Visual vs. Phonemic Writing:
The Power of Kanji Radicals vs. Indo-European Roots

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1. Introduction

1.1. Radicals

All radicals included as headings in the radical directories of kanji dictionaries[1] seem to be basic vocabulary to humans. They include 1) terms for people, such as 'child' and 'woman'; 2) body parts, such as 'mouth' and 'hand'; 3) common (or formerly common) concrete objects, such as 'sword' and ' stone; 4) basic elements, such as 'water' and 'fire'; 5) common living things, such as 'tree' and 'dog'; 6) basic adjectival concepts, such as 'big' and 'small'; 7) basic actions, such as 'cover' and 'walk'.

This paper shows that the kanji radicals are "visual morphemes" (Bolinger 1946) that compose semantic networks of meanings, the nature of which can be described by cognitive linguistics. Let us first consider the semantic nature of the radical in terms of a single kanji and then in terms of the network of kanji containing it.

1.1.1. Radicals as morphemes : the right level of analysis at which to begin our study

Although some studies focus on whole kanjis[2] as morphemes (e.g., Morioka 1987), this preliminary examination of the kanji writing system, begins at a finer grained level of analysis. In it, we assume that whole kanjis can be broken down

into radicals (Inoue et al. 1983), which are themselves morphemes. There is quite a bit of obvious intuitive support for the claim that kanji radicals are meaningful units. For example, as noted earlier, one of the principal methods for organizing kanji dictionaries is by radicals. Teachers of kanji tend to begin any explanation of a new kanji by first identifying its radicals (e.g., Okazaki et al. 1992, Toyoda 1995). And, according to Miyakoshi (2000), informal experiments show radicals help children to learn new kanji compounds. He found that when elementary school students in the fifth grade were shown new Sino-Japanese kanji compounds composed of known radicals, the students could write them after a few minutes without looking at them, but when the same students were shown Sino-Japanese compounds composed of kanjis with unknown radicals, they had much more difficulty remembering and writing them. Moreover, from the field of psycholinguistics, Morimoto (1980) concludes that kanjis with the same radical are psychologically "close" and similar in meaning, and Kiriki (1986) found that radicals had a priming effect. Given all of the above, it seems quite reasonable to conclude that kanji radicals are, in fact, meaningful units, and, as such, that their behavior is deserving of thorough semantic analysis.

1.1.2. The semantic behavior of a radical within a single kanji

Basicly, within each kanji in the set of kanjis containing a given radical, the radical can do one of two things : 1) it can simply retain a subset of the total set of meaning properties possessed by the free morpheme/independent kanji from which it is derived; 2) it can extend the meaning of the free morpheme/independent kanji from which it is derived. Both 1) and 2) above can occur with or without semantic influence from other 'parts' of the kanji. Despite any such influence, however, it is clear that such parts tend to play a secondary role in a kanji's meaning, while the radical provides the 'core' meaning. Moreover, as is suggested by the above and by the radical directory of dictionaries, it seems that a kanji's radical

specifies a kind of 'semantic domain' into which the kanji falls.

1.1.3. Radicals in Networks of Kanjis

Further analyzing this notion of semantic domain, we find that the meanings of the set of kanjis containing a given radical can be thought of as a network. At the center of the network is the meaning of the kanji from which the radical is derived. This we shall call the "central radical meaning". Extending out from that central meaning are the various meanings of the kanjis in which the radical appears. What is more, however, is that these extended meanings appear to be derived in a limited number of ways, which we shall refer to as "categories of extension". Kanjis that share a category of extension are grouped together in the schematic below.

