Beyond Reading: Visual Processing of Language in Chinese and English

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Abstract

Reading Chinese appears to involve to a greater degree short-term memory's visuospatial buffer and conceptual store, whereas reading English involves to a greater degree the phonological loop. I review findings that show how these *relative* processing differences can affect memory and persuasion. Relative processing differences can affect the way in which readers integrate visual features with words in memory (e.g., words' print color or font style), in the way in which readers associate words with nonverbal information in memory (e.g., brand names with logos), in the way in which words are organized in and subsequently retrieved from memory (e.g., retrieval of product features based on semantic associations versus order of learning), and, I predict, in the nature of decision making (e.g., spatial reasoning). The processing framework I develop, suggests that language can affect cognition even if mental representations are language free.

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Introduction

One of the earliest known writing systems were hieroglyphic inscriptions, dated as early as 3100 BC. Hieroglyphs were recognizable pictures of objects, or pictograms. These pictograms were sometimes logograms which visually represent an object's meaning. Many hieroglyphs, depending on context, also functioned as phonograms – phonetic elements that are combined to form words or phrases. Phonograms function much like a rebus. An example of a rebus in English are the drawings of an *eye* and a *deer* to represent the word "idea."

Modern Chinese logographs evolved from pictograms. Logographs can function as concept symbols, use the rebus principle, or combine concepts (e.g., the combination of the characters for *sun* and *moon* to form "bright"), but today most words use a combination of characters of which one indicates meaning and the other sound. While characters no longer rely on identifiable pictures beginning readers are still instructed with pictorial aids as a mnemonic, though the pictorial aid is often not related to the character's pictographic origin.

In contrast to Chinese, most modern languages rely on phonetic scripts consisting of symbols that generically represent the sounds of words and not their meanings. The alphabet, which uses abstract symbols to represent phonetic elements, emerged in the 17th century BC in Palestine. Alphabetic scripts include the Latin alphabet (e.g., English and Spanish), Arabic, Hebrew, and Cyrillic scripts (e.g., Russian). Moreover, within their written forms, languages such as Japanese and Korean rely on a mix words written in either a logographic or phonetic script. Written Japanese relies on Kanji which is based on Chinese logographs, two phonetic Kana scripts, as well as Romaji which employs the Latin alphabet. Korean Hancha is based on Chinese logographs and Hangul uses an alphabet.

My goal is to convey that there are important differences in the processing of logographic and alphabetic scripts that affect memory and persuasion. I begin by highlighting basic differences in the mental coding of written words. I then review a growing body of research, including yet unpublished data, that shows how relative differences in basic encoding processes can affect higher-order processes involved in consumer memory and persuasion. First, I will discuss differences in the integration in memory of words with nonverbal information such as font style, print color, and logos. Second, I will discuss qualitative differences in the processing of verbal information such as associative-, spatial-, and temporal processing. This section also includes lines of future research that promise to tap into processes involved in decision making. Finally, I conclude by suggesting that visual processes are integral to the processing of language beyond the process of reading; that language differences can affect cognition.

Reading Chinese and English

The notion that short-term memory (STM), or working memory, is involved in language comprehension dates back to Huey (1908). There are different components of short-term memory – e.g., the visuospatial buffer, the phonological loop, and a modality-free conceptual store – that are coordinated by a central executive processor (for a review, see Jonides, 1995).[1] STM includes both storage and processing components. The *phonological loop* codes linguistic information in phonological form and processes, or rehearses, that information by re-circulating it in a serial manner (Baddeley, 1986). The *visuospatial buffer* stores information in an imaginal code and rehearses information perceptlike, that is, as if viewing a scene that contains the imagined objects (Kosslyn, 1980).[2] Finally, the *conceptual store* codes information in a modality-free way, in terms of its conceptual properties (Potter, 1993). Reading *any* language relies on each of these components to encode verbal information (Figure 1). However, languages appear to do so to differing degrees.

Phonological aspects pervade in reading alphabetic scripts. Readers of English, for example, tend to phonologically recode (sub-vocalize) written words (e.g., McCusker, Hillinger, & Bias, 1981). English words are primarily rehearsed phonologically in STM's phonological loop (Baddeley, 1986; Paivio, 1986; Van Orden, 1987).

