

**PHONETICS OF KANJI AND POSSIBLE PSYCHOLINGUISTIC CORRELATES:
NOTES BY A NOVICE***

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This discussion is intended to highlight aspects of kanji that may be important for models of on-line processing of reading Japanese and possibly models of alexias in Japanese patients. These notes are not a full explanation of the Japanese writing system; for that, the reader should see the first chapter of PHH.

Redundancies in kanji characters. The fascination of kanji to a dictionary-browser is how unpredictable and yet how redundant they are. On the one hand, neither the meaning nor the pronunciation of an unfamiliar character can be determined from examining it in isolation. Furthermore, most of the familiar kanji still have to be seen in context in order to choose among their possible pronunciations. There are almost always at least two of these (one of Chinese origin, called the *on*-reading, and one of native origin, called the *kun*-reading), often five or more. Context is of course also needed to choose among their possible meanings; most words have several, although 'counting meanings' is hard to do since a more-or-less apparent chain of connections usually runs through the set of meanings associated with a given character.

On the other hand, there are two sources of redundancy which should play a large role in the mental storage/retrieval of kanji. Even Western psycholinguists know that most kanji are formed of several component groups of strokes and that very often one of these groups, usually the one termed the 'radical', carries some meaning of greater or less specificity--ones like 'hand', 'water', 'fire', 'woman', 'child', 'animal', 'word', 'tree', 'metal', 'person', and so on are quite evident to the beginner. The novice user learns that sometimes they are present in a character without carrying their usual semantic weight, but their mnemonic value as chunks ('familiar subpatterns'--PHH) is still quite evident. And in fact a major experience of the first few months of kanji study is the emergence of chunks in the percept, even those in the thousands of uninterpretable kanji yet to be learned. (The fact that there are such chunks in the percept obviously means that the complexity of a character cannot be equated with the number of strokes in it; probably there is no objective measure of complexity, and intersubjective ratings should be used when control of complexity is needed for an experiment.)

The other source of redundancy--not noted in Western psycholinguistic literature until the discussion in PHH, and so far studied experimentally only for Chinese (Seidenberg 1985)--is the fact that there are often phonetic resemblances among some of the pronunciations of kanji which share a component, typically without having any shared meaning. A very striking example is

yoo 'sheep' 羊 ,
yoo 'ocean', 'Western'. 洋

*This paper was originally prepared as an internal working memo to S. Sasanuma and her Communication Research group at the Tokyo Metropolitan Institute of Gerontology, Summer 1988.

PHH give two other examples (p. 11) of kanji that function as phonetic components, which they call 'phonemic radicals'. The kanji are

青 'blue' with the *on*-reading /sei/ and
 古 'old' with the *on*-reading /ko/.

Each of these is shown with five different homonymous kanji that contain it.

These correspondences are due to the fact that in China of some millennia past, most of the kanji were composed of a semantic radical and an element called a 'phonetic', which was also a character by itself. Sound changes have obscured many of these phonetic relations in modern Chinese (Seidenberg 1985 suggests that about 25% of modern Chinese characters are phonetically transparent) and they are still further obscured in Japanese, to the point where they are not taught, and where skilled readers are no more aware of them than English readers are aware that 'reed' visually and phonetically contains 'reed'. I assume that the reason that these phonetic relations are unattended is because they do not correspond to any segmentation of the word, because predictive value in a given case will be unknown, and also because they are no help at all in learning the meaning of a kanji, at least not if one's speaking vocabulary is more limited than one's reading vocabulary, as is likely to be the case after childhood. In contrast, semantic radicals are taught, at least to foreigners (even though their predictive value also seems low) and native speaker/readers are aware of many of them.

There are further interesting redundancies. First, as mentioned, many kanji have more than one *on*-pronunciation and more than one *kun*-pronunciation, and many also have more than one meaning. It turns out that in maybe 10% of cases (judging from leafing through the basic 2,000 kanji dictionary published by Gakken), there is some degree of correspondence between the separate meanings and the separate pronunciations, though again this appears to be below the level of native-reader awareness.

For example, the character (78) 市 has the *on*-reading 'shi' when it means 'town' but the *kun*-reading 'ichi' when it means 'market'. More examples are given in Sample B, below. In such cases, the link between sound and meaning, although idiosyncratic, is reliable; in the context of looking at the kanji, either one is a cue to the other. To put it another way: when looking at such a kanji, the same amount of contextual information is needed to determine the sound as to determine the meaning, so there is no a-priori reason to assume that recovery of the meaning is prior to recovery of the sound, although of course that could still turn out to be the case.

