due to a more direct connection between Chinese characters and meaning. This kind of processing is identified with the right cerebral hemisphere (Endo, Shimizu & Nakamura, 1981; Nguy, Allard & Bryden, 1980; Tzeng, Hung, Cotton & Wang, 1979), as is information regarding color. Since both the color-naming task and logogram recognition are processed in the right hemisphere, Biederman and Tsao suggest that the extra Stroop interference could be a result of competing processes.

Phonological mediation

Perfetti, Zhang, and Berent (1992) hold that phonological processing takes place in the reading of Chinese characters. Similar to the English debate, the question is considered to be not one of if but of when, that is, whether it is pre- or post-lexical. Perfetti, Zhang and Berent claim that phonological activation always begins pre-lexically, and plays some part in identifying the word. They say that at worst phonological activation occurs at the instant of recognition, and almost certainly not post-lexically.

There is more evidence that suggests there is phonetic recoding involved in processing logographic characters. Zhang and Perfetti (1993) gave Chinese subjects "tongue-twister" stories, where the passages had an inordinate number of words beginning with the same phoneme. Subjects took longer to silently read the tongue-twister stories than regular stories. The results suggest that the interference is phonological in nature, caused by the repeated phonemes in the tongue twister condition.

Many studies have been conducted where short-term recall of phonemically dissimilar logograms was better than the recall of phonemically similar logograms in both Japanese speakers and Chinese speakers. Shwedel (1983) reports interference caused by phonemically similar characters in a memory recall test with Chinese college students who were also proficient in English, but no such interference in Chinese monolinguals. No reading tests were given prior to the experiment, however, and as the monolinguals were from the Hong Kong working class and had very little education, it is presumed they were not highly proficient readers, even in Chinese. Shwedel points out that all subjects had to fill out a preliminary questionnaire and reported no difficulty in doing so. Based on his results, Shwedel concludes that the logograms are non-phonological in nature, and that those who have never learned a phonological script may not experience phonological interference.

In fact, there is evidence from readers of both alphabetic scripts and logographic scripts that supports this view. Morais, Cary, Alegria and Bertelson (1979) taught the task of adding or deleting a phone at the beginning of a word to literate and illiterate Portuguese adults. Both groups had similar backgrounds, except that the literate group had learned moderate reading skills. In the introductory trial, the subjects were taught to add or delete a "sound" to the beginning of letter strings, using data that consisted of nonwords that became words when the task was performed correctly (e.g., in the deletion task nonword purso becomes Portuguese urso, "bear"). In the experimental trials there were two conditions: 1. Completion of the task changes a word to another word, and 2. Completion of the task changes a nonword to another nonword. They found that the illiterate group was unable to delete or add a phone to the beginning of a letter string, while the others, with similar backgrounds but some reading skills, could perform the tasks easily. They conclude that people do not naturally become aware of language as a sequence of phones, but that the knowledge is learned, usually through learning the alphabet.

Read, Zhang, Nie and Ding (1986) replicated this experiment using Chinese materials and two groups of literate Chinese, one which had learned alphabetic script (Alphabetic group) and one which had not (Nonalphabetic group). Again, subjects were taught how to do the tasks before performing them, in word and nonword conditions. Their results were very similar to those of Morais et al. The nonalphabetic group had considerable difficulty in performing the tasks where the alphabetic group did not. This lends further support to the concept that phonetic segmentation is learned behavior.

Hu and Catts (1993) designed a project to counter this argument. They tested Chinese beginning readers, first and third graders, who had very little experience with alphabetic script. The children were shown a small set of characters which they were later asked to identify from within a larger set of characters. There were three levels of phonological interference: Characters with the same rhyme and same tone, same rhyme and different tone, and different rhyme and different tone. The children showed the greatest interference, and least recall, on the character sets with same rhyme and same tone. The greatest recall and least interference were in the different rhyme and different tone set. This certainly seems counter to the findings of Shwedel, but may have little real bearing on the segmentation tasks by Morais et al. because the tasks are so different. As pointed out earlier by Rozin and Gleitman (1977) and Liberman, Shankweiler, Liberman, Fowler and Fischer (1977), children are naturally more aware of syllabic structure than phonemic structure. Tasks involving words that rhyme are more involved with the syllabic structure of words.

In a task similar to Hu and Catts, Tzeng, Hung and Wang (1977) also tested Chinese subjects on recall of Chinese characters. Characters were presented both as word lists and as sentences. In the word lists, characters were divided into three categories: Same-consonant (SC), in which the characters all represent words that begin with the same consonant but are otherwise dissimilar, Same-vowel (SV), in which the words differ only on the initial consonant, or Same-consonant and Same-vowel (SCSV), where the spoken words differ only by phonemic tonal segments. They find that discerning phonetically similar items produces more confusion in short-term memory retention.

Hung and Tzeng (1981) and Perfetti, Zhang and Berent (1992) also point out that it may be in short-term memory rather than lexical recognition where phonological processing of logograms plays a role. Hung and Tzeng (1981) asked Chinese speakers to identify characters with a certain radical in a Chinese text. The subjects were much more likely to miss the characters that did not use the radical as a phonetic. This is similar to English speakers counting the letter "e" and failing to notice instances of silent "e". Even though they conclude that phonetic mediation is just one strategy for lexical retrieval, rather than an obligatory stage, they do postulate that a phonetically based working memory for linguistic information is universal.

Dual-route theory

Until now I have discussed studies that provide evidence for either phonological processing or visual processing of logographic characters. There are also some studies that have found both effects. In Mou and Anderson (1981), visual similarity created an interference as well as phonological similarity for Chinese speakers performing a short-term memory task. This is unlike findings in English, where visual similarity did not affect recall in such tasks (Baddeley, 1966), but similar to other studies in Chinese (Ju & Jackson, 1995; Perfetti & Zhang, 1991; see above). In the case of Mou and Anderson, phonemic similarity caused more interference than visual similarity. Wydell, Patterson and Humphreys (1993) conducted an experiment similar to Van Orden's (1987, where subjects classified "rows" as a flower) utilizing Japanese kanji. Subjects were asked to categorize lists of words that contained homophones into semantic categories. They also found not only the same homophony effect as Van Orden, but a similar effect for visually similar kanji as well.

Hung, Tzeng and Tzeng (1992) created a Stroop-like interference effect similar to that done by Golinkoff and Rosinski (1976), using Chinese characters with Chinese subjects. In this experiment, the subjects were presented with a set of simple drawings with Chinese characters written on them as distractors, one character on each drawing. The subjects' task was to call out the names of the objects depicted in the drawings, ignoring the written words. There were seven test conditions, manipulating visual and phonological variables by utilizing characters that have similar pronunciations or appearances with the characters that represent the objects in the drawings. Their test conditions were 1. Completely Congruent (where the character represents the object in the drawing), 2. Completely Incongruent (no relation, either phonologically or visually, between the character and the character that represents the object in the drawing), 3. Similar Graph/Same Sound, 4. Similar Graph/Different Sound, 5. Different Graph/Same Sound, 6. Different Graph/Different Sound, and 7. Psuedo-Character. Test condition 7 utilized contrived characters that look very much like Chinese characters but are completely meaningless. However, through the Chinese "phonogram" system, skilled readers of Chinese would be able to have a sense of how the character "should" be pronounced. As might be expected, the Completely Congruent condition yielded the quickest response times and the lowest error rate, and the Completely Incongruent condition yielded the longest response times and the highest error rate. The Completely Incongruent condition even proved slower than the Different Graph/Different Sound condition. However, it is unclear how these conditions would involve different processes. The Completely Incongruent condition utilized the same distractors as the Completely Congruent condition in a randomized order, where the Different Graph/Different Sound condition utilized different characters. Aside from this difference in how the characters were chosen, it appears that both conditions utilized incongruent characters.

Overall, these results suggest some phonological processing of logographic characters for Chinese speakers. It appears that incongruence in the characters created interference in the picture naming task. Both phonological similarity and graphic similarity in the characters caused less interference. Phonological similarity in the characters appeared to cause the least interference.

Summary and conclusion

There is a great deal of debate over how words are recognized by skilled readers. Many researchers believe that English words are recognized on sight, and that any phonological coding involved occurs after meaning is accessed. This is called the "direct visual access" model of word recognition.

Others hold that phonological processing plays an active part in skilled reading. They propose that there are multiple routes to word recognition, and that phonological processing may occur before, during or after lexical access. This is called the "dual-route" model.

Though many who favor this model assert that phonological activation is largely pre-lexical, it seems that few researchers support a pure "phonological mediation" model, which states that phonological processing is exclusively pre-lexical, and a phonological representation is <u>necessary</u> to access meaning. In this model, there is no direct visual access. Most researchers reject this model based on the fact that exceptionally spelled words (<u>cough</u> vs. <u>though</u>), homographs (<u>wind</u>, <u>bow</u>, etc.), homophones (<u>there</u> and <u>their</u>), and purely lexical representations used in English (%, &, $) are certainly accessed visually.

Other languages use writing systems that are very different from English. There are alphabetic systems, syllabic systems, and logographic systems. A logographic system utilizes characters that analytically represent the meaning of words rather than their sound. Such a system is used in Chinese, Korean and Japanese.

