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Scripted Thought: Processing Korean Hancha and Hangul in a Multimedia Context

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We compare the cognitive processing of words written in alphabetic scripts with the cognitive processing of words written in logographic scripts. We suggest that the processing of words written in alphabetic scripts relies more heavily on the storage of—and the serial rehearsal properties of—short-term memory's phonological loop. In contrast, the processing of words written in logographic scripts relies more on the storage of—and the spatial-relational rehearsal properties of—visual short-term memory. A series of three experiments investigates implications of these processing differences within a single language, Korean, where words can be written in the alphabetic Hangul or in the logographic Hancha. These experiments examine contextual interference from auditory and visual stimuli, relational memory between brand names and auditory and visual brand identifiers, and two qualitative processing outcomes, serial-order memory and spatial-relational memory.

Written language is central to branding and marketing communications. Written words are used to communicate brand and product benefits and to create associations and experiences, and they are important brand identity and identification components in the form of slogans and brand names. We examine processing differences in reading alphabetic and logographic scripts and investigate whether script variation affects not just peripheral perceptual processes but also central cognitive processes. We examine the interaction of words with nonverbal auditory and visual information in a multimedia context. This extends previous research that has examined verbal processing in isolation. We also examine whether alphabetic and logographic scripts are processed in qualitatively different ways.

Logographs are read by approximately one-quarter of the world population. Chinese logographs have been adapted to Japanese Kanji and Korean Hancha, where they maintain the same meanings but not the same pronunciation. Whereas logographs represent meaning, most modern languages rely on alphabetic scripts consisting of symbols that represent sounds. These scripts include the Latin alphabet (used in, e.g., English and Spanish) and Arabic, Hebrew, and Cyrillic scripts (used in, e.g., Russian). Japanese Kana and Korean Hangul have also developed their own sound-based scripts that complement and supplement the use of logographs.

Most previous research has been conducted across languages and populations of different cultural backgrounds. Variations in scripts are, therefore, confounded by linguistic differences, including grammar, degree of homophony, words' meanings and composition, and other cultural factors that may differ across populations. In order to avoid these confounds, we examine script variations using biscriptal Koreans, who are efficient at reading and writing alphabetic Hangul and logographic Hancha.

Next, we review research on differences in processing alphabetic and logographic scripts and develop hypotheses that are tested in a series of three experiments. Experiment 1 examines the effect of auditory and visual distracters on memory for Hangul and Hancha words in a multimedia presentation format akin to television ads. In the same format, experiment 2 examines the integration in memory of Hangul and Hancha brand names with auditory and visual brand identifiers. Experiment 3 examines serial-order memory and spatial-relational memory for Hangul and Hancha words, two processes that are fundamental to reasoning, persuasion, and problem solving (Jonides 1995), as well as judgment (Unnava, Burnkrant, and Erevelles 1994). We conclude by discussing the theoretical and practical implications of our findings.

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PROCESSING ALPHABETIC AND LOGOGRAPHIC SCRIPTS

A large subset of content words in Korean can be written either in the alphabetic Hangul or in the logographic Hancha.[1] Korean Hangul uses an alphabet consisting of 24 letters, including 14 consonant and 10 vowel symbols. Vowels are represented by long horizontal or vertical lines distinguished by small marks, while consonants are represented by two-dimensional signs. The symbols suggest the articulations involved: lips together, tongue touching the roof of the mouth, an open throat, and the like. Like logographs, Hangul makes syllables visually discriminable by organizing them into blocks. Korean is particularly suited to provide a rigorous test of script-variation hypotheses, as a large subset of words can be transcribed freely into either Hangul or Hancha. The proportion of the logographic Hancha in a text can vary between zero and over 50% (Taylor 1997).

There appear to be fundamental processing differences in reading alphabetic and logographic scripts. Phonological aspects pervade in reading alphabetic scripts. Readers of English, for example, tend to phonologically recode (subvocalize) written words (e.g., McCusker, Hillinger, and Bias 1981) and rehearse words phonologically in short-term memory's phonological loop (Baddeley 1986; Paivio 1986; Van Orden 1987). Phonology also plays an important role in the semantic processing of Hangul (Cho and Chen 1999).

The process of reading differs considerably when a reader has to visually distinguish thousands of logographs. For logographs, the association with pronunciation is largely arbitrary and acquired via rote associative learning. Orthographically similar characters are mostly pronounced in different ways, and dissimilar ones can be pronounced similarly. Because logographs represent meaning, a reader can mentally access concepts unmediated by phonology, or subvocalization, though the activation of pronunciation may be immediate (Perfetti and Zhang 1991). Reading logographs is not dominated by phonological processes and appears to rely to a greater degree on visual processes in Chinese (Hung and Tzeng 1981; Schmitt, Pan, and Tavassoli 1994; Tavassoli 1999, 2001, forthcoming; Zhou and Marslen-Wilson 1999) and in Hancha, especially for skilled readers (Cho and Chen 1999).

These relative processing differences have been found to affect a variety of behaviors. The psycholinguistic literature has predominantly examined the role of phonology in gaining lexical access for different scripts. For example, a phonemic mask (e.g., rait) facilitated the identification of a previously briefly presented target word in English (e.g., rate) more than a graphemic mask (e.g., ralt; Perfetti, Bell, and Delaney 1988). It is important to note, however, that both masks facilitated word identification—by reinstating properties that the target had already activated—compared with a control condition (e.g., busk). In contrast to English, graphemic masks (and primes) facilitated Chinese word identification more than phonemic ones, while both were more effective than controls (Perfetti and Zhang 1991). A related effect was found for skilled Korean readers. Homophones—words that sound the same but have different meanings, like "to," "too," and "two" in English—caused confusion in a categorization task for Hangul but not for Hancha words, whereas visual foils caused more errors for Hancha words (Cho and Chen 1999).