Second, there are also sound-resemblances among native-based *kun* readings of a given kanji, though these seem to be less systematic than those among Chinese-based pronunciations, and may more often be due to chance. However, it is not their history but their possible contribution to reading processes that concerns us.

It is also important to note that in many cases, the horrific standardly-cited figure of five or six pronunciations for a kanji is inflated by the inclusion of two kinds of variants. The first type are due to the phonology of Japanese: any word that begins with an unvoiced consonant may sometimes begin with its voiced counterpart when it is the second (or subsequent) element in a compound, and this variant is denoted by the same kanji as the unvoiced variant. For example,

139 'heart' 心

has the *kun* readings 'kokoro' and, as a second element in a compound, '-gokoro'; and it has

the *on* readings 'shin', '-jin'; similarly

432 'fire' 火

has the *kun* readings 'hi' and 'bi' (found e.g. in the compound 'hana-bi', flower+fire, 'fireworks'). (The counterpart of /h/ is /b/; the /h/ was historically a bilabial fricative in all environments, but now only before /u/, as in 'Fuji', phonetically [ɸɯjɪ]). Although this voicing rule is not applied consistently, it is extremely pervasive and any native speaker will know it; in addition, the explicit correspondence between voiced and unvoiced consonants found in the kana systems undoubtedly brings it to metalinguistic consciousness as well. (Syllables beginning with voiced stops are written by adding the diacritic " to the syllable beginning with the corresponding unvoiced stop, e.g., ta, da .)

The second type of variants are those which come from making different orthographic choices about how much of a word should be considered to be represented by a kanji and how much by the following string of hiragana. For example:

the kanji (844) 借

meaning 'loan, rent' may be considered to correspond either to the whole word 'kashi' in the phrase

'kashi-ya', 'house for rent',

or to just the syllable 'ka' in the verb 'kasu' 'lend, rent', and in the graphic alternative for

"house for rent"

corresponding to ka-shi-ya. Once the reader knows the fullest form that a kanji may be used for, the fact that it sometimes is redundantly supplemented by some kana, like the 'shi' in 'ka-shi-ya' above, doesn't seem likely to make reading more difficult in the general case. The question is worth testing, however.

Finally, a still lower degree of redundancy appears to be present which might possibly be able to aid the reader. In many cases, the variant *on* readings have arisen because the same word was borrowed from (temporally or geographically) different Chinese dialects with somewhat different meanings and with different but not wholly unrelated sounds. For example, many kanji with an *on* reading that begins with /m/ also have a reading that is just the same except for beginning with /b/

--consider 'tree', 木

with the *on* readings 'boku' and 'moku'.

The 'context' that determines the meaning and reading choices for a given kanji, most of the time, is the adjacent kanji or immediately following kana, rather than a more global or remote level of context. A single kanji can represent a single lexical item, but most of the time, it appears as an element of a compound noun, a verb, or an adjective; and if it is a verb or adjective, there will be a following string of kana that include its inflectional morphemes. The 'context' determining pronunciation and meaning, then, is largely lexical (also for the interpretation of English orthography); this fact surely affects the reading process. I would expect to find some kind of experimentally verifiable difference between making choices of pronunciation at this local/lexical level of integration of information and making a choice at some more global semantic level--which also must happen sometimes in reading Japanese.

Four kinds of graph and sound correspondences. Looking in the Gakken dictionary under the *on*-reading entries for the first six kana (a, i, u, e, o, ka) produced at least one pair of kanji,

and with as many as five pairs, with shared phonetic 'radicals' for each heading. This sample (Sample A) will be given below, and then the factors which are likely to contribute to the psychological salience of these homonyms will be discussed. After that, a sample (Sample B) of kanji where there is a high degree of correlation between the several pronunciations and the several meanings will be given. (Many of such cases turn out to have one meaning which is essentially obsolete or extremely specific; the ones that I suspect are too marginal to use are marked with *.)

In addition to the words of the above types, the psychologist will persist in noting what the linguist would rather ignore: there are also words which share components accidentally--that is, kanji which are presently homonyms which share *semantic* radicals, and kanji which have phonetic components that have come to look alike through simplifications of the orthography. Since some semantic radicals occur in dozens of kanji and since Japanese has a huge proportion of homonyms, this is not surprising, and it must be dealt with. A short list of such words is given as Sample C; finding more of this type is very easy.

Sample D consists of kanji which share components and native-based *kun*-readings; such words are not discussed by PHH. I try to give some sense of the less systematic nature of these sound-kanji correspondences, whose history I do not know.

Kanji Examples

Sample A - kanji which share pronunciation and phonetic component:

*: this is the only *on* reading for this kanji in the Gakken dictionary.