The process of reading Chinese differs considerably where a reader has to visually distinguish upward of 7000 logographs. Reading Chinese logographs appears to rely less on phonological but more on visual processes (Hung & Tzeng, 1981; Schmitt, Pan, & Tavassoli, 1994; Tavassoli, 1999; Zhou & Marslen-Wilson, 1999). Even when logographs represent sound,

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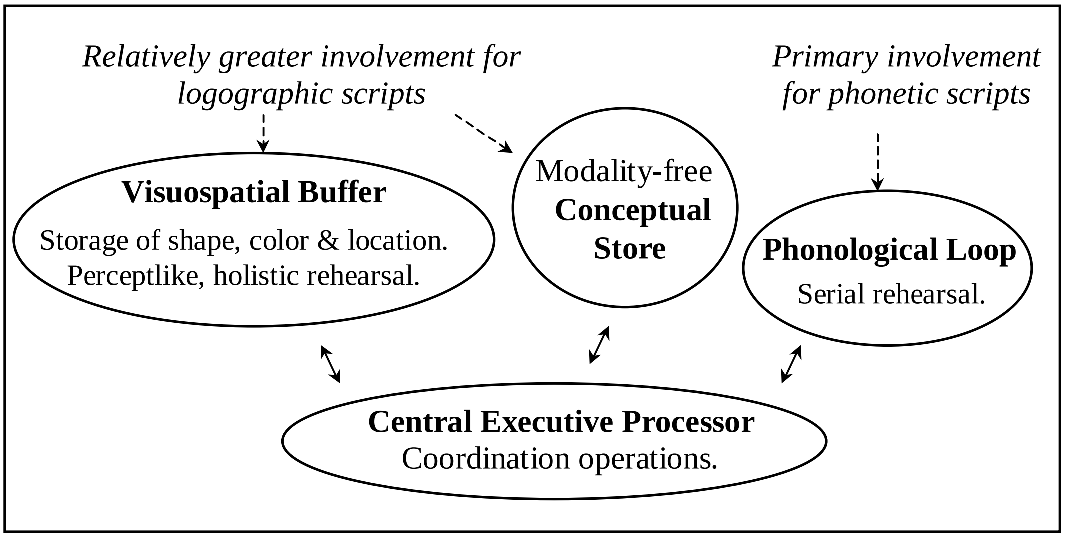
[1] The central executive processor can be characterized as a set of operations that coordinate information in the components of STM. Coordination tasks include both the prioritizing of separate goals, as well as the scheduling of activities in the various stores to achieve a single goal (for a review, see Jonides, 1995).

[2] The visuospatial buffer can be further differentiated into information about memory for an object's form (i.e., the visual store for color, form etc.) and memory for metric location (Smith & Jonides, 1994).

the association with pronunciation is largely arbitrary and acquired via rote associative learning. Because logographs are symbols that represent meaning (morphemes) a Chinese reader is able to mentally access meaning unmediated by phonology, or subvocalization (Perfetti & Zhang, 1991).

Figure 1

Different Stores in Short-Term Memory



Phonology alone would also be a very ambiguous mental code in Chinese. Because there are only about 1300 syllables in Mandarin (including tones) there are a large number of homophones, such as *to*, *too*, *two* or *so*, *sow*, *sew* in English. The problem of homophones is eliminated in writing as there are ten times more logographic components available than spoken utterances (Cheng, 1981). As a result there may be a greater need to rely on contextual semantic information in Chinese, as rehearsed in STM's conceptual store (Tavassoli, 1999a).

Chinese may rely on STM's visuospatial buffer to a greater degree than does reading English because of the visual complexity of characters and/or based on their disambiguity with respect to homophones. Several demonstrations of this difference can be found in the masking and priming literature. For example, a phonemic mask (e.g., "rait") was more effective than a graphemic mask (e.g., "ralt") in facilitating the identification of a target word in English (e.g., "rate") (Perfetti, Bell, & Delaney 1988). In contrast, graphemic primes and masks facilitated Chinese word identification more than phonemic ones (Perfetti & Zhang 1991). These processing differences are underscored by the finding that learning to read Chinese depends less on phonological awareness skills and more on visual skills than does reading ability in English (Huang & Hanley 1995).

To summarize, psycholinguistic research suggests that there are some basic differences in the cognitive processes involved in reading logographic and phonetic scripts. English appears to rely to a greater degree on STM's phonological loop, whereas Chinese appears to rely more on the visuospatial buffer. It is important to note, however, that a greater reliance on a visuospatial code does not suggest that a Chinese reader views a logograph as a pictorial representation of a concept and that both Chinese and English involve phonological *and* non-phonological codes (Liu, Zhu, & Wu 1992). Differences must, therefore, be considered a matter of the degree (cf. Hung & Tzeng 1981). These low-level processing differences established in the psycholinguistic literature can, however, have profound effects on higher-order processes. Convergent findings on how such differences may affect higher-order processes involved in memory and persuasion are beginning to emerge in the consumer psychology literature.