The low-level processing differences found in the psycholinguistic literature have been found to extend to higher-level processes involved in consumer memory and attitude formation. Schmitt et al. (1994) extended models of lexical access from the psycholinguistic literature to a memory-retrieval model. They found that, regardless of whether words were learned auditorily or visually, native Chinese speakers were able to recall logographs better by writing them down during free recall, whereas native English speakers were better at recalling alphabetic words by speaking them. The authors suggest that the effort to write provides a prime for words' graphemic code in memory, which should be more pronounced for Chinese logographs, and that the effort to speak provides a prime for words' phonological representation in memory, which should be more pronounced for English words.

It is not clear, however, whether script or other language differences produced the results of Schmitt et al. (1994), especially because the results extended to spoken words. For example, the nonsense words developed by Schmitt et al. (1994) contained phonemes that were on average less common in English than in Chinese. This may have heightened attention to the sounds of the words in English. Moreover, homophones are far more common in Mandarin Chinese, where there are only about 400 syllables used to form words (1,300 with tones) compared with about 4,000 syllables in English. The high occurrence of homophones makes sound an unreliable mnemonic source, and Chinese speakers may have learned to strategically supplement phonological with visual-orthographic information that uniquely represents a word. Using Korean Hangul and Hancha prevents these potential confounds, because words are pronounced in the same way with both scripts.

Scripts have also been found to affect attitude formation. Pan and Schmitt (1996) found that attitude ratings of American listeners were more sensitive than those of Chinese listeners to the match between the product class and the gender of the presenter. In contrast, attitude ratings provided by Chinese readers were more sensitive than those provided by American readers to the match between the femininity or masculinity of fonts and feminine (e.g., lipstick) or masculine (e.g., motorcycles) products. Tavassoli (2001) also found that Chinese consumers were more sensitive to visual features of written words. Compared with readers of English words, readers of Chinese logographs were more likely to remember the print color of a brand name and were influenced more by a color match among brand names in brand evaluations (Tavassoli 2001). Selective attention may best explain these results, in that more visual attention is required

[1] Hancha is sometimes spelled Hanza, Hanzza, or Hanja. Hangul is sometimes spelled Han'gul or Hankul and is also called Onmun.

for reading logographs, which would heighten incidental memory for their visual features.

In addition to selective attention for scripts, Tavassoli (1999) made arguments concerning central cognitive processes. He found that memory for the presentation order of written words was more pronounced for native English speakers than for native Chinese speakers. He argued that this is because the rehearsal of English words relies to a greater degree on short-term memory's phonological loop, which rehearses information in a serial manner. Because this study found no cross-cultural differences in a condition that used pictorial equivalents of the words, differences such as those in word meanings or educational differences were largely controlled for. However, it is possible that the results are based on grammatical differences between Mandarin Chinese and English. For example, the grammatical element of a classifier, which is mandatory for Chinese nouns but virtually absent in English, can also affect how words are organized in memory (Schmitt and Zhang 1998; Zhang and Schmitt 1998). In other words, Chinese speakers may have encoded relations among words based on uncontrolled grammatical elements that could disrupt memory for serial order. Similarly, because of the high number of homophones in their language, Chinese speakers may have learned to be more sensitive to a word's verbal context. This facilitates the encoding of semantic associations among words, which could also disrupt memory for serial order (Tavassoli 1999). The use of Korean avoids these potential confounds, because classifiers and homophones do not vary across Hangul and Hancha.

To summarize, previous research suggests that reading alphabetic words relies more on phonological processes, whereas reading logographs relies more on visual processes. However, it is not clear whether these processes are peripheral or whether they extend to central cognitive processes. Moreover, it is often not possible to control for linguistic factors such as grammar or the degree of homophony, as well as other cultural differences across populations. Examining script differences for Hangul and Hancha controls for many of these potential confounds.

HYPOTHESES

Interference from Auditory and Visual Distracters

We expect that memory for Hangul and Hancha words is differentially sensitive to nonverbal auditory and visual distracters. Consider, for example, modality effects within a single language. Auditory ads interfered more with recall memory for competitive auditory ads than with recall memory for visual ads (Unnava and Sirdeshmukh 1994). These findings are consistent with the notion that same-modality items are mutually more interfering than items in different modalities. However, the encoding variability hypothesis (e.g., Unnava and Burnkrant 1991) offers a competing explanation for these results. Namely, different modalities offer distinctive retrieval cues for items during recall. This alternative explanation does not, however, apply to the finding that item recognition, which does not rely on retrieval, is also better when competitive information is in a different modality (Tavassoli 1998). Spoken words interfered more with recognition memory for spoken words than for written words, and vice versa (Tavassoli 1998).

Whereas these studies examined the interference between verbal stimuli, the theoretical arguments extend to the interaction of verbal with nonverbal information. For example, it is easier to perform two competing tasks concurrently when one is auditory and the other is visual than it is when both are in the same modality (Treisman and Davies 1973). Similarly, the well-known suffix effect shows that sounds played at the end of a list of written English words interfere with memory for the last few words, whereas a visual suffix does not (Crowder and Morton 1969). Finally, in an interesting study addressing overlap in short-term memory resources, Unnava, Agarwal, and Haugtvedt (1996) found that reading an English ad interfered with the generation of nonverbal visual product images, whereas hearing an ad interfered with the generation of nonverbal auditory product images.