In Japanese the logographic characters are called kanji. Unlike other languages that utilize Chinese logograms, there are several anomalous phenomena that affect how kanji are pronounced. Most of these are minor influences on the language, but the phenomenon of *on*-readings and *kun*-readings is very productive. This refers to different pronunciations that a kanji character may realize, some of which are native Japanese (*kun*-readings) and others which are Sino-Japanese (*on*-readings). The correct pronunciation must be gleaned from context.

There is a lot of very convincing evidence that different orthographic scripts are processed differently, especially in the case of Japanese aphasia patients (Sasanuma 1975). What is more controversial is how it is exactly that the processing of logographic script and alphabetic script differs. There is a strong belief among many that logographic characters are not processed phonologically. However, many other researchers feel that phonological processing takes place in logographic characters.

Ironically, this debate closely parallels the debate in English reading research. As in the English debate, many favor a dual-route hypothesis. It is held that the characters, being lexical representations, are largely accessed visually, but that phonological activation also plays a role in word recognition. Phonological processing may take place before, during, or after lexical access.

CHAPTER 3

METHOD

Utilizing the same design as Golinkoff and Rosinski (1976) and Hung, Tzeng and Tzeng (1992), this study investigates phonological processing of Japanese kanji characters when read by native speakers of Japanese. This design uses a picture/word interference task to create a Stroop-like effect.

In Hung, Tzeng & Tzeng's 1992 study, they utilized seven test conditions using Chinese materials and Chinese speakers as subjects. Subjects were asked to call out what was represented in a simple drawing while ignoring written words superimposed on the pictures. The seven test conditions were 1. Completely Congruent, 2. Completely Incongruent, 3. Similar Graph/Same Sound, 4. Similar Graph/Different Sound, 5. Different Graph/Same Sound, 6. Different Graph/Different Sound, and 7. Psuedo-Character.

However, due to the nature of the Chinese writing system, I believe that it must be difficult to gather data for some of these test conditions. "Same Sound", "Different Sound", and "Different Graph" conditions are easy enough, but the "Similar Graph" conditions may sometimes miss the mark. For example, consider the two sets of characters below:

	<u>a fish</u>			<u>a sheep</u>	
魚	漁	魷	羊	洋	羚
CC	SGSS	SGDS	CC	SGSS	SGDS

In each set of characters above, the first character ("fish" and "sheep", respectively) is taken from Hung, Tzeng and Tzeng's Completely Congruent (CC) condition, the second from the Similar Graph/Same Sound (SGSS) condition, and the third from the Similar Graph/Different Sound (SGDS) condition. A representation of the characters from the CC condition appear as phonetics on the right side of the characters in the SGSS condition, and as an element (probably a radical) on the left side of the character in the SGDS condition. In this way, all the characters share a common graphic element, but it is debatable how <u>similar</u> they actually are. The phonetics on the right of the characters in the SGSS condition are large and prominent, but the elements (probably radicals) in the SGDS condition are small and narrow. In the case of "sheep" it even has a slightly different shape, with the lower portion of the element trailing off to the left. This is very common. When elements appear on the left side, they are usually radicals, and they are usually reduced and narrow. Sometimes they are even "radically" different. Shown below are the characters "water" and "spirit", which are radicals, and the forms that the radicals take when they appear on the left side of a character:

<u>water</u>	<u>spirit</u>
水→氵(海)	心→忄(忙)

However, most radicals retain some semblance of their appearance, as in "fish" and "sheep" above.

The nature of Chinese orthography makes it easier to gather data for the SGSS character set, since characters with the same phonetic have similar pronunciations, and the phonetic usually appears on the right, where it is large and prominent in the character. In contrast, the SGDS set is difficult to produce. Using characters with common radicals definitely produces characters that are different in pronunciation and share a common graphic element, but radicals usually appear on the left, where they are diminished and narrow, and often of a slightly different shape. Characters in Chinese have only one pronunciation, so this kind of similarity is the closest one can get to characters that are visually identical, yet with different pronunciations.

In the case of the characters' use in Japanese, the characters can realize multiple pronunciations in different contexts. Examples for the characters that represent the English words "fish" and "sheep" appear below.

character	pronunciation	meaning
魚	sakana	fish
魚屋	sakanaya	fish shop
魚類	gyorui	kinds of fishes
羊	histuji	sheep
羊飼	histujikai	shepherd
羊毛	youmou	wool

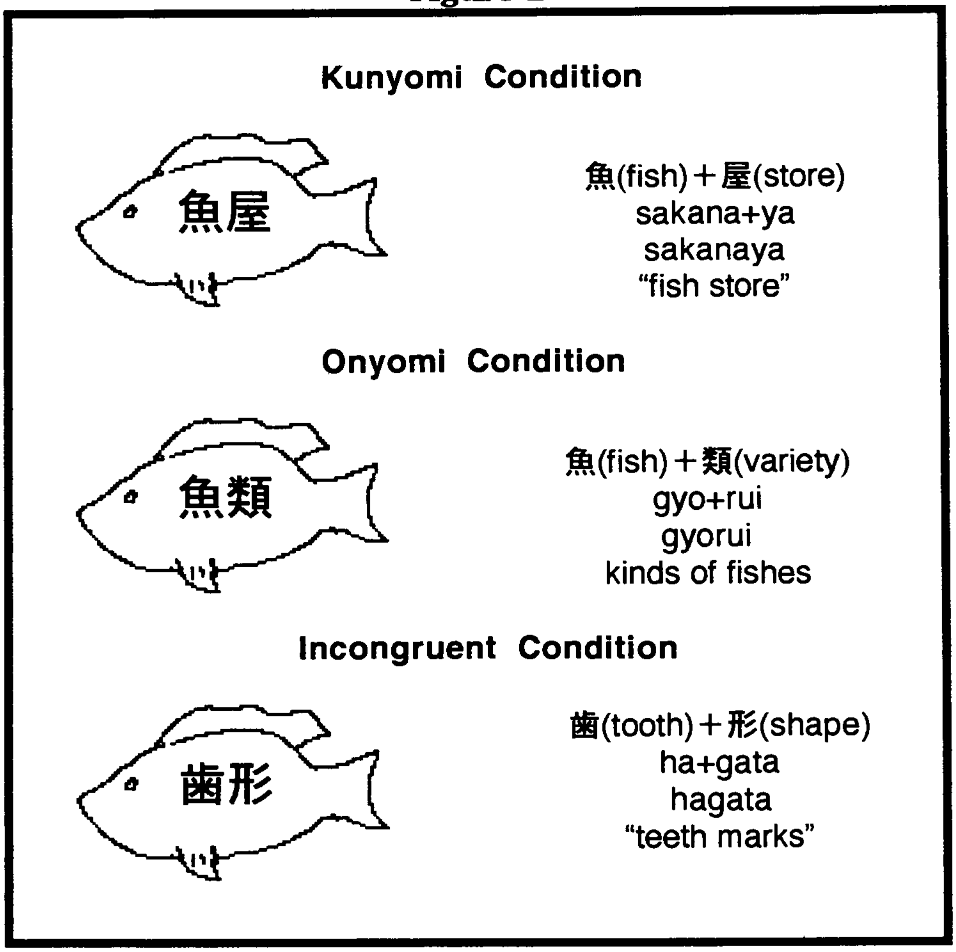
By using two-character compounds, it is possible to use the same character in two different environments where it will realize different pronunciations, as seen in Figure 2 (next page).

By using this property of Japanese orthography, this experiment investigates the reading processes of Japanese speakers reading kanji characters. Such an investigation can only further our knowledge of phonological mediation in skilled reading.

Design

Subjects were given a sheet depicting 20 drawings, and assigned the task of identifying the objects shown in the drawings. The task was performed while ignoring distractors that were written on the drawings. Each distractor was a two-character compound word in Japanese. Subjects performed this modified Stroop task in three conditions: 1. Kunyomi condition, where the first character of the compound semantically represents the character that represents

Figure 2



the object in the drawing (graphically identical), and is also pronounced the same as the spoken representation of the object in the drawing (phonologically identical), 2. Onyomi condition, where the first character of the compound represents the object semantically (graphically identical), but is in a compound where it realizes a radically different pronunciation than the spoken representation of the object in the drawing (phonologically incongruent), and 3. Incongruent condition, where neither character of the compound has any relation to the object in the drawing (both graphically and phonologically incongruent). The three conditions are seen in Figure 2 (all of the test materials, practice materials, and English translations of the test materials can be seen in the Appendices). The Kunyomi condition presents an example of each character's *kun*-reading, which are native Japanese pronunciations. The Onyomi condition presents an example of each character's *on*-reading, which are pronunciations borrowed from Chinese. The 20 drawings in all three conditions are the same.

To create the test materials, it was necessary to identify 20 sets of three words each, following these criteria for each set:

1. The first word of each set must be a one-character word, that can be easily represented (and recognizable) in a drawing.
2. The second word of each set must be a two-character compound of which the first character is the same as the character identified above, and is pronounced the same (the *kun*-reading).
3. The third word of each set must be a two-character compound of which the first character is the same as the character identified in #1 above, and is pronounced differently (the *on*-reading).
4. All words must be relatively high-frequency, easily

recognizable words.

This became particularly difficult since *kun*-readings are not that common in compounds. Compounds in which the second character was the target character were unusable, as were compounds that had more than two characters.