Nonverbal Aspects of Processing Written Language

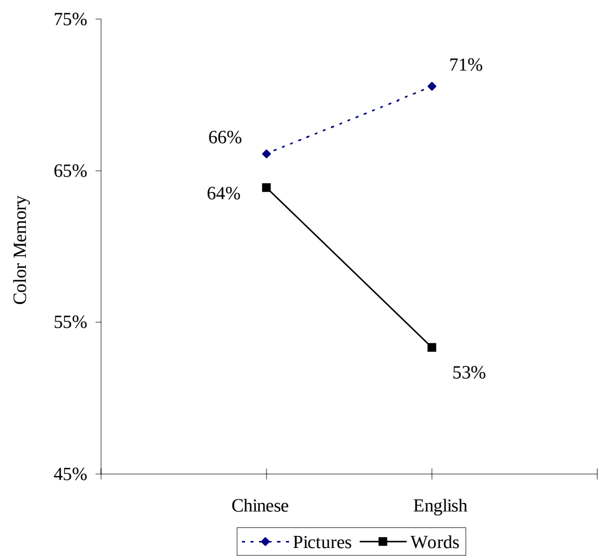
Nonverbal Features of Verbal Information

One aspect of interest to consumer researchers is the integration of words with acoustic and visual information. Several prominent theories on information integration address the integration of features of a single concept or object. *Information Integration Theory* is concerned with the recognition of words' stored meanings as a convolution of phonetic (e.g., pitch) and visual features (e.g., speaker's face), as well as lexical, syntactic, and semantic context (for a review, see Massaro 1996). Treisman's (1988) *Feature Integration Model* is similarly concerned with the conjoining of attributes of a single visual object (color, shape, size, etc.) into a single percept. The architecture used for perceptual processing also provides the mechanism for integration. The degree of integration between features of an item is defined by the directness of the connections between the processes that are used to encode the features (McClelland 1996).

The findings from the information integration literature provide a basis for interesting predictions regarding "trade dress", such as color, font style, and other visual components associated with a brand. For example, Chinese readers should better integrate in memory written words with their print color, because they rely more on the visuospatial buffer than English readers. I tested this hypothesis across languages using a learning task of otherwise equally memorable words printed in different colors (Tavassoli, 1999b). I found that Chinese participants better remembered the print colors of words than did English speakers. As figure 2 indicates, there was no memory difference for the color of objects, the control condition, which are assumed to be processed similarly across cultures.

Figure 2

Color Memory for Words and Pictures (Tavassoli, 1999b)



This processing difference also extended to brand evaluations. Consider *Apple's* former rainbow colored logo which acquired connotations of freedom and fun, compared to *IBM's* blue which signals solidity, or worse, stodginess. Would a new brand that copied *Apple's* or *IBM's* colors be influenced by their connotations? Chinese readers, but not English readers, evaluated an unknown brand more positively if it shared the color of highly rated pseudo-brands than if it shared the color of poorly rated pseudo-brands (Tavassoli, 1999b). This type of process has been receiving growing legal attention and several countries have recently passed laws against "brand piracy" through copying another brand's color if this has acquired secondary meaning.

Pan and Schmitt (1996) previously examined the impact of features of a scripts and of speakers' voice on evaluation. They found that attitude ratings provided by Chinese consumers were more sensitive to the match between the femininity or masculinity of fonts for feminine (e.g., lipstick) and masculine products (e.g., motorcycles). In contrast, American consumers were more sensitive to the match between the product class and gender of the presenter in auditory communications. The encoding of elements such as color and font style therefore have an effect on attitude formation. In other words, in Chinese brand names were evaluated more in terms of visual features, whereas English speakers evaluated brand names more in terms of phonological features.

Zhang and Schmitt (2000) proposed that language may actually prime an encoding process for bilingual consumers. The authors used biscriptual labels and suggested that the more prominently displayed name would prime a type of encoding process. Their findings suggest that when the English name was more prominently displayed than the Chinese one, the biscriptual brand names were evaluated more in terms of their phonetic fit. In contrast, a more prominently displayed Chinese name seemed to act as a visual/semantic prime causing a biscriptual Chinese-English brand name to be evaluated more in terms of the semantic fit between the translations.

The Interaction of Verbal and Nonverbal Items of Information

The previous section examined the use of nonverbal features such as color for verbal information such as brand names. Another branding issue is concerns the use of nonverbal information such as a logo in conjunction with verbal information such as a brand name or advertising copy. For example, the conjoining of elements such as a brand name (in English) and a picture have been examined in terms of meaningful associations (e.g., Houston, Childers, & Heckler, 1987; Lutz & Lutz, 1977; Schmitt, Tavassoli, & Millard, 1993). In Tavassoli and Han (2000) we proposed that there should be a difference between logographic and phonetic scripts in the potency with which mnemonic associations are formed between brand names and visual and acoustic information.