To summarize, the more the distracter and the target stimuli overlap in the cognitive resources required for their processing, the more interference the distracter causes. This relationship has been established in a variety of domains, including dual task performance, memory, and mental imagery. We examine how distracters affect cognition in ways similar to the ways in which background sounds or music and visual stimuli affect the processing of words contained in a television ad. If Hangul is processed in the phonological loop to a greater degree than Hancha is, then sounds should interfere more with the processing of Hangul words than with that of Hancha words. In contrast, visual distracters should interfere more with Hancha words if they are processed in visual short-term memory to a greater degree. These arguments predict the following interaction effect:

H1: Auditory distracters should interfere more with memory for Hangul words, whereas visual distracters should interfere more with memory for Hancha words.

Relational Memory with Auditory and Visual Brand Identifiers

Marketers are concerned not only with minimizing the interference from competing stimuli, but also with relations formed in memory between noncompeting stimuli (e.g., Houston, Childers, and Heckler 1987; Lutz and Lutz 1977; Meyers-Levy 1991; Schmitt, Tavassoli, and Millard 1993). One of the most important of such branding strategies is to associate a brand name in memory with auditory and visual brand identifiers. These associations serve to differentiate a brand and provide powerful memory retrieval cues for identity and evaluative information stored in memory. Jingles, which had fallen out of favor with advertisers in the 1970s, are making a strong comeback under the new guise "sonic

brand triggers" (Croft 1999). Companies are registering auditory brand identifiers, such as NBC's familiar three-tone chime and the MGM lion's roar, as intellectual property. Very little is known, however, about the degree to which relations between words and nonverbal auditory and visual information are encoded in memory, even within the context of a single language.

Consumer research has examined the effectiveness of nonverbal brand elements such as logos (Henderson and Cote 1998), jingles (Yalch 1991), and sound effects (Miller and Marks 1992). In terms of memory, for example, a logo or jingle can lead to brand recognition or a sense of familiarity, which can drive purchasing decisions. Information is, however, designed not only to maximize the memorability of single items, but also to enable consumers to encode relationships among items of information (Meyers-Levy 1991). Across modalities, the conjoining of elements such as a brand name and a picture has been examined in terms of meaningful associations for English words (e.g., Houston et al. 1987; Lutz and Lutz 1977; Schmitt et al. 1993). To our knowledge, consumer research has not explicitly explored nonmeaningful relations formed between such elements, even within a single language. Marketers do, however, extensively employ nonmeaningful auditory cues and logos to enhance brand memory. We propose that there should be a difference across alphabetic and logographic scripts in the potency with which mnemonic associations are formed between brand names and auditory and visual brand identifiers.

Cross-script differences for relational memory with auditory and visual information should exist, because the more items rely on the same encoding mechanisms, the stronger the integration of information. In a review of the literature on information integration, McClelland (1996) concludes that 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).

This conclusion concurs with findings on cross-modal relational memory between separate items of information. Most of the research on relational memory has focused on relations formed between words. For example, when subjects learned a mixed list of spoken and written words, words that had been learned in the same modality were better memory cues for one another than were words that had been learned in different modalities (Penney and Butt 1986). Similarly, consumers performed better at a pair-recognition task involving brand names and product categories when these were learned in the same modality than when they were learned in different modalities (Tavassoli 1998). Whereas these findings relate to relational memory among words, they parallel those on the integration of words with nonverbal information in an on-line task. Information integration in a coordination task—when a pilot needs to integrate visual, auditory, and verbal information to make a cognitive decision—has also been found to be greater when there is a larger processing overlap (Yee, Hunt, and Pellegrino 1991).

In summary, research suggests that relational memory should be stronger the more two stimuli rely on similar encoding processes. Previous cross-lingual research has been concerned almost exclusively with the processing of words in isolation, that is, without considering nonverbal contextual stimuli. Two published studies have examined nonverbal aspects of alphabetic and logographic words, namely, font and color (Pan and Schmitt 1996; Tavassoli 2001), which are surface characteristics of text per se. However, these results are explained better by selective attention than through a process of association.

We examine relational memory between separate items of information. We propose that the greater reliance on phonological processes in the encoding of alphabetic scripts should facilitate the encoding of mnemonic relations between Hangul words and auditory brand identifiers. In contrast, a greater reliance on visual processes in the encoding of logographs should facilitate the encoding of mnemonic relations between Hancha words and visual logos. These arguments predict an interaction between script and stimulus pairing:

H2: Auditory brand identifiers should be integrated in memory more strongly with Hangul words, whereas visual logos should be integrated in memory more strongly with Hancha words.

Serial-Order and Spatial-Relational Memory

Hypotheses 1 and 2 on interference and relational memory between verbal and nonverbal information are based on relative differences in the processing overlap in the phonological loop and visual short-term memory. Because these short-term memory stores also exhibit different rehearsal properties, we expect there to be qualitative differences in the way in which Hangul and Hancha words are encoded in memory.

The phonological loop rehearses information in a serial manner, much as one would rehearse a telephone number (Baddeley 1986; Paivio 1986). Differences in memory for the order in which information was presented is especially important for memory-based judgments, which are sensitive to the order in which information is retrieved from memory (Hastie and Park 1986; Unnava et al. 1994). Because of its greater reliance on the phonological loop, memory for Hangul words should retain more information about the serial order at presentation than memory for Hancha words will retain. We therefore attempt to replicate with biscriptal Koreans the finding of Tavassoli (1999), who found that verbal serial-order memory was better in native English speakers than in native Chinese speakers.