Forty-two such sets were created and shown to a group of six volunteers, all native speakers of Japanese. The volunteers did not perform the test conditions, as it was thought that it would distract from the selection task at hand. They were merely asked to identify what they saw in the drawings, and to read out loud the words in isolation. It was noted if they responded quickly, after deliberation, or not at all (some of the drawings or words, it turns out, were quite obscure).

Twenty-two of the 42 sets were discarded based on the criteria that the drawing prompted a high number of responses that differed from the target word, or one of the compounds was obscure or unknown. With six respondents, and three items to each set (the drawing, the kunyomi compound and the onyomi compound), there were a total of 18 responses for each set. Of the 20 chosen sets, all had 15 or more correct responses. Most "incorrect" responses occurred during identification of the objects in the drawings. Most were merely a matter of vocabulary, for example saying <u>jidousha</u> (automobile) instead of <u>kuruma</u> (car). It is believed that these kind of errors are negligible, for it is apparent that the object in the drawing was recognized. Other errors were due to the visual representations in the drawings, therefore, some of the drawings were modified. Then the test materials were assembled using ClarisWorks on a Macintosh computer with Japanese Language Kit, and printed onto heavy card stock. Each sheet was 8½ x 11 inches, and contained the twenty pictures in a 4 x 5 grid. Each test condition used the same 20 pictures in a different, randomized order for each condition. The Incongruent condition was created using the distractors from the kunyomi condition in a scrambled order. All subjects saw all three test conditions, and the order of the test conditions was counter-balanced across subjects. With three test conditions, there are six possible orders, so each possible order was utilized with five subjects.

Subjects

Subjects were 30 native Japanese students attending Portland State University in Portland, Oregon. A letter was sent to every Japanese student attending the university on a non-immigrant visa (this was the mailing list). Completion of secondary education (through high school) in Japan was chosen as the criteria to insure that all subjects would be competent readers of Japanese. Out of 33 respondents to the invitation letter, 30 respondents had completed secondary education or more in Japan. Many of them (14) had completed a bachelor's degree in Japan, seven had 2 or 3 years of college study (five of which had completed a two-year degree), three had completed a master's program, and one had a vocational college degree. The other five had come to the United States having completed high school in Japan.

Three respondents had completed junior high school in Japan, but graduated high school in the United States. Even though they apparently performed the tasks as easily as the others, their data was thrown out based on the pre-determined criteria discussed above.

All subjects were 18 years of age or older, 9 men and 21 women. They were 11 graduate students, 10 undergraduate, 7 post-baccalaureate, and 2 ESL students at Portland State University. Subjects need only have been native speakers of Japanese, and English proficiency was not necessary.

The length of the subjects' stays in America ranged from 3½ months to 10 years. The mean length of stay for all subjects was about 3 years. Six subjects had been in the United States for more than 5 years. Only one had lived in the United States for more than seven years (for ten years). In contrast, roughly half (16) had stayed in the United States for less than three years, six of which had been in the United States for less than one year.

Procedure

Subjects were met one at a time in a private, quiet area to perform the experimental tasks. In most cases the sessions were carried out in private "study rooms" in the campus library. The subject was seated next to the researcher rather than across the table. It was explained that since I am not a native speaker of Japanese, it was necessary for me to view the materials right side up as I watched them perform the task. This was actually true, but the primary reason was to help the subject feel at ease.

First, the subject read and signed the release form. Then some practice sessions were conducted. The subject was shown a sheet of 8½ x 11 inch card stock that presented an empty 4 x 5 grid (all practice and test condition pages can be seen in the Appendix). The blank grid was used as an explanatory aid to acquaint the subjects with the tasks of the practice and test condition pages. The next sheet they saw would have a similar grid, with a drawing in each of the 20 squares. Their first task was to identify what is depicted in the twenty drawings. The practice sessions were timed to help become accustomed to the stopwatch. The practice sheet was laid face down in front of the subject. I turned the page over, stating

"Please begin", as I started the stopwatch (this procedure was used for all of the practice sheets and test condition sheets).

Most subjects did not identify all 20 of the target words exactly. Corrections were made, saying (in Japanese, if necessary, though very few sessions were not conducted in English), "Of course, this picture can be called 'jidousha' (automobile), but I want you to call it 'kuruma' (car)." Then the subject was asked to identify the pictures again, using the desired vocabulary. The few subjects who identified all 20 pictures as desired were asked to go through the pictures a second time as well.

Then the subject was shown a second page, this time with one of the kanji compounds that realizes a *kun*-reading written in the center of each square, and subjects were asked to read the words out loud. The third practice sheet was a similar page with the *on*-readings.

Few incorrect responses were given when reading the word lists. When made, most errors were self-corrected on the spot. When a subject left an error uncorrected, corrections were made, taking a non-threatening stance as a non-native speaker, saying, "Is this word 'mimihana'? I was taught that this is 'jibi'" (the compound was of the characters 耳 "ear" and 鼻 "nose", as in an ear and nose doctor). All subjects acknowledged their errors. Most of these errors involved calling out a *kun*-reading for corresponding kanji on the *on*-reading sheet.

Once all the practice material was finished (three sheets), it was explained what the nature of the test conditions would be. It was explained that there will be a picture and a word in each square, and the task was to call out the name of the picture, like with the first practice sheet, and not the written word, as with the second and third practice sheets.

All subjects performed all three test conditions. Order of the conditions was counter-balanced across subjects. Three test conditions makes for a total of six possible orders. With 30 subjects, each possible order was utilized with five subjects. The time it took to call out all 20 items on a page was recorded to $\frac{1}{100}$ of a second using a hand-held, sports-type stopwatch. The number and nature of errors made during the test conditions were also recorded.

Research hypothesis

Such a design should, by measuring the interference caused by the different distractors, reveal whether phonological or visual processing is a more powerful influence in reading logographic characters. In other words, if the Incongruent condition shows greater interference than the other conditions, this would suggest that the other conditions create less interference due to their phonological or graphic similarity. Previous research suggests that this will happen. The degree of interference in the Onyomi condition is where the interest in this study lies. If the interference in the Onyomi condition is greater than that seen in the Kunyomi condition, this would suggest that phonological representations create less interference than graphic representations, and consequently, it would suggest that logographic Japanese kanji characters are phonologically mediated.

I hypothesize that the Kunyomi condition will realize the least interference, since the first character of the compound is both visually and phonologically identical to the character that, in isolation, represents the object in the drawing. In contrast, the Incongruent condition should realize the most interference, in that the first characters of those compounds are both phonologically and visually different from the character that represents the object in the drawing. In the Onyomi condition, if the degree of interference is low, like the Kunyomi condition, this would suggest that graphic similarity creates an equally powerful effect on word recognition as phonological similarity. In other words, if the Kunyomi and Onyomi conditions produce similar times despite their phonological disparity, this would suggest that the effect is caused by something else, i.e., their graphic similarity. In contrast, if the Onyomi condition produces times similar to the Incongruent condition, it would suggest that visual similarity is not a factor in kanji recognition, and that the effect is created by phonological similarity. It is believed that the Onyomi condition will produce results very similar to the Incongruent condition, in that the mismatched pronunciations of the distractor and the target will create a conflict, causing interference in the picture naming task. Such results would support the theory of phonological mediation in the reading of logographic characters.

CHAPTER 4

RESULTS

Mean response times (in seconds) for the each of the three conditions are presented in Table 2. As expected, the Incongruent condition produced the longest times (mean 16.77),and the Kunyomi condition produced the shortest times (mean 14.63). The Onyomi condition produced times that fell in between (mean 15.45).

For the statistical analysis, three calculations were computed for each subject, using Minitab statistical software. For each subject, I computed the difference between their time in the Incongruent condition minus their time in the Kunyomi condition (Incongruent-Kunyomi), their time in the Incongruent condition minus their time in the Onyomi condition (Incongruent-Onyomi), and their time in the Onyomi condition minus their time in the Kunyomi condition (Onyomi-Kunyomi). Then the mean of each of these differences was computed across all subjects. A T-test was run on the mean of each difference to test for significance. This procedure

Table 2

Condition	Example (魚= /sakana/, "fish")	Mean time
Kunyomi	 魚屋= /sakanaya/, "fish store"	14.63
Onyomi	 魚類= /gyorui/, "kinds of fishes"	15.45
Incongruent	 歯形= /hagata/, "teeth marks"	16.77

created a paired-sample T-test, comparing the subjects' performance between conditions. The mean differences, and their corresponding *p*-values, can be seen in Table 3 (next page).

With α set at 0.05, the mean difference between the Incongruent condition and the Kunyomi condition (2.140 seconds) proved to be significant (p=0.001). However, the mean difference between the Incongruent condition and the Onyomi condition (1.325

Table 3

Comparison	Mean Difference	p-value (α=0.05)
Incongruent - Kunyomi	2.140 seconds	p=0.0001
Incongruent - Onyomi	1.325 seconds	p=0.058
Onyomi - Kunyomi	0.815 seconds	p=0.16

seconds) did not prove significant (p=0.058) and the difference between the Onyomi condition and the Kunyomi condition (0.815 seconds) also did not prove significant (p=0.16). Unfortunately, the data in general are not terribly robust, with barely more than 2 seconds difference between even the Kunyomi and the Incongruent (a difference which proved significant).