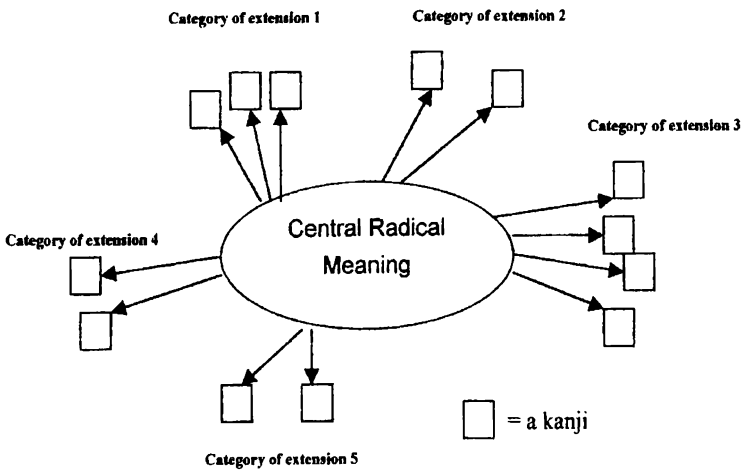


Diagram 1 : Semantic network of kanjis extended from a central radical meaning

1.2. Comparing Radicals and Roots

We first present three Japanese radicals and their semantic networks

of kanjis to illustrate the above claims. We then present three Indo-European roots whose meanings are roughly the same as the radicals' together with their derivatives in English and, one by one, compare and contrast the behavior of each root plus its derivatives with that of each radical plus the kanji in which the radical appears. In so doing, we see that while derivatives might exhibit some tendency to extend from roots via the categories of extension proposed for kanji, the root/derivative data fails to exhibit three important features observed in the radical/kanji data, and we discuss how these differences likely stem from the 'visual' nature of kanji writing versus the 'aural/phonemic' nature of English.

2. Semantic networks of kanjis containing a given radical

In this section, we examine three radicals and their networks of "joyo" kanji (kanji that all literate Japanese should know) to show that the networks are indeed systematic, even for basic vocabulary. [3] In each network, we find a limited set of categories of extension.

First, we look at the network of kanjis containing the radical 'sun' and provide a diagram of its semantic network. Then, we present two other networks of kanjis containing the radicals, 'stone' and 'walk', and we observe that kanjis containing the two nominal radicals extend via a common set of categories of extension while the verbal radical has a different set. [4]

2.1. The 'sun' radical, 日

The sun radical, 日, is used in kanjis that express meanings having to do with phenomena directly or indirectly involving the sun — the prototypical example of a round thing that shines in and moves across the sky — including time and phenomena obscuring the sun.

(1) Kinds of sun

日 (the sun)

星 (star) (Both the sun and stars emit light.)

曜 (heavenly body, shine) (Like the sun, all visible heavenly bodies are round and shine in the sky. By their exhibiting these perhaps most salient properties of the sun, it is possible that the other heavenly bodies were thought of as types of sun. The second meaning, 'shine', is also listed in the 'properties of the sun' section below)

(2) Nouns/concepts necessarily utilizing the sun or "made of" the sun.

The entire time domain in Japanese is full of nouns that directly or indirectly utilize the sun. On the other hand, the "made of" category lacks exemplars, which is not surprising given the fact that humans cannot interact directly with the main body of the sun.

昼 (daytime, afternoon) (these exist when the sun is shining most brightly)

時 (time) (calculated in relation to the movement of the sun)

暦 (calendar) (a record of days, or solar appearances)

旬 (ten days) (a grouping of solar appearances)

早 (early) (when the sun appears, it is early in the day)

暁 (dawn) (when the sun appears)

昔 (before, long time ago)

春 (spring)

晩 (evening)

暫 (a moment of time)

(3) Activities involving the sun

昇 (rise) (a basic perceived solar activity)

暮 (set) (a basic perceived solar activity)

映 (project, reflect) (The sun projects light which is then reflected off of objects; however the image of the sun itself is also reflected on bodies of water, such as the ocean, lakes, ponds, streams, rice fields etc., which should have made the reflected sun an extremely common percept when the kanji was made.)

暖 (originally 'radiate light'; now meaning 'warm')

(3.1) Natural phenomena involving the sun

This category does not apply to all radicals (e.g. it does not apply to radicals such as 'stone', but it would appear to apply to types of radicals, such as the 'sun', 'water', and 'mountain', which are salient parts of certain natural phenomena.)

晴 (clear and/or sunny weather)

曇 (cloudy)

暗 (dark)

(4) Properties of the sun

明 (light, bright, cheerful)

暑 (hot)

暖 (warm)