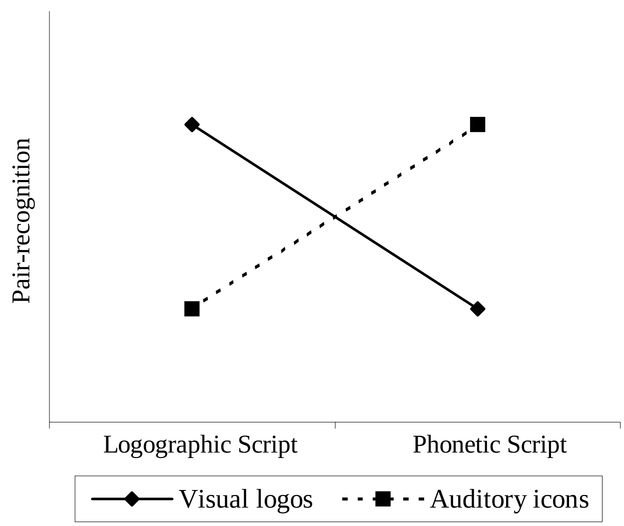
We examined logos which serve as the official visual representation of a brand name and are intrinsic to all identity programs. Taco Bell, for example, has spent twenty times more on permanent media limited to a brand name and logo (e.g., on trucks, banners, and other signage) than on advertising (Shennan 1986). We also examined auditory icons, such as the *MGM* lion's roar, which are used extensively for branding purposes.

Similar to the information integration literature, research on cross-modal associative memory (Penney & Butt 1986; Tavassoli 1998) and cross-modal coordination (Yee, Hunt & Pellegrino 1991) suggest that associative memory between two separate items of information should be stronger the greater the overlap in STM processes active during encoding. A *relatively* greater reliance on visual STM for logographic scripts should therefore facilitate the integration of words with visual logos, whereas a *relatively* greater reliance on phonological STM for phonetic scripts should facilitate the integration of words with auditory icons.

We presented pairs of words matched with logos or sounds and later tested pair-recognition, where half of the pairs were in the same pairing as at learning and half were cross-matched (Tavassoli & Han 2000). The interaction effect of three experiments – using native Mandarin speakers compared to native English speakers, bilingual speakers of Cantonese and English, and Koreans biscriptual in Hancha and Hangul – supported the hypothesis. The nature of the interaction effect is represented in Figure 3.

Figure 3

Memory for Verbal-Nonverbal Combinations (Tavassoli & Han, 2000)



It is also important to recognize that the reciprocal effect of integration is often interference (Penney 1989; Tavassoli 1998). In the above examples, the goal was to integrate information. When stimuli compete for attention, such as in a dual task setting, interference is greater the greater the overlap in processing requirements.[3] For example, an acoustic distractor interferes more with the processing of verbal than pictorial information, and vice versa for a visual distractor (Duncan 1980).

[3] The results in figure 3 refer to associative memory. It is likely that the pattern of results for item-specific memory would have been reversed (Tavassoli, 1998). Specifically, memory for logographic words *in isolation* may be greater in the sound condition, and memory for the alphabetic words *in isolation* may be greater in the logo condition.

Contrast, for example, the finding that memory for words' print colors is greater in Chinese than in English (Tavassoli, 1999b) with the findings of an interference task. Stroop interference in naming a word's print color is greater if the conflicting color word (e.g., the word "red" printed in the color green) is written in logographic Chinese than alphabetic English (e.g., Biederman & Tsao 1979). In addition to semantic interference, the authors suggested that there was more perceptual interference in the Chinese condition. Similarly, symbols produced more Stroop-like interference in the naming of Chinese characters than in the naming of English words (Chen & Tsoi, 1990). However, here the authors believed this was caused by a more *holistic* processing strategy in Chinese.

In a television advertisement, the use of unrelated background music may therefore interfere more with the processing of English, whereas the use of unrelated visual graphics may interfere more with Chinese. In terms of interference, there may even be interesting within-language issues for languages that use a combination of a logographic and phonetic script (e.g., Japanese and Korean). In Japanese, item-memory for words was better when words were presented such that they alternated between the phonetic Hiragana and the logographic Kanji, than if they were all presented only in Hiragana or only in Kanji (Schmitt & Tavassoli 1994). This finding suggests that more resources for processing item-specific information are available in STM when words use different scripts rather than the same script.