These data do not support the research hypothesis. Though the Incongruent-Kunyomi difference proved significant as expected, it was also expected that the Onyomi-Kunyomi difference would prove significant, which did not. Also unexpected was the degree of difference between the Incongruent condition and the Onyomi condition, which equaled more than half of the difference found between the Incongruent condition and the Kunyomi condition. It was expected that the Incongruent-Kunyomi difference and the Onyomi-Kunyomi difference would be largely similar, while the Incongruent-Onyomi difference would be considerably smaller than both of the others (suggesting that the average times for the Incongruent and Onyomi conditions are very similar). Though neither comparison is significant, the Incongruent-Onyomi difference is much more similar to the Onyomi-Kunyomi difference than the Incongruent-Kunyomi difference.

Subject errors

With three conditions containing 20 responses in each condition, each subject gave a total of 60 responses in the test

Table 4

Condition	Target	Production	Distractor
Incongruent	kuchi “mouth”	ha “teeth”	山猫 yamaneko “wildcat, lynx”
Incongruent	yubi “finger”	te “hand”	星空 hoshizora “starry sky”
Incongruent	hoshi “star”	tsuki “moon”	口笛 kuchibue “whistle”
Incongruent	kuchi “mouth”	ha “teeth”	山猫 yamaneko “wildcat, lynx”
Kunyomi	yubi “finger”	te “hand”	指輪 yubiwa “finger ring”
Incongruent	te “hand”	kuruma “car”	車代 kurumadai “car [illegible]”
Kunyomi	tamago “egg”	buta “pig”	卵焼 tamagoyaki “fried egg”

semantic errors   distractor-induced   anomalous conditions. With thirty subjects, there were a total of 1800 responses recorded. Out of these responses, there were seven errors in all, shown in detail in Table 4. Only errors left uncorrected were recorded. Errors that were made but self-corrected during the task were not counted. There was one distractor-induced error, in the Incongruent condition, where "hand" (te) was identified as "car" (kuruma), when the distractor was "car fare" (車代, kurumadai). Other errors made were not caused by distractors, rather, most were caused by semantic confusion, for example, identifying "finger" (yubi) as "hand" (te), though the distractors were unrelated. There were four such errors in the Incongruent condition and one in the Kunyomi condition. There was one completely anomalous error in the Kunyomi condition where "egg" (tamago) was identified as "pig" (buta) when the distractor was "fried egg" (卵焼, tamagoyaki)! All things considered, it is felt that errors are not a contributing factor in this study.

CHAPTER 5

DISCUSSION

In the past, it was traditionally believed that the processes involved in reading logographic characters (such as Chinese characters, or "kanji" as they are called in Japan) were necessarily different from the processes involved in reading English. Many researchers took this assumption for granted. However, much evidence has been presented that suggests that the processing of English and logographic characters is not so different after all. Both seem to have a lexical access route and a phonological access route to word recognition. The question, in the case of both systems, is not a case of <u>if</u> phonological coding occurs, but of <u>when</u>. Probably the most striking difference between logograms and English is that graphic similarity seems to produce an effect on word recognition that is similar to that caused by phonological similarity in the case of logograms (Hung, Tzeng & Tzeng, 1992; Ju & Jackson, 1995; Mou & Anderson, 1981; Perfetti & Zhang, 1991; Wydell, Patterson &

Humphreys, 1993).

This study presented subjects with a Stroop-like interference task, utilizing distractors that were graphically and phonologically identical (Kunyomi condition), graphically identical and and phonologically incongruent (Onyomi condition), and both graphically and phonologically incongruent (Incongruent condition). A significant difference was found between the Incongruent condition and the Kunyomi condition, but not between the Incongruent condition and the Onyomi condition, nor between the Onyomi condition and Kunyomi condition.

From a logical standpoint, this should not be. Having established that the Kunyomi condition is significantly different from the Incongruent condition, it would seem reasonable that the Onyomi condition would prove to be different from one of them and not the other, or from both of them, but not from neither of them. This effect may be due to the fact that the data are not very robust, and the study sample was rather small. Due to the nature of statistical analysis, a small difference is less likely to reach significance with a smaller study sample (other possible factors are explored in Chapter six). I am confident that a larger study sample would yield significant results. The data from this study suggest that such a result would be one of the following: 1. Onyomi causing more interference than Kunyomi, showing a significant difference from Kunyomi but not from

Incongruent, 2. Onyomi causing no more interference than Kunyomi, showing a significant difference from Incongruent but not from Kunyomi, or 3. Onyomi causing more interference than Kunyomi, but less than Incongruent, showing a significant difference from both. I will call these three paradigms Incongruent/Onyomi over Kunyomi, Incongruent over Onyomi/Kunyomi, and Incongruent over Onyomi over Kunyomi.

Incongruent/Onyomi over Kunyomi

This paradigm was favored by the research hypothesis of this study. Such results would suggest that the incongruent pronunciation of *on*-readings causes as much interference as completely incongruent characters, despite their graphic and semantic similarity. This would suggest that phonological access of logograms is pre-lexical, and that visual similarity is not a strong factor in Japanese word recognition. However, the direction of the data (though non-significant) does not suggest this. It must also be pointed out that other research suggests that visual incongruence (or similarity, in the case of short-term memory tasks) of logograms does cause interference effects similar to those caused by phonological incongruence (Hung, Tzeng & Tzeng, 1992; Ju & Jackson, 1995; Mou & Anderson, 1981; Perfetti & Zhang, 1991; Wydell, Patterson &

Humphreys, 1993). Regardless of my original hypothesis, I conclude that the Incongruent/Onyomi over Kunyomi paradigm appears to be the least likely.

Incongruent over Onyomi/Kunyomi

Considering the nature of the data from this study (though non-significant), the Incongruent over Onyomi/Kunyomi paradigm seems plausible. There are several ways to explain such an effect. One very direct explanation is the claim that words in logographic script are accessed visually, and that phonological representations are exclusively post-lexical. Many researchers (Biederman & Tsao, 1979; Hatano, 1986; Koda, 1987; Rozin & Gleitman, 1977) support such a paradigm for the processing of logograms. However, there also exists research suggesting that this is not so (Chao, 1968; Foorman, 1986; Hung, Tzeng & Tzeng, 1992; Lee, Stigler & Stevenson, 1986; Leong, 1989; Mou & Anderson, 1981; Wydell, Patterson & Humphreys, 1993). Another, very similar, interpretation assumes that graphic similarity and phonological similarity are independent variables, but makes no assumption as to the linear order in which these characteristics are processed. Under such an paradigm, an Incongruent over Onyomi/Kunyomi effect would suggest that graphic incongruence creates no more interference than phonological incongruence when performing such interference tasks. This paradigm is supported by Ju and Jackson (1995) and Perfetti and Zhang (1991).

Incongruent over Onyomi over Kunyomi

The direction of the (non-significant) data seems to perhaps favor this paradigm. The ratio of the actual difference between Incongruent vs. Onyomi and Onyomi vs. Kunyomi is not that large, but the *p*-values are quite different. This may suggest that visual incongruence creates some interference, but that phonological incongruence creates even more, which is supported by previous research (Hung, Tzeng & Tzeng, 1992; Mou & Anderson, 1981; Wydell, Patterson & Humphreys, 1993), where it was shown that graphic similarity created an effect similar to that created by phonological similarity, though the phonological effect was larger.

The nature of the "graphic similarity" of Chinese characters may be a factor here. To say that two different characters are visually similar usually does not mean that they coincidentally look alike, but rather that they share a common graphic component, either a radical or a phonetic. In many cases, such a component can also stand as a character by itself. For example, below is the character that represents the Japanese word for "fish", followed by some characters that utilize a representation of that character as one of its components:

魚 "fish" On top: 魯 Left: 魴 Bottom: 鯊 Right: 漁

Above, the element that represents "fish" acts as a radical in the first three characters. It is a phonetic in the character where it appears on the right. In all cases, this element will be recognized as a replica of the character that means "fish". I base this claim on my observations of Japanese speakers explaining how to write characters by identifying their components (e.g., the character 魯 explained as "fish 魚 on the top and day 日 on the bottom"). So when studies claim that visual similarity creates a facilitative or interference effect, in many cases these characters contain a replica of the target character. Especially in the case of graphically complicated characters, it could be the case that some smaller elements such as these may be recognized before, or perhaps concurrent with, the character as a whole. There is no empirical evidence to support this, but it is worth investigating.

In this study, many subjects explained that they were able to avoid processing the lexical items as compounds, instead concentrating on only the first character. The characters in isolation are, of course, realized as *kun*-readings, so this strategy may account for some of the fast times in the Onyomi condition.

It could also be that there is a higher level of automaticity for *kun*-readings. In much the same way that many early researchers took for granted the assumption that logographic script is read through meaning and not through sound, it was assumed as the basis for this research that *on*-readings enjoyed the same level of automaticity in the skilled reading of native speakers as did *kun*-readings. I now believe that this may have been a hasty assumption.

During the reading of the practice materials, there were a number of instances when subjects, while reading out loud the *on*-readings, inadvertently called out a *kun*-reading. Most such errors were self-corrected immediately, and some were addressed by the researcher. There were few such errors when reading the *kun*-readings (i.e., few subjects mistakenly replaced a *kun*-reading with an *on*-reading). This suggests that perhaps *kun*-readings are accessed first or fastest. Unfortunately, since this occurred during the practice sessions, these errors were not recorded. No record exists to validate this data beyond the researcher's recollection.