(5) Semantic extensions

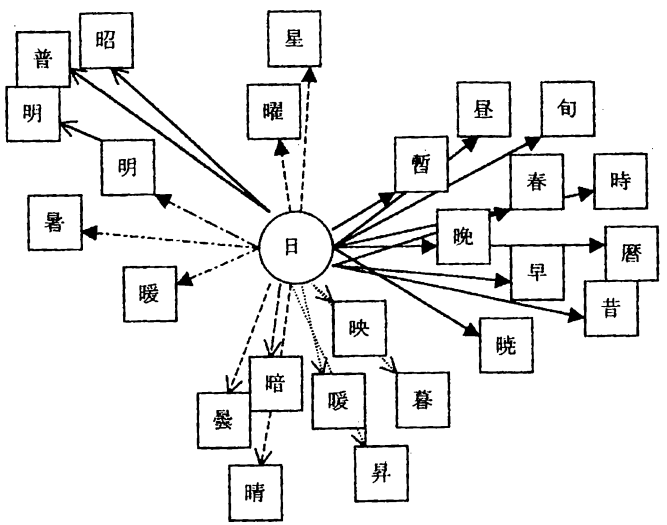
明 (cheerful)

普 (widely) (the sun's light spreads out widely as far as the eye can see. This may have constituted a prototype for something that happens widely, which was then extended, perhaps through metaphor, to the other instances and senses that now occur.)

昭 ('clear' in an abstract sense)

Clearly, the sun radical (and all other radicals) plays a central role in organizing the kanji that contain it. Several Japanese we spoke with agreed that when they see a kanji with the sun radical in it, they assume that the kanji has something to do with the sun. Moreover, if the kanji is new to them, they can use this assumption, together with the context, to approximate the meaning of that kanji. Of course, when they do this, Japanese probably do not consciously consider the specific ways in which the kanji meaning might be related to the radical meaning. Instead, the process is intuitive. Our proposed categories of extension are an attempt to bring these specific ways to light.

However, there are a few other noteworthy points about the categories of extension. First of all, their small number should help readers to guess at new meanings in an efficient way; but even more importantly, with respect to known



kanji's, it seems probable that the categories, working with the radicals, play an important role in the organization of the mental lexicon. In the following

diagram, the categories of extension are represented by different types of arrows.

Diagram 2 : The 'sun' radical and it's network of kanji

2.2. The 'stone' radical, 石

This radical exhibits patterns of meanings similar to those of 'fish', 'tree', 'plant', and 'water' and other nouns whose referents humans manipulate.

(1) Kinds of stone

石 (stone)
砂 (sand)
硝 (niter/salt-peter)
硫 (sulfur)
磁 (magnet/loadstone)
碧 (blue stone)
礁 (stones in sea water)

(2) Nouns necessarily utilizing or made of stone(s)

砲 (sling shot, catapult)
砦 (fort)
碁 (the game of *go*)
碑 (monument)
礎 (foundation)
磯 (beach)
硯 (inkstone)

(3) Activities involving stones

砕 (break/smash)
破 (tear)

磨 (polish)

研 (polish)

(4) Properties of stones

硬 (hard)

(5) Semantic extensions

確 (hard, certain)

碩 (knowledgeable, full of good things) (This meaning suggests the head being as dense as a stone, because it is full knowledge or other good things depending on the kanji with which it combines.)

2.3. The 'walk' radical, 彳 (walk, go)

The three categories of extension proposed for this radical appear to be similar to those for other verbal radicals. In addition, two of the categories for this radical, (3) and (5) are the same as those proposed for the nominal radicals above, but the final one seems to be different. We call this category "concepts associated with walk/go" and it includes concrete things like 'path', subjective percepts like 'distant', and abstractions like 'late'.

(3) Activities that involve walking and/or going

行 (go)

復 (return) ('going back' to where one started)

往 (go) (a sort of 'round-trip go' involving both going and coming back)

役 (guard) (guarding meant carrying a weapon and walking/going with or around whomever or whatever one was guarding)

征 (go and conquer) (to conquer some people somewhere, one must first

walk/go to them)

待 (wait) (walking/going and then stopping temporarily often means waiting)

徐 (go slowly)

徒 (walk to somewhere)

循 (follow)

御 (ride a horse carriage) (a way of going)

(5) Semantic extensions of walk/go

微 (little) (derived from walk quietly, sneak)

得 (get, gain) (derived from the result of walking, finding a shell/treasure and picking it up with the hand)

律 (law) (derived from walking and making things even)

徹 (carry though) (derived from walk and through)

徳 (virtue) (derived from walk up to the altar < walk and heart and right)

(6) Concepts associated with walk/go

径 (path, ally)

彼 (distant, that, there, he)

後 (late, after, back)

3. English morphological data

Here we list Indo-European roots with meanings similar to those of the kanji radicals discussed above together with their English derivatives in order to see if the sets of derivatives of a given root exhibit categories of extension similar to those observed in the kanji system. Then we further analyze the data to see if it suggests any other generalizations about radicals and kanji versus roots and derivatives.