We also examine the spatial-relational processing of information, which is particularly important for on-line processing of advertising displays, for example, in defining perceptual competition between items (Janiszewski 1998).

Spatial-relational memory reflects the rehearsal property of visual short-term memory, which rehearses information in a percept-like (Kosslyn 1980) and holistic manner (Paivio 1986). Visual short-term memory organization is based on spatial configurations that specify the location of an item as well as its relationship to other items in a display (Jiang, Olson, and Chun 2000).

Even subtle differences in the relative reliance on the phonological loop versus visual short-term memory appear to affect serial-order and spatial-relational memory. For example, memory of the serial positions of English words was better when they were presented auditorily, whereas memory of the spatial positions of English words was better when they were presented visually (Metcalfe, Glavanov, and Murdock 1981). Moreover, spatial memory was better for pictures than for written English words (Vakil, Soroker, and Biran 1992). If processing Hancha words relies more on visual short-term memory than does processing Hangul words, then spatial-relational memory for Hancha words should be superior to spatial memory for Hangul words. Taken together, the arguments about serial-order memory and spatial memory predict the following interaction effect:

H3: The serial order of presentation should be remembered better for Hangul words, whereas spatial positions at presentation should be remembered better for Hancha words.

Summary

We build on research that has examined the effect of script variations on low-level cognitive processes to suggest that differences in reading alphabetic and logographic scripts should extend to higher-level cognitive processes involved in short-term memory. Short-term memory plays an important role in conscious thought and is involved in the encoding and rehearsal of information, the encoding of connections among items of information, and the transfer to and retrieval from long-term memory.

We specifically examine the storage of phonological and visual aspects of written information and the qualitatively different rehearsal mechanisms associated with these stores. We propose that alphabetic scripts should rely to a greater degree on the phonological storage and serial rehearsal of short-term memory's phonological loop, whereas logographic scripts should rely to a greater degree on visual short-term memory's imaginal store and percept-like, spatial-relational rehearsal.

We test predictions from this model using native Korean speakers living in Korea. In experiment 1 we test hypothesis 1, which says that auditory distracters should interfere more with memory for Hangul words, whereas visual distracters should interfere more with memory for Hancha words. In experiment 2 we test hypothesis 2, which says that memory for word-sound pairings should be better for words written in Hangul, whereas memory for word–visual logo pairings should better for words written in Hancha. In experiment 3 we test hypothesis 3, which says that serial-order memory should be better for Hangul words, whereas spatial-relational memory should be better for Hancha words.

EXPERIMENT 1: AUDITORY AND VISUAL INTERFERENCE

Method

Design and Participants. Sixty biscriptal Koreans participated individually in the 2 (script: Hangul vs. Hancha) × 2 (distracters: auditory vs. visual) between-subjects experiment. The average age of the 33 men and 27 women was 26.8 years. The participants were equally divided across conditions.

Procedure. Participants individually completed the experiment at a computer terminal with instructions provided on the screen. Sixteen words were presented one by one, interspersed with either auditory or visual distracters in a continual distracter paradigm. Distracters were not presented simultaneously so that this interference would not be perceptual but would occur only in short-term memory. Participants were explicitly instructed to try to remember the words as well as the sounds or visual images. The distracter was therefore presented in the form of a divided-attention task. After a two-minute filler task, item recognition was tested for the words only. For this memory task, participants saw, in scrambled order, the same 16 words they had learned, as well as 16 new words. Participants had to judge whether a word had been presented earlier—by using the computer mouse to click a green button—or whether the word was new and had not been presented earlier—by clicking a red button.

Stimuli and Pretests

In both conditions the words appeared in black typeface (equivalent to Arial 36-point font) at the center of an otherwise white 17-inch computer screen. In the visual-distracter condition the words appeared for one second and were followed by a two-second exposure to one of 16 shapes, each of which was in a different color. The shapes and words used are shown in black in figure 1. In the auditory-distracter condition each one-second exposure to a word was followed by one of 16 sounds played over headphones (a single sound lasted an average of about two seconds). The sounds were commercially available sound effects that could not easily be labeled verbally. In both conditions there were no pauses between any of the items.

The verbal materials were developed specifically for Korean in a series of pretests. The Hancha logographs were chosen from the pool of 1,800 logographs designated by the Korean Ministry of Education as required learning in the middle school and high school curriculum and are, therefore, commonly used characters. These characters were combined

FIGURE 1

EXPERIMENTS 1 AND 2: WORDS AND VISUAL ITEMS USED

Hangul	Hancha	Visual Items
부성	付星	
청운	淸雲	
진양	真洋	
태경	泰京	
신광	晨光	
최평	最平	
향구	鄕丘	
거봉	巨峰	
영우	永友	
효동	孝洞	
경풍	慶風	
원도	員島	
호림	虎林	
금정	金井	
등복	登福	
명한	明韓	

to form nonsensical two-character words (akin to "Exxon" or "Lycos"). The stimulus set contained no homophones.

Thirty participants—15 per script—also rated each word on five seven-point scales: "What is your overall attitude towards this nonsense word?" anchored by Negative–Positive; "How appropriate is this nonsense word as a brand name?" (Not very appropriate–Very appropriate); "Would you ever try a product carrying this word as its brand name?" (Not very likely–Very likely); "How you would rate this nonsense word in terms of memorability?" (Not very memorable–Very memorable); "Would you readily recognize this nonsense word if you saw it again in a store?" (Not very likely–Very likely). The average ratings for 16 words were similar for each of the scales whether written in Hangul or in Hancha, p's > .68.