** : this is the only reading for this kanji in the Gakken dictionary.

! : this reading is usable in isolation.

Pronunciation	Gakken Dictionary Entry Number	meaning(s) with this pronunciation/ # of listed contexts it is in: total # of listed contexts	
an*	安	128	peace 4:7
an**!	案	218	thought 10:10
i*	遣	496	differ 2:3
i**	禱	1680	latitude line 3:3
in*	因	646	cause 2:2
in**	姻	1939	matrimony 1:1
in**	員	47	member 9:9
in**!	韻	1940	rhyme 4:4
un*	雲	1124	cloud (marginal?) 1:3
un*	云	1813	say (marginal?) 1:2
e	会	12	meet 1:18
e!	絵	976	picture 5:6

Also:

kai!	会	12	meet, meeting 16:18
kai	絵	976	picture 1:6
ei*	映	234	reflect, project (v.t.) 2:6
ei**	英	449	superb, English 5:5
ei*	永	690	always 2:3
ei*	泳	1198	swim 1:2
ei*	詠	1942	chant 3:4
en*	園	412	garden 7:8
en	遠	803	remote 3:6
en*	沿	1379	alongside 2:5
en*	鉛	1681	lead 3:4 (including 'pencil')
o:8	横	297	cross-grained, perverse 4:9
o:	黄	1063	yellow, gold 2.5:7
oku**!	億	389	100 million 3:3
oku**	億	1662	memory; cautious 3:3
on	隠	1511	conceal 2:4
on*	穩	1631	placid, mild 2:3
ka*	果	277	fruit 3:8
ka**	課	531	assign, section 7:7
ka	過	399	exceed, pass
ka	禍	1753	calamity, serious
ka	渦	1845	whirl
ka	歌	478	song
ka	可	510	affirm, pass
ka	河	698	large river
ka	家	81	house
ka	嫁	1469	bride (also semantic)
ka	稼	1882	work, earn

ku	化	100	change (v.i.)
ka	花	551	flower

and for a really stunning example of a phonetic component:

haku	白	266	white
haku	迫	842	press, urge
haku	船	1242	ship, vessel
haku	拍	1456	rhythm, beat
haku	伯	1671	lord, eldest

Sample B. Kanji which have sound/meaning correspondences (sometimes one meaning for *on*-reading and another for *kun*-reading, sometimes a subset relation sometimes two different *kun*-readings with distinct meanings ...):

3	年	nen: year or age toshi: age (only)
181	治	osa-: to govern nao-: to heal
155	重	omo-: serious, weight kasa: pile, piled up
495	編	a(m)-: knit hen: edit, organize
498	裁	ta(u): tailor, cut saga(ku): judge
522	額	hitai: forehead gaku: frame, sum
536	彼	ka(no), ka(re): personal pronoun hi: equinoctial week
542	州	su: sandbank shun: (political) state

Sample C: kanji which share pronunciation and semantic radical:

ka	化	100	change (v.i.)
ka	价	202	price
	(person radical)		
i	違	496	differ
i	道	780	remains, left behind

	(leg/travel radical)		
taku	沢	403	dale
taku	濯	1699	-rinse
	(water radical)		(in compound 'sen-taku' laundry)
taku	収	1413	select
taku	拓	1415	stretch
	(hand radical)		

With coinciding Japanese-based (*kun*) readings:

ko	越	529	surpass
ko	超	1006	cross, exceed

Sample D: sound-meaning relationships among *kun*-pronunciations:

a) distinguishing between two meanings of one polysemous word

hi	火	432	fire
hi	灯	1290	lamp

b)

a	会	12	meet
a	合	46	fit, suit

c) words are neither full homonyms nor compounds

umi	海	158	sea
ume	梅	1009	plum

resemblances which are not in terms of discrete components (could be used as control materials)

d) visually similar parts of kanji are not entire components

ushina(u)	矢	523	lose
ushi	牛	909	cattle

e) parts of words with same pronunciation are not entire morphemes

osu	雄	500	male
o(su)	推	635	recommend

Saliency of phonetic components. Variables which would be expected to play a role in the saliency (cueing power) of a phonetic component need to be looked at in several ways; parallel considerations are in general needed for predicting the cueing power of a semantic radical or other meaning-bearing component. Any experiment that we design should probably look at both phonetic and semantic cueing in some parallel fashion, using one as a control for the other, but given time limitations, I am concentrating on the phonetic aspects in this report.

- 1) How easy is it to form a connection between the kanji and a particular pronunciation? Segmentability factors probably rank very high here, reliability second, and frequency third. (See below.)
- 2) How much information about the identity of the kanji might one get from knowing how it is pronounced? (What is the possible value of the phonetic route to reader comprehension?)
- 3) How much information about the pronunciation can one get from recognizing the phonetic component? (What is the potential value of the phonetic route to reading aloud?)