3.1. 'sun' sawel

Important derivatives that are likely known to most native speakers : *sun, sunny, Sunday, south, southern, solar, parasol, solstice, helium, solarium.* [5]

1. Kinds of sun (1) e.g. "That planet's *sun* is a red giant."

2. Nouns necessarily utilizing the sun or "made of" the sun (3) (*parasol, solarium*, and *helium*, which is created in the sun)

3. Activities involving the sun (1) (to *sun* one'self: to bask in the sun's rays).

3.1 Natural phenomena involving the sun (1) (*solstice*)

4. Properties of the sun (1) (*sunny*)

5. Semantic extensions (1) (*south, southern* : For Indo-Europeans, the sun was always in the south. This is a metonymic extension as the sun and the direction, south, are perceived to be in the same place.)

3.2. 'stone' *stei-* (with derivatives *stone, tungsten*, and *stein*) (also *petr-* and *rock*)

1. Kinds of stone (1) (*tungsten*)

2. Nouns/concepts necessarily utilizing or made of stone(s) (1) (*stein, stone*--a unit of weight) (1) (*petroleum* — but from a different root)

3. Activities involving stones (4) (*stone* 1. To hurl stones at. 2. To remove the stones or pits from. 3. To furnish, fit, pave or line with stones. 4. To rub on or with a stone in order to polish or sharpen.)

4. Properties of stones (1) (*stone* The hard kernel in certain fruits, as the cherry or plum) ; (3) (different roots : the colloquial, "He is a *rock*," which means, "He is solid and reliable." Also, *petrified* can mean 'has become physically like stone' as in *petrified forest.* Additionally, *petrified* can mean 'unmoving due to fear')

5. Semantic extension (1) (*stoned*--to be intoxicated. *Obs.* To make hard or indifferent)

The derivatives *tungsten* and *stein* may actually be compounds in their languages of origin and so, technically, might not be permissible here, since we are examining only single words. The morphemes in *tungsten* mean 'heavy' and 'stone' respectively, and *stein* is short for *steinkrug* 'stone cup'.

3.3 "walk/go" ghredh-: a. *aggress, congress, progress, grade, degrade, degree, digress, egress, ingress, regress, transgress*--plus some uncommon terms: *gressorial, degression, pinnigrade, plantigrade, retrograde, retrogress;* b. *grade; centigrade, degrade, degree* from Latin *gradus* (< deverbative **grad-u-*), 'step', 'stage', 'degree', 'rank'[6]

(3) Activities that involve walking and/or going (1) *aggress*, (similar to the Japanese sense of 'conquer'), *progress, digress, regress, transgress*

(5) Semantic extensions of walk/go (*grade, centigrade, degrade, degree, degress, congress, retrogress*)

(6) Concepts associated with walk/go (*egress, ingress, gressorial, plantigrade, pinnigrade, retrograde*)

4. The differences between roots and radicals outweigh the similarities

The nominal roots and radicals we examined appear to behave similarly in one respect. For the most part, the derivatives of the roots do appear to fall into the categories of extensions proposed for the radicals. This suggests the possibility that the proposed categories of extension constitute some rudimentary semantic paths by which humans have expanded their lexicons as their civilizations became more complex and sophisticated.

Nonetheless, the roots and radicals appear have three times as many differences.

1) The roots are not nearly as productive as their radical counterparts. 2) In terms

of 'centrality', the roots do not signal a semantic domain and, they do not function systematically as central meanings from which the derivative meanings are extended. [7] 3). Synchronically speaking, the most basic derivative of an Indo-European root in English, for example, *stone* can have an extensive polysemy network while the kanji from which a radical is derived cannot.

4.1. 'sun'

Point 1) Productivity

There are only nine or so basic derivatives using the sun root. On the other hand, one of our dictionaries shows 103 kanjis that use the sun radical (Larger dictionaries should include an even larger number). Of these, we have discussed only the 25 that we believe to be *joyo* kanji. Of course, the mandatory inclusion of a radical in any new kanji must be the main reason for the productivity of the radicals. However, it is probably the visual nature of the radicals that allowed them to remain as intact graphical semantic units available to wordsmiths over time.