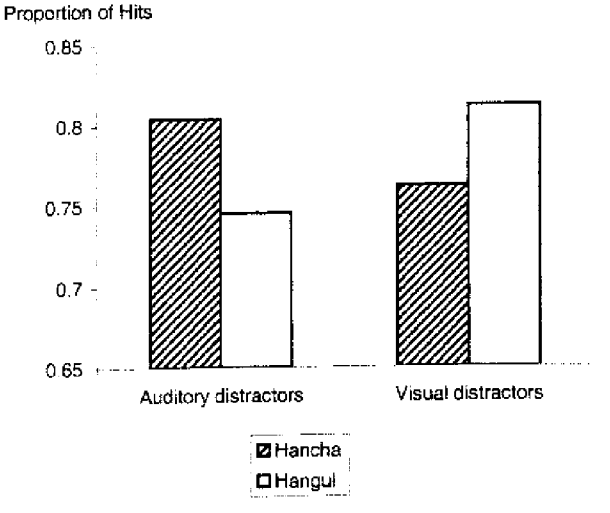
Results

From the item-recognition test, the proportion of hits (words correctly identified as having been presented) was analyzed. Age, sex, and handedness did not have significant effects on the results and were not further considered in the analysis. An analysis of variance (ANOVA) was performed on the between-subjects factors script (Hangul vs. Hancha) and distracter (auditory vs. visual). There were no significant main effects. The interaction effect was significant and consistent with hypothesis 1, $F(1, 59) = 11.89$, $p = .001$. These results are represented graphically in figure 2.

Planned contrasts show that auditory distracters interfered to a greater degree with memory for Hangul words ($M = .76$, SD = .04) than with memory for Hancha words ($M = .80$, SD = .06; $t(28) = -2.15$, $p < .05$). In contrast, visual distracters interfered to a lesser degree with memory for Hangul words ($M = .81$, SD = .06) than with memory for Hancha words ($M = .75$, SD = .07; $t(28) = 2.69$, $p < .02$). Because hits are a proportion, we also analyzed the log odds of this measure. The results are similar. The log odds for Hangul word memory ($M = 1.18$, SD = .26) were lower than those for Hancha word memory ($M = 1.47$, SD = .47) among auditory distracters ($t(28) = -2.08$, $p < .05$). In contrast, the log odds for Hangul word memory ($M = 1.53$, SD = .48) were higher than the log

FIGURE 2

EXPERIMENT 1: RECOGNITION MEMORY FOR HANCHA AND HANGUL WORDS LEARNED AMONG AUDITORY AND VISUAL DISTRACTERS



odds for Hancha word memory ($M = 1.11$, SD = .37) among visual distracters ($t(28) = 2.70$, $p < .02$).

Discussion

Experiment 1 supports the idea that processing alphabetic Hangul words relies to a greater degree on phonological processes, whereas processing logographic Hancha words relies to a greater degree on visual processes. In experiment 1, the words and nonverbal information competed for attention in a divided-attention setting, much as distracting sounds or graphics do in a multimedia television ad. In this case, stimuli interfere more with one another when the processing overlap is greater. In contrast to interference, performance should be better with greater processing overlap when noncompeting stimuli need to be integrated to perform a task, such as in linking a brand name to an auditory or visual brand identifier. Experiment 2 tests hypothesis 2, which says that memory for word-sound pairings should be better for words written in Hangul, whereas memory for word–visual logo pairings should better for words written in Hancha.

EXPERIMENT 2: RELATIONAL MEMORY WITH AUDITORY AND VISUAL BRAND IDENTIFIERS

Method

Design and Participants. Forty biscriptal Koreans participated individually in the 2 (script: Hancha vs. Hangul) × 2 (pairing: sound vs. logo pairing) experiment. Script was a between-subjects factor, and pairing was a repeated factor for which the order was counterbalanced across subjects. The average age of the 22 men and 18 women was 28.8 years.

Procedure. Equal numbers of participants were randomly assigned to the script and counterbalanced pairing conditions. Experiment 2 utilized the same logos, sounds, and words that were used in experiment 1. Participants completed the 30-minute experiment individually at a computer terminal with instructions provided on the screen.

Participants were first familiarized with the verbal stimuli in two tasks that did not differ between conditions. The tasks each used the same 16 words in the same script as were used in the main experiment. In each task the 16 words were presented one by one for several seconds each, in the same order as during the main task. In addition, participants saw the stimulus materials twice more during a test after the first task (the data from the first task are of interest to a different research project). The second preexperimental task was a free-recall test of the 16 brand names. The recall data is an additional control factor to help interpret potential language effects in the main experiment.

For the main experiment, participants were instructed to learn the pairings between the brand names and the auditory and visual brand identifiers (A_1B_1, A_2B_2, . . ., $A_{16}B_{16}$). They learned the word-sound pairings first and the word-logo pairings second, or vice versa. After each learning task, pair recognition was tested. For this memory task, participants again saw the same 16 words as at learning. However, while half of the pairings were the same as at learning (e.g., A_3B_3), half were cross-matched (e.g., A_3B_{11}) in the same way across subjects and conditions. The tests did not include any new sounds or logos, and each item was used in only one pairing. In other words, participants had to judge whether each word-sound or word-logo pair was in the same pairing as at learning—by using the computer mouse to click a green button—or in a pairing that was rearranged among the stimuli at learning—by clicking a red button. At the end of the experiment participants completed a demographics and handedness questionnaire (Oldfield 1971).