The error I recall occurring most often was the production of the *kun*-reading "mimihana" rather than the *on*-reading "jibi" for the compound 耳鼻 (jibi, "ear and nose"). However, there is an interesting discussion regarding this item. Apparently, the three-character cluster 耳鼻科 (jibika, "ear and nose medicine", as in a medical specialization) is much more familiar. It seems that many subjects were confused by the unfamiliarity of the two-character cluster. If this is so, it lends further credence to the concept that *kun*-readings are accessed more readily than *on*-readings, that is, subjects automatically apply *kun*-readings first when faced with the unfamiliar. Another common error was the production of the *kun*-reading "buta-ashi" rather than the *on*-reading "tonsoku" for the compound 豚足 (tonsoku, "pig's feet"). These were the only errors that involved replacing the entire compound with a *kun*-reading. Other errors involved producing the *kun*-reading of only the first character before quickly self-correcting. This occurred with several compounds. In the *kun*-reading list, I can recall only two compounds where errors occurred. One occurred on the first character of 車代 (kurumadai, "car fare"), where the *on*-reading "sha" was given instead of the *kun*-reading "kuruma". The *on*-reading of this character is particularly common and familiar. The other commonly-made error was the reading of 雨風 (amekaze, "rain and wind") as 風雨 (fuuu, "Wind and rain", or "rainstorm"). However, notice that this is not simply a misapplication of *on*-readings, but an instance of character inversion. The lexical item 風雨 "fuuu" is apparently more familiar. Overall, I recall far fewer errors on the *kun*-reading list than the *on*-reading list.

Of course, any conclusions drawn based on these observations should be made with extreme caution, since there is no actual recorded data for support. Without such data, conclusions drawn are little more than speculation. However, there are many cultural and linguistic factors that suggest reasons why *kun*-readings might perhaps be accessed more readily, and these factors warrant discussion.

1. Characters in isolation are pronounced with *kun*-readings. This is probably why characters are, more often than not, identified by their *kun*-readings (e.g., in response to "What character is this?").
2. *Kun*-readings are learned first in school, which may create a familiarity effect. Also, since one-character words tend to be basic and simple vocabulary, spoken *kun*-readings comprise a large part of a child's initial vocabulary, heightening the familiarity effect.
3. There is much more homophony among *on*-readings, making the *kun*-readings more distinctive from each other. Perhaps it is for this reason that Japanese will often tell each other how their names are written using *kun*-readings (to distinguish, say, between these alternate representations of "Fumiko": 文子, 史子 or 富美子).

It has been addressed earlier that Japanese believe *kun*-readings to be representative of meaning in a way that *on*-readings are not. This belief could be due to the meaning of the characters in "kunyomi" (訓読み, "the reading that explains (the meaning)"), and perhaps because *kun*-readings are more solidly established in the Japanese mind as phonological (and semantic) representations of the characters, as suggested earlier by Foorman (1986, quoted on p. 47 of this volume).

In light of previous research, and given the nature of my data (though non-significant), I tend to favor the Incongruent over Onyomi over Kunyomi paradigm as probably the most likely. I believe we may definitely rule out the Incongruent/Onyomi over Kunyomi paradigm. The Incongruent over Onyomi/Kunyomi paradigm is plausible, though more needs to be investigated concerning the automaticity of reading Japanese kanji characters. However, the statistical analysis from this study provides no significant evidence to support any of these paradigms. Further research with larger subject samples is warranted.

CHAPTER 6

CONCLUSION

Many researchers assume that the fundamental difference between reading alphabetic scripts, such as English, and logographic scripts, such as Japanese kanji characters, is largely one of visual vs. phonological processing. In other words, it is believed that English, with its phonetically based script, is necessarily processed through sound, while meaning-based kanji characters are processed visually. However, a moment's reflection on the fact that the printed word is a visual medium, and the fact that we are all capable of reading aloud, seems to suggest that both processes occur in any language. The question becomes not one of if, but of when.

Even among those who accept that this is the case, many still support a dichotomy in the different scripts. They claim that logographic characters are first accessed visually, and a phonological representation (a pronunciation) comes secondarily. In contrast, this paradigm holds that alphabetic scripts are processed first by the phonetic representation that is represented analytically by the script.

This paradigm is particularly favored by some scholars of Japanese. They point to the *on*-readings and *kun*-readings (which are different phonological representations) of kanji characters as evidence. The argument is that the since the characters have multiple pronunciations in Japanese, but the meaning remains consistent, then the meaning of characters is accessed first, after which one of the possible pronunciations is assigned. Hatano (1986) asserts that this is widely believed by Japanese (see above).

Another moment's reflection reveals that to take such an assumption completely for granted may be a form of post hoc reasoning, i.e., "alphabetic scripts represent phonetic units and logographic scripts represent units of meaning, therefore, they are processed in those respective ways in skilled reading". In fact, the research done on the topic has yielded very conflicting results, leading to a controversy in reading research that rages on to this day. There are those that believe that reading (all reading) is a process that goes from the printed word to lexical recognition to a phonetic representation, those who believe in a more powerful role of phonological coding in the reading process, and those who continue to support a dichotomy in the way the different scripts are processed.

One paradigm used to investigate these phenomena is called the Stroop effect, named after the original research conducted by J. R. Stroop (1935). Stroop showed subjects the words for colors, written in different colors of ink. The task was to name the color of the ink (and not the written word). It was found that subjects had great difficulty ignoring the written words. This design aptly demonstrates the automaticity of reading. Subjects could not prevent themselves from reading the words, even when it conflicted with their task at hand.

Several different Stroop-like effects have been discovered over the years. There are two studies that are relevant to this study, one using English materials by Golinkoff and Rosinski (1976), and one using Chinese materials by Hung, Tzeng and Tzeng (1992). These studies involved using pictures rather than colors as the visual stimulus, i.e., subjects were to call out what they saw depicted in small drawings while ignoring written distractors.

This study utilized a similar design using Japanese kanji characters, comparing the level of interference caused by the *on*-readings and *kun*-readings. Subjects were to call out what they saw in the drawings under a Kunyomi condition, an Onyomi condition, and an Incongruent condition. It was believed that, in terms of the level of interference in the naming tasks (as measured by the response times), the Onyomi condition would be quite similar to the Incongruent condition, while the Kunyomi condition would be significantly faster than both the others, indicating less interference and demonstrating a phonological process in character recognition.

Unfortunately, the data are, overall, not very robust. As was expected, a significant difference was seen between the Incongruent condition and the Kunyomi condition. However, no such difference was seen between the Onyomi condition and the Kunyomi condition, nor between the Incongruent condition and the Onyomi condition.

It is difficult to interpret such non-significant data, though it is safe to say that it does not lend support to the research hypothesis. In fact, it seems to support a paradigm found by previous researchers (Hung, Tzeng & Tzeng, 1992; Mou & Anderson, 1981; Wydell, Patterson & Humphreys, 1993) where graphic similarity of logographic characters caused an effect that was similar to, but less powerful than, that created by phonological similarity (though there is some uncertainty concerning the "graphic similarity" of characters, see previous discussion).

Implications for TESOL

This study addresses the reading processes of Japanese kanji characters by skilled native speakers of Japanese, and does not relate directly to second or foreign language acquisition. However, the fundamental question behind this study, that is, how people read, may also be relevant. Having a better understanding of how skilled readers process their native scripts may shed some light on what strategies need to be learned or taught in order to process information in a different script. Of course, this is a much smaller issue for students whose native languages utilize the same script as English (the Roman alphabet). It may be slightly more of an issue issue for speakers (readers) of a language that utilizes a different (e.g., Cyrillic, Arabic, etc.) alphabet. However, for readers of a logographic script, such as Chinese characters, this may be more of an obstacle to attaining reading skills in a second language.

Native Japanese and Korean readers are accustomed to using multiple scripts in the same text. In the case of the Japanese writing system, which uses logograms and syllabaries, none of the native scripts are an alphabet. There is some very limited use of Roman characters in informal Japanese, but these symbols are used more or less logographically.

Logographic elements in Japanese may realize multiple pronunciations depending on their contexts. In the case of Chinese logograms, these readings are known as *kun*-readings and *on*-readings, which are native and borrowed (Sino-Japanese) pronunciations, respectively. Many claim that this uncertainty of pronunciation is evidence that pronunciation is secondary in Japanese script, and that meaning is accessed first in the reading process. Recall that Hatano (1986, see above) claimed that this belief is widespread among Japanese. Whereas this is still a very debatable point, it is certainly a fact that the multiple pronunciations do muddy the waters a bit. In my experience, this phenomenon has led to a perception among Japanese that phonological representations are nearly arbitrary (Hatano also states that the association between kanji and pronunciation is "weakened"). This is probably what leads many scholars of Japanese to take for granted that meaning is accessed first in logographic script. However, is it really "meaning" that is accessed first, or the *kun*-reading, which is believed to represent meaning?