Qualitative Differences in Information Processing

The previous section examined the encoding of words with nonverbal elements, and the implications for memory and evaluation. Encoding differences may also have more dynamic implications. In Schmitt, Pan and Tavassoli (1994) we examined retrieval mechanisms. We found that regardless of whether words were learned auditorily or visually, Chinese speakers were able to recall them better by writing them down during free recall, whereas English speakers were better at recalling words by speaking them. We suggested that the attempt to write primed words' graphemic code in memory which should be more pronounced for Chinese logographs, and that the attempt to speak primed words' phonological representation in memory which should be more pronounced for alphabetic words. In other words, differences in encoding language may also affect the retrieval of words from memory.

Relative differences in the reliance on visuospatial and semantic versus phonological processes in STM can also affect the qualitative nature of processing. For example, I found that memory for presentation order was more pronounced in English than in Chinese (Tavassoli, 1999a). I argued that this is because the rehearsal of English words relies to a greater degree on STM's phonological loop which rehearses information in a serial manner. I also found that English speakers were more likely to retrieve words from memory based on the order in which they learned them (Tavassoli, 1999a). These findings suggest that there may be important differences for memory-based product judgments which are sensitive to memory for the order of presentation in advertising copy (Unnava, Burnkrant, & Erevelles, 1994).

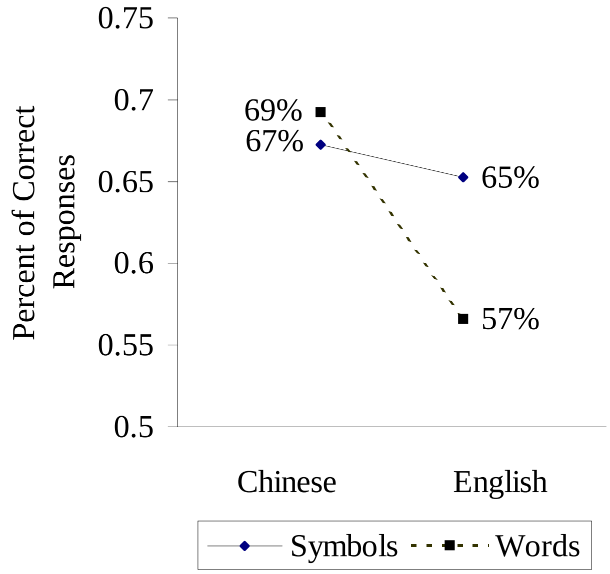
In contrast to order-based retrieval from memory, I found that Chinese speakers would rely more on associations between words (Tavassoli, 1999a). This could be a result of a more *holistic* processing of Chinese (Chen & Tsoi, 1990) in the visuospatial buffer which stores information in a more integrative fashion (Paivio, 1986). Alternatively, it is likely that the high prevalence of homophones in Chinese primes readers to more carefully examine a word's context for disambiguating cues. For example, homophones such as "see" and "sea" in English make the sound of a word an ambiguous mental code as an indicator of the word's meaning. Associative information present in the verbal context, such as "water", may therefore be more active in STM's conceptual store to clarify meaning in Chinese. The heightened reliance on the conceptual store in Chinese may have further implications for the process of categorization which is a fundamental aspect of information processing. In consumer research, categorization has been shown to influence information search, memory for advertising information, inferences about brands, and choice (e.g., Alba & Hutchinson, 1987; Cohen & Basu, 1987).

Finally, reading logographs also appears to involve to a greater degree spatial STM processes. I tested this idea in two experiments, one using meaningful words and their pictorial counterparts as a control, and one using nonsense words and equally memorable abstract symbols as a control (Tavassoli, 1999c). I found that Chinese readers remembered better the spatial location of words scattered on a single page (but not of pictures and symbols) than readers of English (Tavassoli, 1999c).

The findings in the experiment using nonsense words and abstract symbols are represented in Figure 4. They may have particular relevance to consumer research. On the one hand, a heightened degree of spatial attention to words may have implications for visual attention amongst competing stimuli and the layout of advertisements (Janiszewski, 1998). On the other hand, basic STM processes such as the encoding of spatial and serial information are fundamental to pragmatic processes in reasoning and persuasion. Written language may, therefore, prove to be an important contextual factor in decision making and persuasion.

Figure 4

Spatial Memory for Words and Symbols (Tavassoli, 1999c)



Many decision tasks require the integration of verbal with nonverbal information. It would therefore be very interesting to examine across scripts the coordination of activities among the different STM stores by the central executive processor. It may also be fruitful for research to examine across languages purely verbal processes involved in problem solving and decision making. These processes rely on the different STM stores described earlier and represented in Figure 1 (Jonides, 1995). Several well-known verbal decision-making tasks capture, to a large degree, the reliance on some of these stores in isolation.