Results

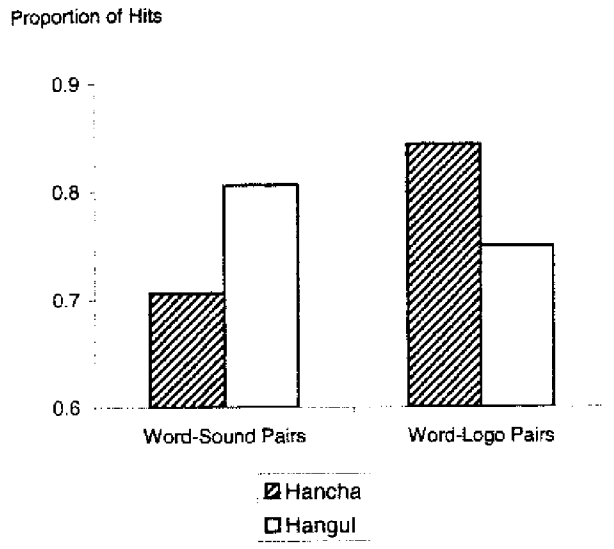
Recall. Recall memory for the 16 words prior to the main experiment was similar in the two scripts. Because one cannot misspell Hangul or Hancha words (no subjects made errors using homophonic logographs) we used a strict recall measure. The mean number of words recalled did not differ for Hangul ($M = 8.8$, SD = 3.0) and Hancha words ($M = 8.3$, SD = 2.83; $p > .59$). This result provides an additional control that aides in the interpretation of the relational-memory results across scripts from the main experiment.

Pair Recognition. From the pair-recognition test the proportion of hits (words correctly identified as being in the same pairing as before) was analyzed. The order of pairings (sound-logo vs. logo-sound), age, sex, and handedness did not have a significant effect on the results and were not further considered in the analysis. A repeated-measures ANOVA was performed on the between-subjects factor script (Hangul vs. Hancha) and the repeated factor pairing (sound vs. logo). The main effects were not significant. The script-by-pairing interaction was significant and consistent with hypothesis 2 ($F(1, 39) = 9.25$, $p < .005$). These results are represented graphically in figure 3.

Planned contrasts show that word-sound pairings were remembered better for Hangul ($M = .81$, SD = .14) than for Hancha words ($M = .71$, SD = .12; $t(38) = 2.42$, $p < .03$). In contrast, word-logo pairings were remembered marginally worse for Hangul ($M = .75$, SD = .18) than for Hancha words ($M = .84$, SD = .17; $t(38) = -1.68$, $p = .10$). Because hits are a proportion, we also analyzed the log odds of this measure. The results are similar. The log odds for word-sound pairings were higher in Hangul ($M = 1.74$, SD = 1.18) than in Hancha ($M = .94$, SD = .62; $t(38) = 2.67$, $p < .02$). In contrast, the log odds for word-logo pairings were lower in Hangul ($M = 1.42$, SD = 1.35) than in Hancha ($M = 2.45$, SD = 1.74; $t(38) = -2.08$, $p < .05$).

FIGURE 3

EXPERIMENT 2: PAIR-RECOGNITION MEMORY FOR HANCHA AND HANGUL WORDS PAIRED WITH SOUNDS AND LOGOS



Discussion

The interaction effect from experiment 2 further supports the idea that there are relative differences in the reliance on short-term memory's stores in reading Hangul and Hancha words. In tasks that used Hangul, relational memory for pairs of words and sounds was better, whereas in tasks that used Hancha, relational memory for pairs of words and visual logos was better. This effect surfaced despite the knowledge from experiment 1 that the interference in processing between these same stimuli has a reciprocal attenuating effect. In other words, the differences in relational memory cannot be attributed to peripheral cognitive processes, such as perceptual interference between items. Instead, it appears to be a result of central cognitive processes involved in short-term memory. Experiment 3 examines the nature of these processing differences in more detail by examining qualitative differences in the rehearsal of Hangul and Hancha words. Specifically, we test hypothesis 3, the hypothesis that serial-order memory, which is encoded in the phonological loop, should be better for Hangul words, whereas spatial-relational memory, which is encoded in visual short-term memory, should be better for Hancha words.

EXPERIMENT 3: SERIAL-ORDER AND SPATIAL-RELATIONAL MEMORY

Method

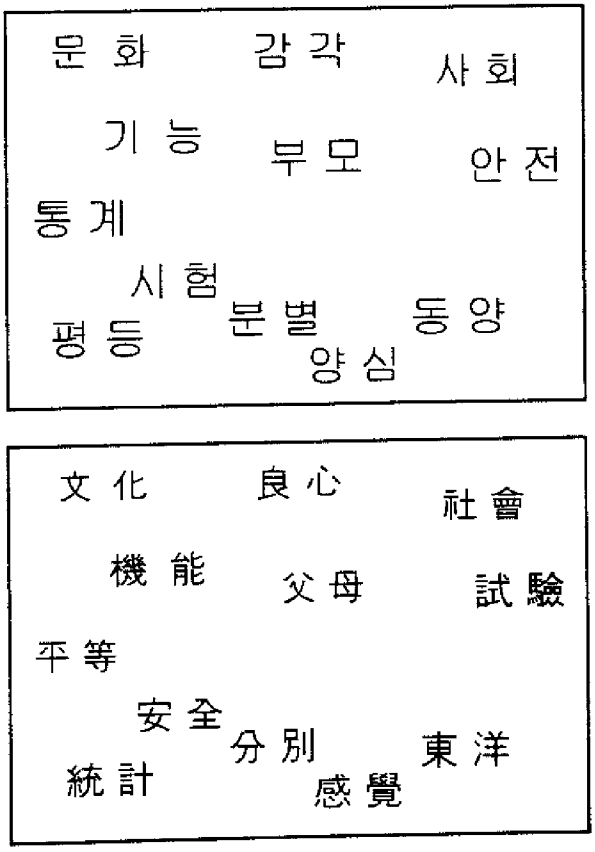
Design and Participants. One hundred biscriptal Koreans participated individually in the 2 (script: Hancha vs. Hangul) × 2 (memory task: serial order vs. spatial) between-subjects experiment. The average age of the 61 men and 39 women was 31.1 years.