Point 2) Centrality

Although nine words contain the sun root, it is unlikely that the root functions as a core concept linking all the words, as the 'sun' radical links all the kanjis that contain it. For example, many native speakers have never heard of the root *sawel* and would never dream that it, or anything else, links the meanings of *helium, southern,* and *solstice*. This, no-doubt, is largely due to sound and spelling changes that have obscured the fact that all the words do indeed share a common root. Radicals, on the other hand, remain unaffected by sound changes, because they do not represent phonemics, as alphabetic systems do ; they essentially represent meanings. [8] Moreover, it is this visual-semantic nature of kanji radicals, and whole kanjis, that allowed them to be applied to native Japanese morphemes/words (*kun yomi*) as well as borrowed Chinese morphemes/words (*on yomi*). Thus, the visual-semantic nature of the kanji system enables a single radical "grapheme" (and/or a

kanji grapheme) to link the meanings of words of different pronunciations and origins, and to preserve the connections over time. In turn, this contributes to the radicals' power as semantic organizers/indices for those who read them. Also, the constant visual form of kanjis despite disparate pronunciations is critical to the functioning of the radical index of kanji's dictionaries.

In terms of inventing new kanji, the visual-semantic nature of the kanji system, together with the obligatory inclusion of a radical in a new kanji, should have made the composers of new kanji very conscious of radical meaning. They would have had to make a conscious decision about which radical to include based on the radical's meaning. This might account, at least in part, for the fairly straightforward organization of meaning extensions we have observed. English words, on the other hand, can develop, by various means, and be written down without necessarily considering the semantics of morphemes. [9] One example illustrating kanji users' consciousness of morpheme meaning (albeit perhaps whole kanji) versus English speakers' lack of it is found in the naming of children. While Japanese parents normally consider both the sound and the meanings of morphemes when naming a child, English-speaking parents usually pick a name just because they like the sound of it and/or because it designates someone they admire.

Point 3) Polysemy of the most basic derivative

Some of the words listed above are extended meanings of the word *sun* itself. On the other hand, the 'sun' radical does not undergo similar extensions. A better example of this phenomena is found with *stei-* 'stone', so the subject of polysemy will be discussed in more detail under point 3) in the following section.

4.2. 'stone/rock'

Point 1) Productivity

Similar to the 'sun' root in its behavior, the 'stone' root has far fewer

derivatives than its radical counterpart has kanji. The radical appears in 84 kanji, of which we have discussed 21 *joyo*.

Point 2) Centrality

By itself, the root fills few of the categories of extension proposed for the radicals. On the other hand, if we consider three roots of the same meaning taken together, we find exemplars for all the categories of extension.

While the radical for 'stone' functions synchronically as a centralized meaning linking all the derivative kanji, the root *stei-* does not perform a similar function. *Stei-* is only evident in *stein* and most English speakers would have no idea that it means 'stone' in that word. Moreover, the fact that the roots *petr-* and *rock*, co-exist with *stei-* in English argue further against its centrality. The phenomenon of different roots with nearly identical semantics is not uncommon in English, but it is virtually non-existent among Japanese radicals.

Point 3) Polysemy of the most basic derivative

Another point of difference is that the basic English derivative, *stone*, undergoes quite a bit of meaning variation all by itself (though not in every category of extension), and the extended meanings are in most cases noticeably associated with the basic meaning of *stone*. The independent kanji from which the 'stone' radical is derived — the synchronic counterpart of the word *stone* in English, however, does not undergo meaning change. It only undergoes meaning changes when it appears in kanjis that contain other parts.[10] This lack of meaning change in the basic kanji from which the radical is derived might serve to preserve the integrity and clarity of the radical meaning when it appears in the set of kanjis that contain it. To explain in more detail, we have proposed that a radical serves as a central meaning/domain marker, and that the meanings of kanji containing that radical are arrived at via the aforementioned categories of extension. However, if radicals themselves had large

polysemy networks, then the radical/kanji system of meaning would loose much of its clarity and systematicity.

As we have described it, the radical is analogous to a simple hub of meaning with extended meanings linked back to it via a small set of predictable sorts of connections. Changing the current radical system so that the basic meaning or two of a radical could extend freely would undoubtedly undermine the semantic indexing function of kanji radicals. Kanji radicals, as listed in kanji dictionaries, have extremely simple and basic meanings. We can be sure that if a radical itself had numerous meanings, it would reduce or even destroy the functionality of radicals in the kanji dictionary system, and, similarly, it might reduce or even destroy the functionality of the radical-based cognitive semantic system that we have attempted to describe. Thanks to the small number of meanings a radical can have, the network of kanji containing it is kept simple.