In the Japanese language, foreign loanwords are usually written in katakana, for example, "glass" becomes グラス "gurasu". However, many Chinese loanwords are adopted in their kanji forms and given *on*-readings, sometimes changing their pronunciation. For example, the name Mao Tse Tung (毛沢東) becomes "moo taku tou" in Japanese. This only remotely resembles the Chinese name. Admittedly, it is hardly unusual for loanwords to be adapted to the borrowing language's phonographic rules (compare the French and English pronunciations of "Paris"). However, I understand that this strategy of reading Chinese goes as far as students of classical Chinese being <u>taught</u> to read Chinese using Japanese pronunciations.

This tendency extends into the use of Roman characters in

Japanese, which are usually used logographically. For example, "Fourth Floor" in an address is often represented as 4F, but these characters will read by Japanese as "yon-kai" (yon, "four" + kai "floor"), the same reading as the more "traditional" representation of 4階. It can be seen that any phonetic units represented by the letter F have no bearing on its use here. In similar ways, tel can be read as "denwa" (電話) or cm as "senchi" (センチ).

I believe that this kind of whole-word recognition and assignment of native pronunciations may carry over into second language learning (Koda's 1987 and 1990 data support this). Successful learners are those who understand that in alphabetic script pronunciation is (for the large part) not arbitrary, and who learn to utilize grapheme-phoneme correspondences in English.

However, foreign language education in Japan does not foster these skills, focusing rather on understanding the meaning of complicated texts by way of grammar translation. Words are processed holistically, and are ultimately processed into Japanese pronunciations. I feel students could realize much greater success if introduced to the sounds of English through a more phonologically-based curriculum. This does not necessarily mean teaching the students phonographic rules (and their exceptions), but probably more along the line of teaching such concepts as rhyme and alliteration, which can foster understanding and acquisition of the rules.

Limitations of the study

I believe that it may have been too hasty (as addressed earlier) to assume that there is the same level of automaticity in the reading of *kun*-readings and *on*-readings. Taking such a concept for granted, without any investigation or evidence to support it, will most certainly color any conclusions concerning the data.

Concerning the lack of robustness in the data, I feel this may have been caused by the nature of the procedure used in the study. When subjects were doing the warm-up session and the interference tasks, they were simply told to "do it quickly". Use of the phrase "as quickly as you can" was avoided because it was felt that this might make subjects nervous. I also wanted to avoid a "speed-for-accuracy" effect. As a result, even though the error rate in this study is a fraction of that seen in Hung, Tzeng and Tzeng's 1992 study, response times are consistently longer (Hung et al. told subjects to do the tasks "as fast as you can"). Response times in Golinkoff and Rosinski's 1976 study are considerably slower still, but their subjects were children.

I also feel that a couple of my distractors, 耳鼻 (jibi, "ear and nose") in the Onyomi condition and 雨風 (amekaze, "rain and wind") in the Kunyomi condition, were inappropriate because of the unfamiliarity of the lexical items. This undermined the automaticity necessary to validate the experiment. However, I believe the other 38 distractors were able to overcome any detrimental effects caused.

The drawing used for "brush" had a very low recognition rate during the practice session. Subjects provided such vocabulary as "pen", "rocket", "sword" and "Japanese radish"! However, since these misunderstandings were addressed before performing the test conditions, I feel this also had little effect on the validity of this study.

Recommendations for further study

I believe we could benefit from a study similar to this one with a larger subject sample, so that the data could be interpreted more reliably. With a larger sample size, it may be easier to produce more robust data. In the case that the difference might be naturally small, a larger sample size will determine if the difference is significant.

Investigation into the automaticity of Japanese kanji recognition also deserves further research. It may be the case that *kun*-readings are accessed first or fastest, and that *on*-readings may be processed secondarily, rather like irregularly-spelled words are processed more slowly in English speakers (Baron & Strawson, 1976).

Another area that deserves further research is the concept of whether radicals and other logograph components are recognized on some level as the lexical entries that they represent. If this is so, then the "graphic similarity" effect found by some researchers may be an artifact of semantic association or even phonological recognition of the character's components.

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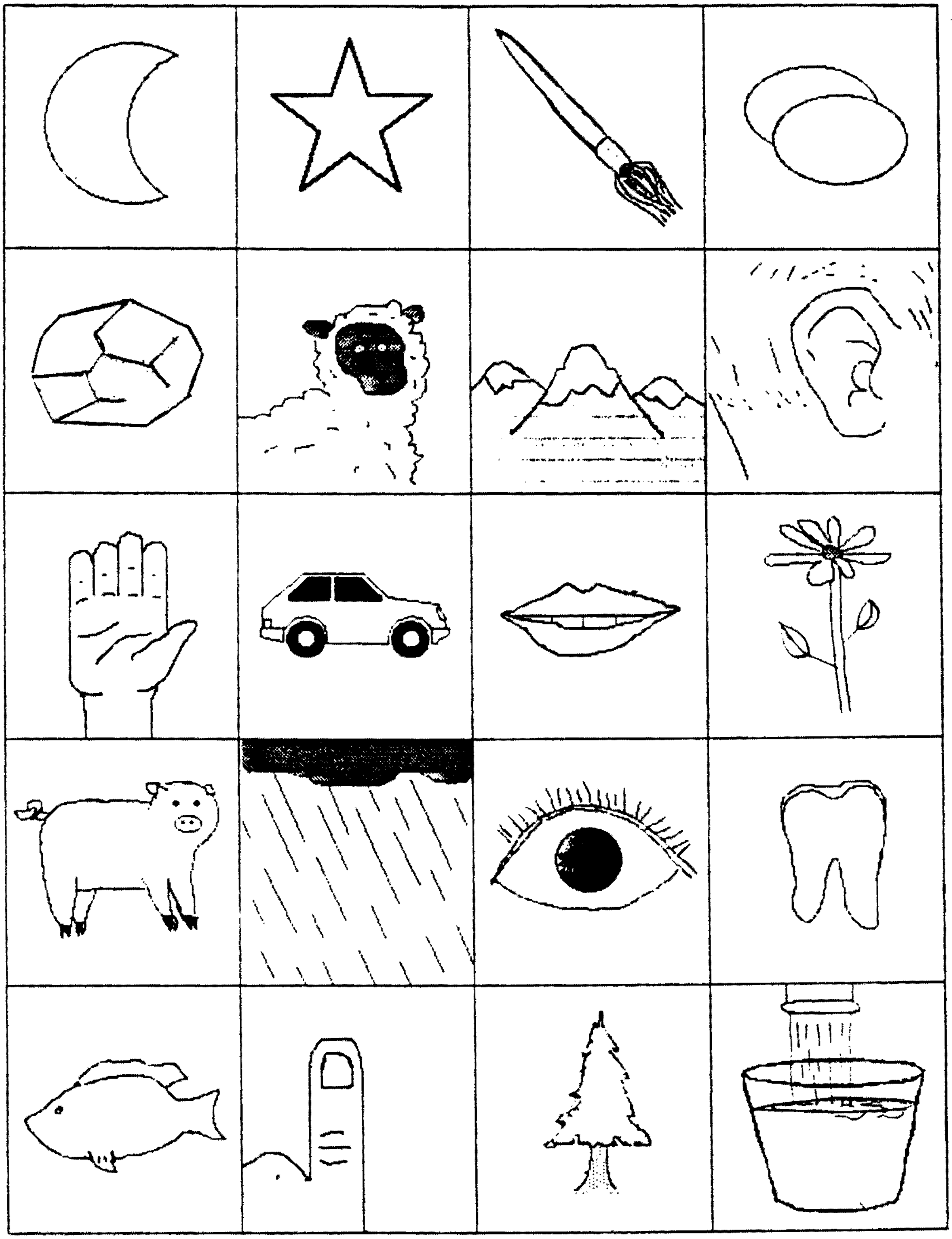
Appendix A

The practice materials



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山猫	星空	口笛	花火
指輪	筆箱	雨風	目玉
耳元	水色	羊飼	魚屋
月見	豚肉	石垣	歯形