Many situations in normal life require the need to reason about spatial relations, including giving directions, memory for the location of objects, and taking someone else's perspective when viewing a scene. Consider, for example, the following *spatial reasoning* task which relies mainly on STM's visuospatial buffer (after Byrne & Johnson-Laird, 1989):

The dog is on the right of the cat
The pig is on the left of the cat
The cow is in front of the pig
The hen is in front of the cat

Where is the cow with respect to the hen?

Previous research suggests that problems of this sort require the construction of a mental representation that includes spatial relations among elements, as well as the ability to manipulate this information. A phonological code does not allow a person to solve the problem (Jonides, 1995). Compare this task to a *2-back task* which relies directly on the sequential processing of the phonological loop (Jonides, 1995). In this task, a subject might view a series of words and has to quickly respond "yes" or "no" as to whether a word is the same as the word that was shown 2 words earlier.

I expect that Chinese speakers would perform relatively better at a spatial reasoning task, and that English speakers would perform relatively better at the 2-back task. Because these types of tasks are often components of more complex decision tasks, it would be of particular interest to identify situations where the outcome of a decision task could be influenced by relative processing differences. Language differences are as much about performing better or worse at a task, but about inherent biases in STM processing (e.g., sequential versus spatial, or holistic) that can affect the shape of a decision outcome. In other words, language may affect cognition in *qualitative* ways.

Language and Cognition

The argument that language affects cognition is most commonly associated with Whorf's *linguistic relativity principle* (Sapir, 1929; Whorf, 1956). Whorf argued that there is no constant or universal way of arranging data (i.e., categorizing) but that linguistic factors influence the way in which "we cut nature up, organize it into concepts, and ascribe significance" (Whorf, 1940/1956). Earlier tests of the hypothesis primarily focused on the idea that differences in language map onto differences in *perception*, such that people with different color terminologies might perceive hues differently (Brown & Lenneberg, 1954; Heider & Oliver, 1972).

Whorf's ideas have drawn sharp criticism, however. The possibility that perception of fundamental physical elements necessary for survival such as space and time would differ have been dismissed on a priori grounds (Feuer, 1953). And it has been argued that natural languages may be too ambiguous and schematic to be functional as a mental code (Pinker, 1994). Instead, we may share a universal "mentalese" (Pinker, 1994) and the deep structure of grammar may not only be universal (Chomsky, 1986) but even innate (Pinker, 1994). This position assumes that cultural influences such as language do not affect cognition; that consumers learn about, evaluate, compare, and chose products using similar mental processes across writing systems.

More recently, the Whorfian Hypothesis has been reconceptualized in terms of how linguistic forms are represented, how they operate in the mind and how they affect the concepts and categories which denote objects and relations in the world (Hunt & Agnoli, 1991). The idea that language affects *conception* has been tested using the grammatical construct of *classifier* that some languages contain (Schmitt & Zhang, 1998; Zhang & Schmitt, 1998). Classifiers often depict perceptual properties of objects such as shape, size, thickness, and length, and conceptual properties such as bendable, elastic, graspable. They are special types of measures that are used in conjunction with numerals (one, two, three etc.) or determiners (a, the, that, this) to form noun phrases. For example, the counterparts in Chinese for the English noun phrases "a table" is *yi* (numeral) *zhang* (classifier used for flat, extended objects such as table or paper) *zhuo-zi* (table) (Schmitt & Zhang, 1998; Zhang & Schmitt, 1998).

Classifiers have been found to affect consumer choice if the conceptual knowledge triggered by syntactic and semantic components provides relevant information (Schmitt & Zhang, 1998; Zhang & Schmitt, 1998). Speakers of classifier languages were more likely to place objects with common classifiers into a classifier-related schematic cluster (e.g., into categories of "flat objects," "long objects," "graspable objects" etc.) (Schmitt & Zhang, 1998).

Interestingly, both the ideas that language affects *perception* (e.g., of color) and *conception* (e.g., of classifiers representing shape) were tested using "visual" elements. The research I reviewed also relies, in part, on "visual" processes. I would like to introduce quite a different way of thinking about how language may affect cognition based on an information processing perspective. Specifically, I propose that *relative* differences in the reliance on the visuospatial buffer, phonological loop, and conceptual store have a *qualitative* effect on the nature of information processing for logographic and phonetic writing systems. As a result, Chinese readers differ from English readers in the way in which they encode visual features of words in memory, in the way in which they associate words with nonverbal items in memory, in the way in which words are organized in and subsequently retrieved from memory, and possibly, even in the nature of decision making. The causal mechanism I described are independent of grammar or symbolic content. In other words, cognition and language can not be regarded as divisible even if, as some argue, mental representations themselves are language free.