Stimuli. We selected words from a list of frequently used bisyllabic nouns commonly found written both in Hangul and in Hancha (Park and Vaid 1995). The words are shown in figure 4, which also shows the spatial configuration of the Hangul words at learning and the Hancha words at test.

Procedure. Equal numbers of volunteer participants were randomly assigned to the script and memory task conditions. In the serial-order memory condition, the 12 words were viewed one by one for two seconds each on a 17-inch computer screen. A white screen appeared between items for one second. Participants were given only the generic instructions to study the information presented. After a two-minute filler task, participants had unlimited time to reconstruct the serial order of the information presented in a sorting task. For this purpose, the words had been printed on

FIGURE 4

EXPERIMENT 3: SPATIAL POSITIONS OF HANGUL WORDS AT LEARNING AND HANCHA WORDS AT TEST



index cards and shuffled into random order. Participants had to identify the order of presentation by sorting all the cards into a single pile according to the order of presentation. The Spearman rank correlation (ρ) between the presentation order and the order in which participants sorted the cards was the serial-order memory measure.

In the spatial memory task participants viewed the same 12 words scattered across the screen, surrounded by a border, for a total of 35 seconds, followed by a blank screen for one second. After the same filler task as in the serial memory condition, participants received a piece of paper in the same format as the on-screen display, containing the same 12 words in the identical overall configuration as during learning. However, among half of the words, the spatial position had been switched. Subjects had to circle those words that they believed were in the same position as at learning and put a cross through the words they believed were in a different position than at learning. Subjects were told that half the items were in a different position, and they were not allowed to leave any words blank. The proportion of words correctly identified as being in the same position as at learning (hits) was the spatial memory measure. In both conditions, participants completed a brief questionnaire including demographic information and a handedness questionnaire (Oldfield 1971) after completing the memory task.

Results

Serial-order memory was better for Hangul ($\rho = .83$) than for Hancha words ($\rho = .66$). The planned contrast comparing the Fisher z-transformed values (at the individual level) was significant, $t(48) = 3.87$, $p < .0005$. In contrast to serial-order memory, spatial memory was worse for Hangul ($M = .69$, SD = .15) than for Hancha words ($M = .79$, SD = .15; $t(48) = -2.33$, $p < .03$). Because the spatial memory measure is a proportion, we also analyzed the log odds of this measure. The results are similar. The log odds were lower for Hangul ($M = 1.16$, SD = 1.81) than for Hancha words ($M = 2.71$, SD = 3.36; $t(48) = -2.03$, $p < .05$). These results are represented graphically in figure 5.

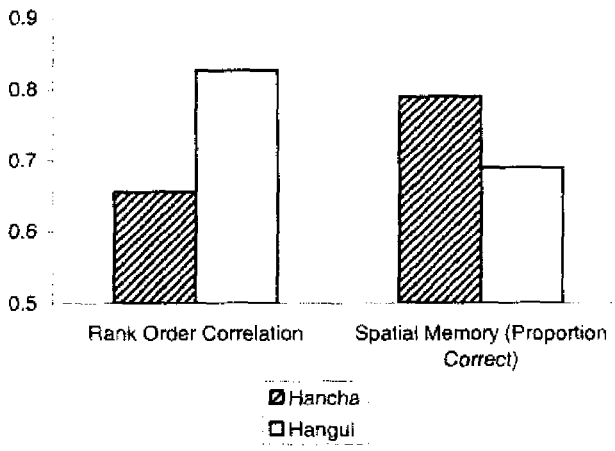
In order to compare the relative differences in performance across the two memory measures—serial-order memory and spatial memory (log odds)—we compared the standard normal deviates corresponding to the respective p-values (Rosenthal and Rubin 1979). The p-values for the contrasts between the Hangul and Hancha conditions in the two memory tasks differ significantly ($Z = 5.49$, $p < .0001$), supporting the interaction effect proposed in hypothesis 3.

Discussion

The results of experiment 3 demonstrate that memory for Hangul words reflects the serial rehearsal property of the phonological loop, whereas memory for Hancha words reflects the spatial-relational rehearsal property of visual short-term memory. These findings further suggest that variations in alphabetic and logographic scripts should not be regarded as a peripheral aspect of language processing but that they have implications for central cognitive processes.

FIGURE 5

EXPERIMENT 3: SERIAL-ORDER MEMORY AND SPATIAL MEMORY FOR HANGUL AND HANCHA WORDS



GENERAL DISCUSSION

Previous consumer and psycholinguistic research suggests that the basic processing of alphabetic words relies relatively more on phonological processes, whereas the basic processing of logographs relies relatively more on visual processes (Cho and Chen 1999; Hung and Tzeng 1981; Schmitt et al. 1994; Tavassoli 1999, 2001, forthcoming; Zhou and Marslen-Wilson 1999). This article tested and extended implications of this model to include short-term memory processes, within the context of a single language, Korean, thereby avoiding a myriad of cross-lingual and cross-cultural confounds.

The results of three experiments are consistent with and raise confidence in the model. The results also extend the verbal-processing model to the interaction of words with nonverbal auditory and visual information in a multimedia context. Psycholinguistic research has not been concerned with the interaction of verbal and nonverbal information, as this falls outside the traditional realm of inquiry. Contextual interference from auditory and visual stimuli and relational memory between brand names and auditory and visual brand identifiers are, however, of importance to consumer memory and branding.