歯科	星座	月光	羊毛
魚類	雨期	水分	耳鼻
目録	花粉	指示	口語
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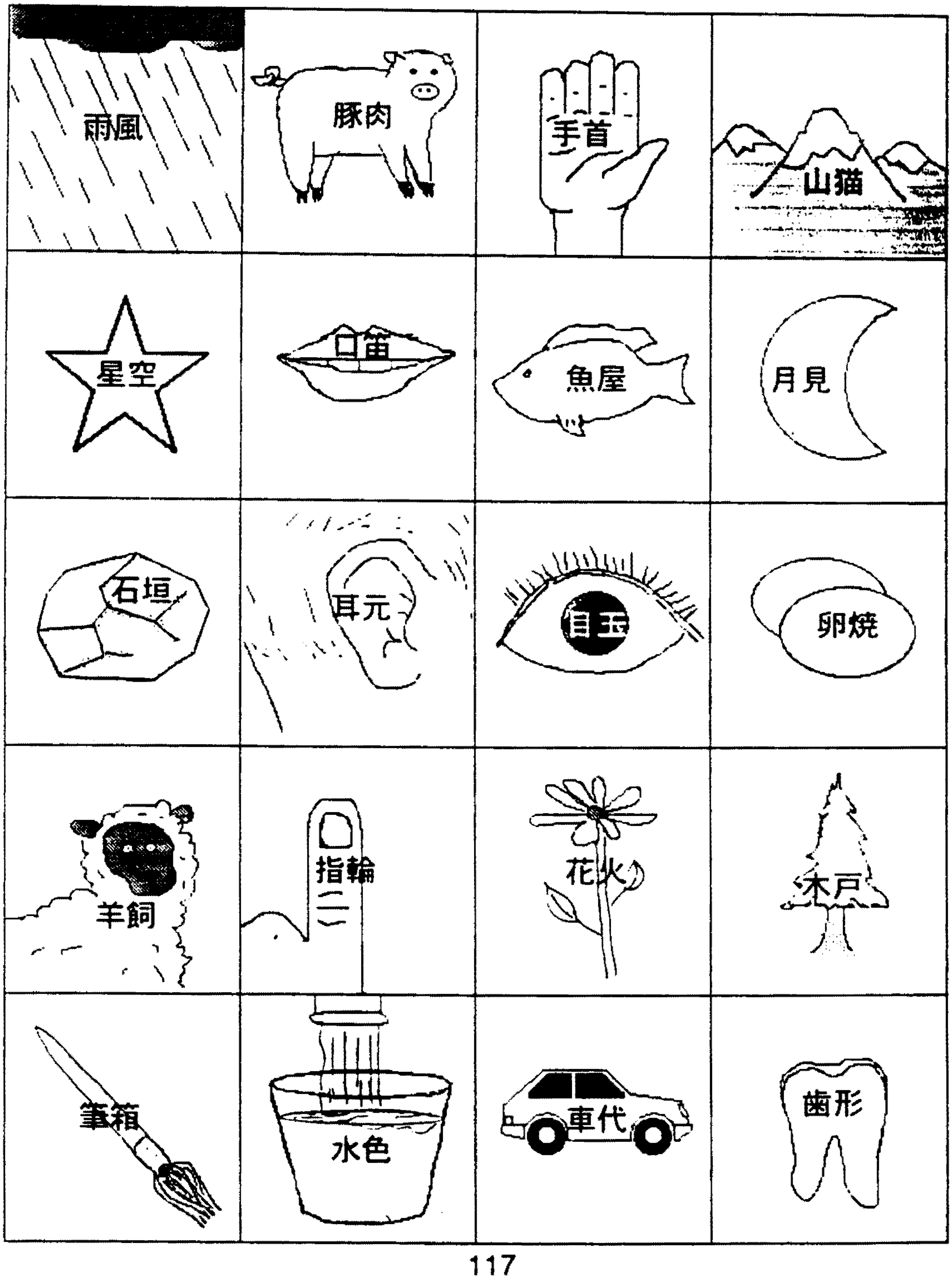
卵白	豚足	手話	木材

Appendix B

The test materials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星空
口笛
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月見
石垣
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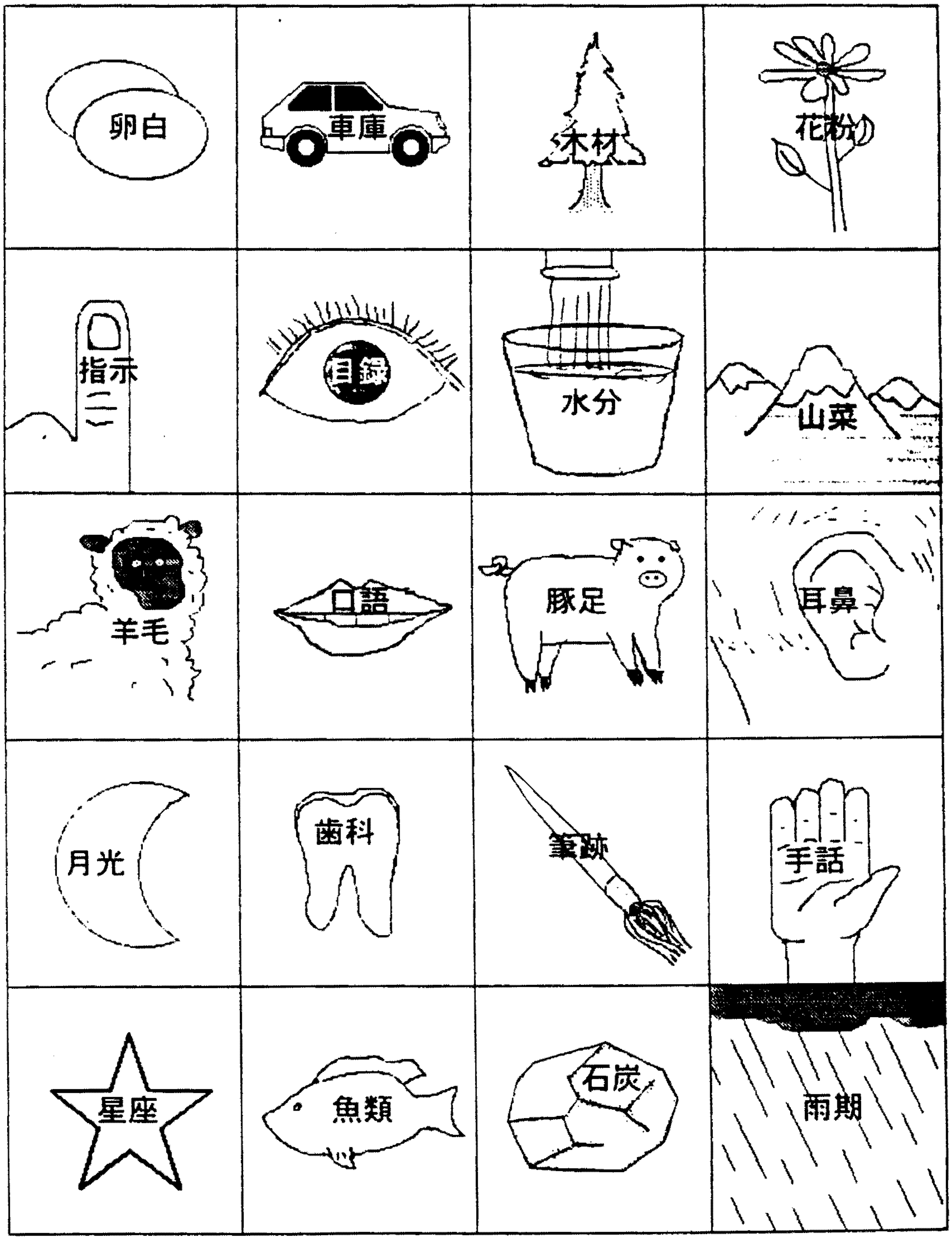
歯形