Summary

The field of marketing has recognized the need to understand consumer memory, attitude formation, and decision making across cultures. The main source of knowledge on consumer behavior has come, however, from studies within a single culture. Implicitly, this research assumes that consumers process information in the same way globally.

I reviewed the role of visuospatial, conceptual and phonological involvement in the encoding and rehearsal of written Chinese logographs and alphabetic English words. The framework suggests that relative differences across languages in the reliance on short-term memory's stores may influence higher-level processes involved in memory, persuasion, and even decision making. Moreover, in light of the theme of this volume, it is noteworthy to emphasize that the concept of *visual persuasion* includes the processing of verbal information.

References

Alba, J. W., & Hutchinson, J. W. (1987). Dimensions of consumer expertise. *Journal of Consumer Research*, *13,* 411-454.

Baddeley, A. D. (1986). *Working Memory*. Oxford: Clarendon Press.

Biederman, I., & Tsao, Y.-C. (1979). On processing Chinese ideographs and English words: Some implications from Stroop-test results. *Cognitive Psychology, 11*, 125-132.

Brown, R., & Lenneberg, E. (1954). A study in language and cognition. *Journal of Abnormal and Social Psychology*, *49,* 454-462.

Byrne, R. M. J., & Johnson-Laird, P. N. (1989). Spatial reasoning. *Journal of Memory and Language, 28*, 564-575.

Chen, H.-C., & Tsoi, K.-C. (1990). Symbol-word interference in Chinese and English. *Acta Psychologica*, *75,* 123-138.

Cheng, C.-M. (1981). Perception of Chinese characters. *Acta Psychologica Taiwanica*, *23,* 137-153.

Chomsky, N. (1986). *Knowledge of Language: Origin, Nature and Use*. New York, NY: Praeger.

Cohen, J. B., & Basu, K. (1987). Alternative models of categorization: Toward a contingent processing framework. *Journal of Consumer Research*, *13,* 455-472.

Duncan, John (1980), "The Locus of Interference in the Perception of Simultaneous Stimuli," *Psychological Review*, *87*, 272-300.

Feuer, L. S. (1953). Sociological aspects of the relation between language and philosophy. *Philosophy of Science*, *20,* 85-100.

Heider, E. R., & Oliver, D. C. (1972). The structure of the color space in naming and memory for two languages. *Cognitive Psychology*, *3,* 333-354.

Houston, M. J., Childers, T. L., & Heckler, S. E. (1987). Picture-word consistency and the elaborative processing of advertisements. *Journal of Marketing Research*, *24*, 359-369.

Huang, H. S., & Hanley, J. R. (1995). Phonological awareness and visual skills in learning to read Chinese and English. *Cognition*, *54* (1), 73-98.

Huey, E. B. (1908). The psychology and pedagogy of reading. New York, Macillan.

Hung, D. L., & Tzeng, O. J. L. (1981). Orthographic variations and visual information processing. *Psychological Bulletin*, *90*, 377-414.

Hunt, E., & Agnoli, F. (1991). The Whorfian hypothesis: A cognitive psychology perspective. *Psychological Review*, *98,* 377-389.

Janiszewski, C. (1998). The influence of display characteristics on visual exploratory search behavior. *Journal of Consumer Research*, 25, 290-301.

Jonides, J. (1995). Working memory and thinking. In E. E. Smith & D. N. Osherson, *Thinking,* Cambridge, MA: The MIT Press, 215-265.

Kosslyn, S. M. (1980). *Image and Mind*, Cambridge, MA: Harvard University Press.

Liu, I.-M., Zhu, Y., & Wu, J.-T. (1992). The long-term modality effect: In search of differences in processing logographs and alphabetic words," *Cognition, 43*, 31-66.

Lutz, K. A., & Lutz, R. J. (1977). Effects of interactive imagery on learning: Applications to advertising. *Journal of Applied Psychology, 62*, 493-498.

Massaro, D. W. (1996). Integration of multiple sources of information in language processing. In T. Inui & J. L. McClelland (Eds.), *Attention and Performance XVI: Information Integration in Perception and Communication*, Cambridge, MA: MIT Press, 397-432.

McClelland, J. L. (1996). Integration of information: Reflections on the theme of attention and performance XVI. In T. Inui & J. L. McClelland (Eds.), *Attention and Performance XVI: Information Integration in Perception and Communication*, Cambridge, MA: MIT Press, 633-656.