4.3. 'walk'

Much more so than the nominal roots, the verbal root for 'walk' seems to parallel the kinds of extensions seen for the kanji radical, and two possible causes for this present themselves. First is the fact that the proposed set of verbal categories of extension has few but fairly general members. Second is the fact that because basic Latin verbal roots, such as 'walk/go', exhibit a productive pattern of combination with what once were prepositions (e.g., *a-*, *con-*, *pro-*, *de-*, *re-*, etc.), a pattern of related meanings extending from a root results that resembles the pattern of related meanings extending from a central radical. Combination with suffixes also contributes to this, but to a lesser degree.

Nonetheless, the generalizations made for the nominal radicals still seem to hold. (1) (productivity) *Ghredh-*, even with its 21 derivatives is not nearly as productive as its radical counterpart, which appears in 38 kanji, and only a handful of the words derived from *ghredh-* are part of ordinary native speakers' lexicons, while

all 18 of the kanji we listed are *joyo*. (2) (Centrality) Very few native speakers do not know this Indo-European root — or any other for that matter. Most native speakers do not know the meaning of even the most common derivative form, *gress*, and they certainly have no idea that words such as *congress, grade*, and *degree* share a common root. Therefore, neither the Indo-European root nor any of its derivative roots can be a central meaning from which the meaning of all derivative words extend in any synchronic sense. (3) (Poiysemy of the most basic derivative) There is no basic derivative of *ghredh-* that means simply 'walk' today, but *ghredh-* itself, has undergone more polysemy than the 'walk/go' radical, as seen in the Latinate senses, 'step', 'stage', 'degree', and 'rank'. Also, it is possible that, in some cases, the extended meanings of derivatives that include *gress-* represent extensions of *gress-* that were formed before the derivative word was formed. If so, such cases would also involve polysemy of the root.

5. Phonemic vs. Visual writing and the problem of unique but random symbols

Evidently, meanings can be assigned to random (but essentially synchronically fixed) combinations of phonemes virtually without limit. To explain why this is so, at the moment it can only be said that it is part of the evolutionary miracle that is language. Alphabetic systems represent (albeit sometimes very sloppily, as is the case with English) phonemic systems. As a result, they inherit the productivity with which meanings can be attached to combinations of phonemes. In an alphabetic system, lines and dots or little patterns of them compose letters or groups of letters that stand for phonemes, which in larger groups stand for whole words. Then, miraculously, the brain can attach virtually countless meanings to those groupings of written phonemes.

On the other hand, if the writing system of a hypothetical language did not represent phonemes, but was instead composed only of whole words, each graphically

represented by a unique but apparently random marking, such as a bar-code, people could not learn the system. The task would simply exceed the capacity of the human visual memory system. Random configurations of lines and dots cannot work. Therefore, it stands to reason that any writing system that does not encode phonemes must use other organizational devices to reduce randomness and make the system learnable.

Kanji does not represent a phonemic system. The lines and dots and combinations of lines and dots do not represent phonemes. Therefore, other organizational features must and do exist in the system. One such device is the system of approximately 250 kanji radicals.

5.1. Why *those* 250 kanji? Non-random features of radicals.

The mere presence of the radical indexing system in kanji dictionaries certainly supports the claim that radicals serve as semantic domain labels and even lends some support to the claim that radicals are basic meanings from which the meanings of the kanji that contain them extend. But the mere presence of the system does not explain why the set of radicals in the directory is what it is.

One reason is probably that the radicals themselves are not random assemblages of strokes. They are either iconic, such as sun, moon and tree, or they are symbols that are abstractly connected to the concepts they represent, such as one 一 and two 二, and above 上 and below 下. In this way, they provide core meanings grounded in physical-perceptual experience from which more abstract notions can be extended, and they greatly reduce the randomness of the kanji system. [11]

5.2. How radicals help make the kanji system learnable : *Implicit mediators* and patterned invariance

One of the most fundamental ways in which people learn is by 'association'. According to Wolf & Vellutino (1993 : 361), Tulving & Pearlstone (1966) note:

> Associative learning seems to involve something akin to a search for and "discovery" of **implicit mediators** (often called retrieval cues) that may link two associates in a component of memory called the **semantic network**.