卵白
車庫
木材
花粉
指示
目錄
水分
山菜
羊毛
口語
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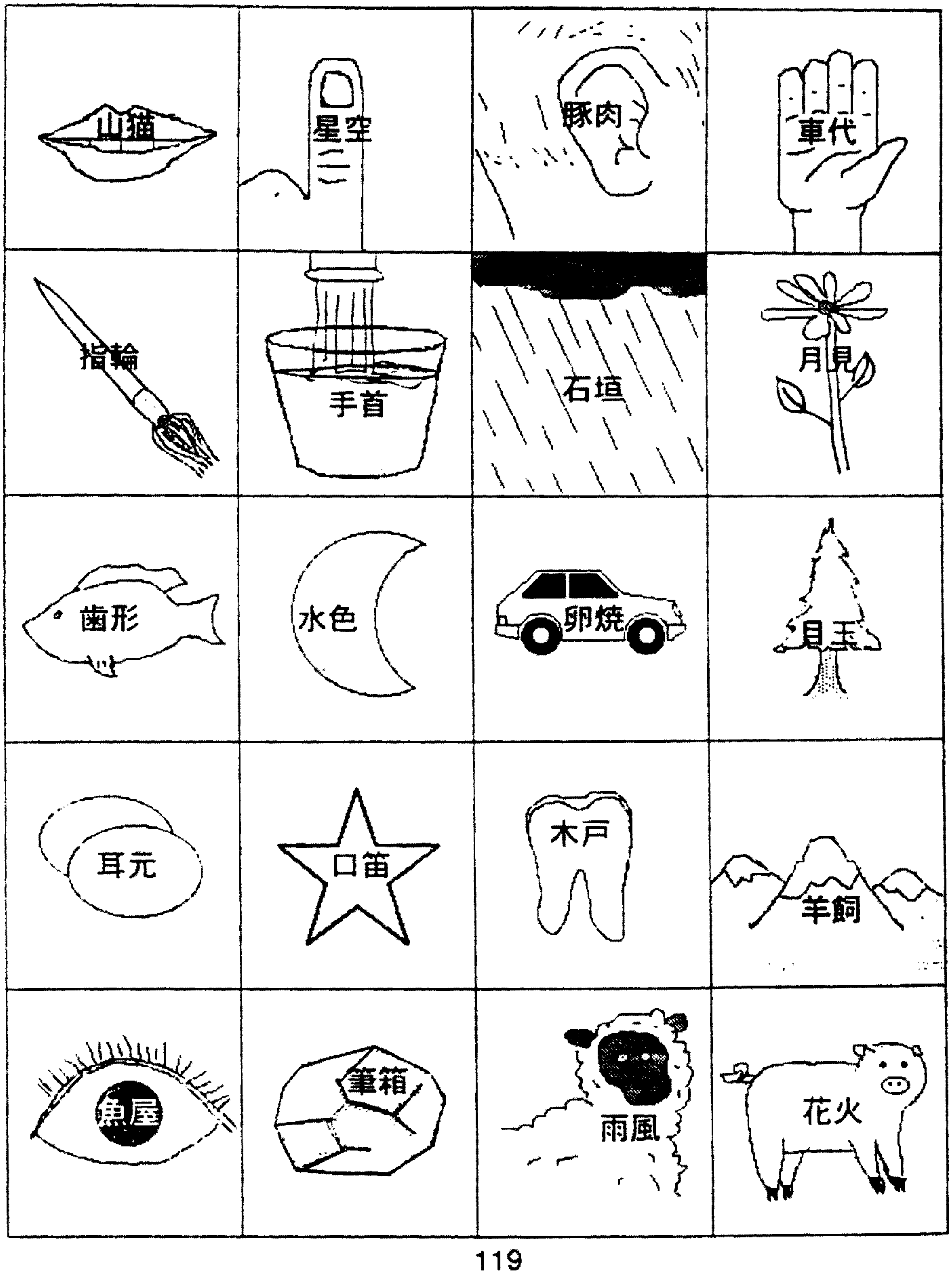
月光
齒科
筆跡
手話
星座
魚類
石炭
雨期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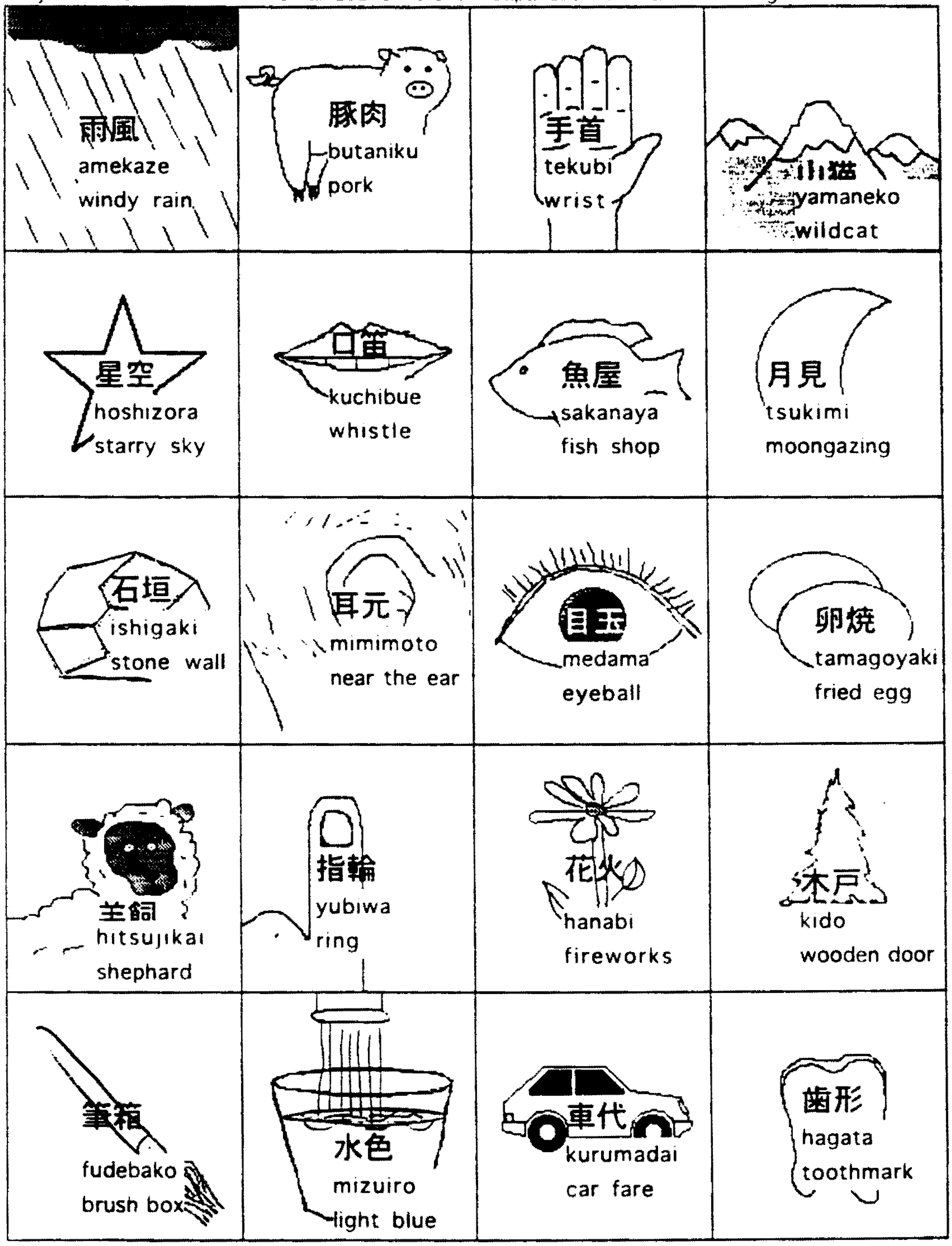
星空
豚肉
車代
指輪
手首
石垣
月見
歯形
水色
卵焼
目玉
耳元
口笛
木戸
羊飼
魚屋
筆箱
雨風
花火

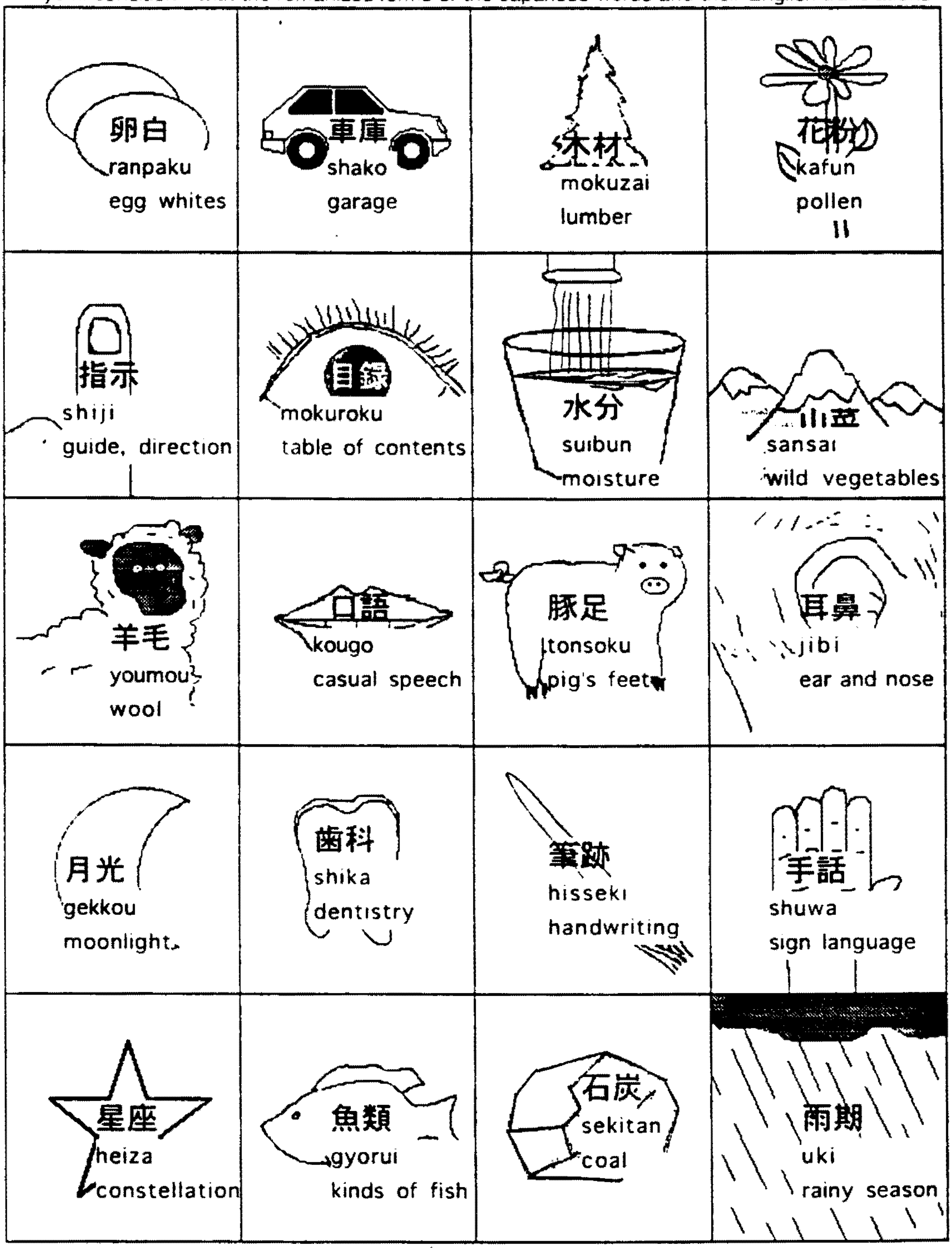
Appendix C

Translations of the test materials

Kunyomi condition - with the romanized forms of the Japanese words and their English translations



Onyomi condition - with the romanized forms of the Japanese words and their English translations



Incongruent condition - with the romanized forms of the Japanese words and their English translations