McCusker, L. X., Hillinger, M. L., & Bias, R. G. (1981). Phonological recoding and reading. *Psychological Bulletin, 89*, 217-245.

Pan, Y., & Schmitt, B. (1996). Language and brand Attitudes: Impact of script and sound matching in Chinese and English. *Journal of Consumer Psychology, 5,* 263-277.

Paivio, A. (1986). *Mental representations*. NY: Oxford Press.

Penney, C. G. (1989). Modality effects and the structure of short-term verbal memory. *Memory and Cognition*, *17*, 398-422.

Penney, C. G., & Butt, A. K. (1986). Within- and between-modality associations in probed recall: A test of the separate-streams hypothesis. *Canadian Journal of Psychology*, *40,* 1-11.

Perfetti, C. A., Bell, L., & Delaney, S. (1988). Automatic phonetic activation in silent word reading: Evidence from backward masking. *Journal of Memory and Language, 27*, 59-70.

Perfetti, C. A., & Zhang, S. (1991). Phonological processes in reading Chinese characters. *Journal of Experimental Psychology: Learning, Memory and Cognition, 17*, 633-643.

Pinker, S. (1994). *The Language Instinct*. New York: Harper Perennial.

Potter, M. C. (1993). Very short-term conceptual memory. *Memory and Cognition*, *21*, 156-161.

Sapir, E. (1929). Conceptual Categories in Primitive Languages. *Science*, 74, 578.

Schmitt, B. H., & Tavassoli, N. T. (1994). The influence of the writing system on brand perceptions in Japan. The *Asia Pacific ACR Conference*, Singapore, June 13-16.

Schmitt, B. H., Pan, Y., & Tavassoli, N. T. (1994). Language and consumer memory: The impact of linguistic differences between Chinese and English. *Journal of Consumer Research,* 21, 419-431.

Schmitt, B. H., Tavassoli, N. T., & Millard, R. (1993). Memory for print ads: Understanding relations among brand name, copy and picture. *Journal of Consumer Psychology*, *2*, 55-81.

Schmitt, B. H., & Zhang, S. (1998). Language structure and categorization: The role of classifiers in cognition, memory and ad evaluations. *Journal of Consumer Research*, *25*, 108-122.

Shennan, J. R., Jr. (1986). Permanent media can generate a long lasting image. *Hotel & Motel Management*, *201*, 30.

Smith, E. E., & Jonides, J. (1994). Working memory in humans: Neuropsychological evidence. In M. Gazzaniga (Ed.), *The cognitive neurosciences*, Cambridge, MA: The MIT Press, 1009-1020.

Tavassoli, N. T. (1998). Language in multimedia: Interaction of spoken and written information. *Journal of Consumer Research*, 25, 26-37.

Tavassoli. N. T. (1999a). Temporal and associative memory in Chinese and English. *Journal of Consumer Research*, 26, 170-181.

Tavassoli, N. T. (1999b). Colored judgements and memories in Chinese and English. *MIT working paper.*

Tavassoli, N. T. (1999c). Spatial memory for written words in Chinese and English. *MIT Working Paper.*

Tavassoli, N. T., & Han, J. (2000) Branding with logographic and phonetic scripts: Memory for relations among brand names, logos, and auditory Icons. *MIT Working Paper*.

Treisman, A. (1988). Features and objects: The Fourteenth Bartlett Memorial Lecture. *The Quarterly Journal of Experimental Psychology*, *40A* (2), 201-237.

Unnava, H.R., Burnkrant, R. E. & Erevelles, S. (1994). Effects of presentation order and communication modality on recall and attitude. *Journal of Consumer Research*, 21, 481-490.

Van Orden, G. C. (1987). A ROWS is a ROSE: Spelling, sound, and reading. *Memory & Cognition*, *15*, 181-198.

Whorf, B. (1956). *Language, thought and reality: Selected writings of Benjamin Lee Whorf*. J. B. Carroll (Ed.), Cambridge, MA: The MIT Press.

Yee, P. L., Hunt, E., & Pellegrino, J. W. (1991). Coordinating cognitive information: Task effects and individual differences in integrating information from several sources. *Cognitive Psychology*, *23*, 615-680.

Zhang, S., & Schmitt, B. H. (1998). Language-dependent classification: The role of classifiers in consumer cognition, judgement and choice. *Journal of Experimental Psychology: Applied*, *4*, 375-385.

Zhang, S., & Schmitt, B. H. (2000). Creating effective local names for global brands. *CIBER Working Paper Series No. 00-4, UCLA.*

Zhou, X., & Marslen-Wilson, W. (1999). Phonology, orthography, and semantic activation in reading Chinese. *Journal of Memory and Language, 41*, 579-606.