Because every kanji either is a radical or contains one, radicals can be mediators with which to associate the kanjis that contain them. That this is true strictly in terms of vision is clear. For example, if all the kanjis of the language were written on cards, anyone who could recognize the visual permutations of the radicals could sort all the kanji into separate piles, just by visual recognition of the radicals' form, and without knowing the meanings. However, as our schematics of radical networks show, radicals might also function as mediators assisting in the formation of regular lexical semantic associations between kanji containing a given radical.

On the other hand, association alone does not explain the categories of extension, which are analogous to "rules". Apparently, humans' proclivity for pattern analysis and rule learning is founded on our ability to detect patterned invariance. According to Wolf & Vellutino (1993 : 362), Gibson (1966) suggests that

> humans are naturally inclined to "search for invariance" in new learning situations to aid them both in reducing the amount of information they would otherwise be required to store, and to facilitate detection of distinguishing attributes in things having overlapping features. She also suggests that we are naturally endowed with mechanisms that allow us to store representations of invariant relationships in the form of rules and *algorithms* that can be used generatively.

The results of Miyakoshi (2000), noted in the introduction of this paper, would seem to indicate that radicals do assist learning in this way. However, it also seems likely that the above mentioned phenomena had something to do with the formation

of the radical/kanji system in the first place.

According to Wolf & Vellutino (1993 : 362-3) "**association** underlies one of the most rudimentary and ubiquitous of all cognitive abilities, specifically, the ability to *symbolize*." Thus, association could have been behind the first kanji symbols and generative rules and algorithms could have imposed the network structures we have observed.

6. Conclusion

Kanji radicals behave differently than English morphemes in three primary respects. 1) Kanji radicals are far more productive than Indo-European roots. 2) Every radical constitutes a central organizing meaning to which the meanings of all words containing it are linked, but no root appears to perform a similar function. 3) While the kanji from which a radical is derived always holds a simple core meaning over time, the synchronic counterpart of the basic Indo-European root word undergoes meaning change freely. [12] In our discussion of the above points in terms of radicals, we have proposed specific explanations involving the visual nature of kanji. We have also hypothesized, based on cognitive processes involved in reading and all learning, about the necessity of radicals, or something like them, in any functional non-phonemic visual representation of language.

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Notes

1. The other elements of a kanji will simply be referred to as 'other parts'.
2. In this paper, for clarity's sake, we have made 'kanji' a countable noun.
3. The size requirement of this paper precludes the possibility of examining a large enough number of kanjis to make a statistically valid sample, but we believe that, in general, radicals follow the patterns we describe.
4. Although we include only one verb in this paper, other verbs appear to behave similarly. Upon further investigation, we might find that radicals representing other parts of speech, such as adjectives, might show distinct categories of extension.
5. There are numerous other words that include the root for 'sun', but they are specialized terms unknown to people without specialized knowledge. For example, consider the following, preceded by their category of extension numbers: (2) *solarimeter,* (3) *solarize,* and (5) *solanine.* Such terms are not considered here because they do not correspond to the level of vocabulary selected for Japanese.
6. The English word *walk* is extended from *wel* (2) - but is not productive.
7. Contrary to the results found for their radical counterparts, roots that have undergone considerable sound change would probably not prime derivatives well.
8. Interestingly, it has been observed that English also does this, but to a much lesser degree. For example, the common orthographic form of *sign* and *signature* preserves a connection to the words' common root, despite a differences in phonemics (Wolf & Vellutino 1993 :

356).

9. One exception to this rule is the conscious composition of Latin and Greek morphemes by scientist wordsmiths.
10. This suggests that kanjis are kinds of compounds. We will look at the compound nature of kanjis in greater detail in a subsequent paper.
11. As another visual linguistic system, non-phonemic signs in sign-language must also get around the problem of randomness. It is possible that the problem is solved similarly in sign language and that sign language also has something akin to radicals grounded in iconicity etc. We will attempt to confirm this possibilty in subsequent research.
12. Although, we have included just three examples, it should become evident to anyone who carefully reads a compendium of Indo-European roots (see American Heritage Dictionary's collection of Indo-European roots) that, overall, roots do not behave differently in terms of the generalizations 1-3 above.