The results of experiment 1 demonstrated that auditory contextual interference was higher for alphabetic words than for logographic words, and vice versa for visual distracters. This suggests, for example, that ads containing alphabetic words should be designed to minimize the use of distracting auditory information, which may potentially compete for the attention that is required in order to learn the verbal

information. In contrast, ads containing logographic words should be designed to minimize the use of distracting graphics or complex visual displays.

It would be particularly interesting for future research to explore not only effects on memory but also effects on elaboration. One of the limitations of our research is that experiments 1 and 2 used nonsense stimuli, which limit the findings to rote rehearsal processes. Using meaningful verbal stimuli would allow researchers to examine the effect of distraction not only on learning but also on thoughts based on persuasive information. In contrast to memory, a more distracting context may even improve persuasion by limiting message counterarguing (Bither 1972; Festinger and Maccoby 1964).

The reciprocal effect of interference between stimuli lies in the formation of relational memory between items of information. "Like visuals or smells, sounds can become associated with brands, and once they are, they become hugely powerful as branding devices" (Andrew Ingram, Radio Advertising Bureau, as quoted in Croft 1999, p. 41). Although auditory information competed more with attention for alphabetic words than with attention for logographic words, relational memory was stronger between auditory brand identifiers and alphabetic words than between auditory brand identifiers and logographic words, and vice versa for visual information.

Logos have been found to be important mnemonic brand cues in English (Henderson and Cote 1998) and to influence brand considerations by serving to connect a brand name to other information in memory (Schechter 1993). Future research should also examine auditory and visual cues that carry meaning. Meaningful associations can enhance memory (Lutz and Lutz 1977; Schmitt et al. 1993) and facilitate the encoding of thematic information (Meyers-Levy 1991). Moreover, by creating a degree of incongruence between verbal and nonverbal information, one can stimulate more elaborate message processing (Houston et al. 1987). Our results suggest that auditory cues should be relatively more potent in these various capacities for alphabetic brand names, whereas the effectiveness of visual cues should be higher for logographic brand names.

Our results also apply to qualitative differences in the processing of alphabetic and logographic scripts. Alphabetic words appear to be organized in memory based to a greater degree on the order in which they were learned (see also Tavassoli 1999), whereas logographs appear to be organized in memory based to a greater degree on spatial relations. The degree to which order is encoded in memory affects the degree to which consumers retrieve information in the order that they learned it (Burgess and Hitch 1992). Memory for the order, therefore, critically affects memory-based judgments by increasing the likelihood that the first information presented in an advertisement comes to mind (Unnava et al. 1994). Future research should examine whether "putting your best foot forward" is more important for persuasion attempts in alphabetic than in logographic ad copy.

Spatial-relational memory for verbal information in advertisements also has important implications. Expectations about the organization of a layout can affect the efficiency of information search (Biederman, Glass, and Webb 1973; Janiszewski 1998). Our results suggest that such expectations, and therefore issues like consistency in the design of Web pages, may play a more important role for logographic scripts. There are also competitive spatial effects among stimuli in an information display that can affect search behavior (Janiszewski 1998). It would be interesting for future research to examine, across scripts, effects of spatial layout of information within an advertisement, as well as the layout of multiple information sources on the same print page or Web page. Moreover, whereas we examined only spatial relations among verbal stimuli, it would be interesting to examine the interaction between words and visual stimuli in a display. The effect spatial layout has on defining competition for attention among items of information (Janiszewski 1998) or in creating associations among items of information should be stronger for logographic scripts.

Finally, we need to caution that our research relied on the presentation of single words. Much of the verbal information we process is in terms of sentences. However, sentences cannot be written entirely in Hancha, and alphabetic and logographic sentences cannot be compared in Korean. Isolating the effect of script in comparisons across different languages is also difficult because of grammatical differences. However, it would be of particular interest for future research to examine whether more complex thought can be "scripted" in the way that basic thought was "scripted" in our findings. Basic short-term memory processes such as the encoding of spatial-relational and serial-order information are fundamental to pragmatic processes in reasoning, persuasion, and judgment (Jonides 1995). The outcome of an elaborative consumer decision process or complex-reasoning task may therefore be shaped by the relatively more serial processing of alphabetic words compared with the more spatial-relational processing of logographs.

CONCLUSION

The present findings contribute to a stream of literature in consumer behavior that shows that the formation of memories and attitudes can be affected by linguistic differences (Pan and Schmitt 1996; Schmitt et al. 1994; Schmitt and Zhang 1998; Tavassoli 1999, 2001, forthcoming; Zhang and Schmitt 1998). This article demonstrates that scripts can influence such processes independent of a language's grammar or vocabulary.

Together, these findings offer evidence in support of the revised Whorfian hypothesis (Whorf 1956) as conceptualized in Hunt and Agnoli (1991). Hunt and Agnoli (1991) offer a cognitive psychology perspective on how cultural variations in the lexical, syntactical, semantic, and pragmatic aspects of language can influence thought. However, they "assume that when language stimuli are received they are converted from a visual or auditory code to an abstract lexical code" (Hunt and Agnoli 1991, p. 379). In contrast,

our findings suggest that reading alphabetic and logographic scripts relies on central phonological and visuo-spatial cognitive processes to different degrees. As a result, a script that consumers have learned and use on a daily basis can profoundly influence thought in qualitative ways, as well as through its interaction with other stimuli in a multimedia context.

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