Factors relating to cueing correct pronunciation include:

Frequency/reliability factors

- 1) (Token) frequency of the component across all the kanji it appears in.
- 2) (Type) frequency of component (how many different kanji it appears in).
- 3) (Type) reliability of phonetic cue--what percent of different kanji (of the total types) are pronounced according to this cue.

Segmentability factors

- 5) Does this reading occur in isolation? How frequently by type/ by token?
- 6) Does this reading occur in compounds where the other element(s) of the compound are familiar and easily segmented off? E.g., the other element might be the *on* agentive -sha, the *kun* substance -mono.

Factors relating to retrieval of meaning via a phonological route include the above, but also include

- 7) How many other kanji (type/token) does this pronunciation occur in (ambiguity of the pronounced kanji). Some syllables, like 'ka' or 'sho', have as many as 50 meanings, so retrieving the pronunciation wouldn't be a very strong cue to retrieving the meaning.

Designing experiments: routes to retrieval of sound and meaning in reading Japanese. The standard description of kanji reading is to say that upon seeing a kanji, the reader retrieves its meaning first, and then its sound, taking context into account at some point during both procedures. While I have no intention of disputing this as a sketch of the most heavily used 'route,' the previous discussion of the relations between sound and kanji has been motivated

by a interest in the question of whether readers could not also access the sound independently of and even prior to the meaning of some kanji; and if they could, do they; and if they do, under what conditions?

First of all: are the phonetic redundancies that I have exemplified available to the reader? A connectionist approach (McClelland and Rumelhart, 1981) would probably say that all possible associations are made, but that some of them will contribute very little to the actual recognition of a kanji in a given task paradigm while others will dominate the process (in effect, like having multiple box-and-arrow paths--see Seidenberg, 1985). Manipulation of the task paradigm might make normally 'invisible' associations 'visible'.

To put it more formally, we have several linked research questions: First, which of the potential connections between kanji and pronunciation can be demonstrated in normal readers? Second, which of these 'psychologically real' connections are used on-line in skilled reading of text containing familiar and unfamiliar kanji. And third, which of these connections might be demonstrated in the various acquired alexias?

The following short sketches of possible experimental designs are intended to get us started thinking seriously about work on this topic. In all tasks discussed, we should consider the possibility and the possible effects of using compounds rather than isolated kanji or pseudo-kanji.

Tasks which might be used:

- 1) Multiple choice of pronunciation (and meaning, for comparison) of well-formed but non-existent pseudo-kanji. William Bright (personal communication) suggests using real Chinese characters that are no longer in use in Japan or that were never used in Japan as a basis for designing good pseudo-kanji, though the effects of the divergent modes of kanji simplification would have to be corrected for.
- 2) Visual list recall (serial or free) of kanji lists containing words pronounced alike and/or words with related meanings. One would expect interference among words pronounced alike; increased interference among words which are pronounced alike and have a phonetic component in common; and decreased interference among words which have a semantic link (e.g. all fruit). I don't know what to predict for words which share a semantic radical, or how having a shared semantic radical would interact with whether the semantic connection among them is obscure or obvious.
- 3) Visual list recognition for kanji; I would expect more false positives for words sharing more properties. 'Sharing a phonetic component', 'having the same pronunciation', 'sharing a semantic radical' and 'having an overall visual similarity' should all be separate properties, but hopefully similarities in terms of shared components should be much more powerful in inducing confusion than visual similarities that arise from having similar-looking components. Here is a place where American students could be used as a control group or as native raters for overall similarity of kanji, since people who have had no exposure to Japanese or Chinese won't 'see' components the way skilled readers do.
- 4) Response time for judging whether a given kanji has a particular pronunciation: present the pronunciation to the subject in kana or auditorily, then present the kanji; have the subject respond by a yes/no button press. This should be faster in the 'Yes' case if the phonetic component is providing a cue. It should be slower and give more false positives if a phonetic component is present but the associated pronunciation does not occur.

- 5) Semantic classification tasks; the reaction time might be faster when a phonetic component is present (for low frequency words; based on Seidenberg's results, no effect is expected for high frequency words). If this effect could be found, it would be a very powerful argument for a phonetic role in comprehending kanji!

References

- Reference to PHH is to Paradis, Hagiwara, and Hildebrandt, *Neurolinguistic Aspects of the Japanese Writing System*; to Gakken is to *A New Dictionary of Kanji Usage*, published by Gakken. Numbers in parentheses are the reference numbers assigned to each kanji by Gakken.
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