Hemispheric Asymmetries in Reading Korean: Task Matters

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Native Korean readers were studied in a visual half-field paradigm. Subjects were to make speeded judgments on Hangul (syllabic) and Hanzza (logographic) scripts based on phonetic or visual properties of the stimuli. A task by visual field interaction was obtained indicating that, for both scripts, responses on the phonetic task were faster in the right visual field, whereas no visual field differences were found on the visual task. Script type did not interact with visual field. The results support a task-based account of hemispheric differences in verbal processing. © 1997

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Visual laterality studies with brain-intact right-handers have consistently yielded a right visual field superiority in response accuracy and/or latency. This asymmetry has in turn been thought to reflect left cerebral hemisphere specialization for verbal processing, consistent with the long noted clinical association between aphasia and left-sided brain injury.

While the general association between language and the left hemisphere is clearly beyond dispute, there is little agreement over the best way to characterize the precise nature of this association. The canonical finding of a right field superiority in verbal laterality studies is based on studies of a fairly narrow range of subjects (right-handed, monolingual), languages (left to right, alphabetic), stimuli (single words), and tasks (word identification or recognition).

In order to better understand both the scope and the nature of laterality effects, it would be instructive to design research that systematically varies some or all potential parameters, including subject, stimulus, and task characteristics (see Hellige, 1993). With respect to subject variables, for example,

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there is evidence that the right field superiority predominantly characterizes proficient, rather than novice, readers of the language (see Endo, Shimizu, & Nakamura, 1981).

With respect to characteristics of the languages studied, several investigators have wondered whether right field superiority is perhaps an artifact of, or at least influenced by, directional scanning biases related to reading habits. According to this view, readers of right-to-left scripts should show a tendency for a left field superiority. Indeed, a meta-analytic review of bilingual laterality studies found some association between right-to-left reading and a noncanonical pattern of laterality (Vaid & Hall, 1989). Interestingly, directional reading habits may also bias asymmetries observed in *nonlinguistic* laterality tasks, such as facial affect judgment (Vaid & Singh, 1989), where their effect is rarely acknowledged, let alone studied.

SCRIPT-SPECIFIC EFFECTS

The focus of the present study was on another language-specific variable that has received considerable attention in both the clinical and the experimental neuropsychological literature—namely, hemispheric specialization of different writing systems—specifically of alphabetic or syllabic versus logographic scripts. Research interest initially focused on users of Japanese given the presence of both a syllabic and a logographic script in the written language. The hypothesis, as articulated in a 1980 study by Sasanuma, Itoh, Kobayashi, and Mori (1980), based on a finding of a right field advantage for kana (the syllabic script) and a left field advantage for kanji (the Chinese-derived logographic script), was that these two types of symbols represent “distinctively different linguistic operations involving different degrees of hemispheric participation, i.e., the nature of kanji being such that it tends to strengthen a direct mapping from character to meaning without phonological mediation, and hence a greater dependence upon the use of ‘visual’ strategies than is the case with the processing of kana which tends to depend more on the use of ‘phonological’ strategies” (p. 299).

Indeed, many studies with Japanese and Chinese readers have been motivated by testing just such a possibility (see Hasuike, Tzeng, & Hung, 1986, and Paradis, Hagiwara, & Hildebrandt, 1985, for reviews), even while it is becoming apparent that many Chinese characters (particularly compound characters) are *not* purely visually mediated but make use of phonological information (see Chen, 1993). Laterality studies with users of nonalphabetic scripts have produced mixed results with some studies, particularly with Japanese readers, reporting a left field effect for kanji characters (Hatta, 1977; Sasanuma, Itoh, Mori, & Kobayashi, 1977) while others, particularly with Chinese readers, find a right field effect (Tzeng, Hung, Cotton, & Wang, 1979; Zhang & Peng, 1983) or else a varied pattern depending on a variety of linguistic and presentational factors (see Hatta, 1981; Cheng & Yang,

1989). As Hasuike et al. (1986) among others have noted, differences across studies in such dimensions as stimulus exposure duration, the number and type of kanji characters used, the relative familiarity of kana and kanji stimuli and the contrastive effect created by having two scripts versus one in the language, could very well have contributed to some of the discrepancies noted in the literature.

TASK-SPECIFIC EFFECTS

Yet another variable could be at work, as suggested by one line of research with users of alphabetic scripts. This research has shown that when the processing demands of a linguistic task are manipulated, it appears that visual laterality effects can be shifted around. For example, the more phonetic or syntactic the processing demands, the greater is the likelihood of obtaining a right field (and, by inference, left hemisphere) effect, whereas the more visual or configural (or even in some cases, semantic) the processing demands, the greater the likelihood of a left field (and, by inference, right hemisphere) effect (e.g., Chiarello, 1985; Vaid, 1984; Zaidel, 1978).

At least two studies with users of nonalphabetic scripts have directly tested task parameters. Hatta (1981; see also Hatta, Honjoh, & Mito, 1983) found a right visual field superiority in response latencies on semantic category judgments involving kanji characters but no visual field differences on a physical identity matching task. Leong, Wong, Wong, and Hiscock (1985), using Chinese subjects, similarly found a right field superiority when the task was to decide if a character matched the sound of an orally presented character but no asymmetries on a visual task (deciding whether a stimulus was an actual Chinese character or its mirror image).

While intriguing in their demonstration of left hemisphere processing of logographic stimuli under certain conditions, these studies do not allow an assessment of the relative contribution of script and task variables as the script manipulation was not included.

Only one previous study to date has factorially compared task with script parameters in the same experiment: Sasanuma et al. (1980) argued that in the case of a mixed orthography such as found in Japanese, results should be a function of the interaction between the stimuli and task demands. Specifically, they predicted that "the left hemisphere should be more efficient in the use of phonological strategies which are better suited for kana recognition, whereas the right hemisphere should be more efficient in the use of visual strategies which are better suited for kanji recognition" (pp. 299–300). Using a same/different judgment task with lateralized presentation of kana and kanji stimulus pairs where the judgment was to be based either on the sound or on the appearance of the symbols, Sasanuma et al. (1980) found a right field superiority for both scripts for phonetic judgments but no visual field differences in either script for appearance judgments.

KOREAN STUDIES

The present study was aimed at further exploring the relative importance of script and task parameters using a different set of biscriptal subjects—Korean readers. Like Japanese, the Korean written language can be transcribed in two ways—in a phonetic script, Hangul, which has a very consistent mapping between orthography and phonology, and in a Chinese-derived script, Hanzza, that is visually more complex. Hanzza words have an indirect relation to phonology.

While Japanese terms cannot easily be interchanged across the kanji and the kana scripts (see Paradis et al., 1985), many common content words in Korean can normally be written in either Hangul or Hanzza form (see Taylor & Taylor, 1983, for a further discussion of the Korean script). This difference alone between the Japanese and the Korean situation makes the use of Korean particularly useful for research purposes.

Recent psycholinguistic studies of Korean suggest that the two scripts are processed differently: for example, Hangul words are named much faster than the same words written in Hanzza (Nam, 1995; Park & Vaid, 1995; Simpson & Kang, 1994). Moreover, Hangul words are recognized more rapidly in a mixed list when they predominate in the list; Hanzza words are not affected by their proportion in a mixed list (Simpson & Kang, 1994). These together with other differences between the two scripts (e.g., in repetition priming and lexical decision tasks) point to a difference in lexical access whereby reading in the more “shallow” script, Hangul, is more likely to involve the use of a phonological route to word meaning (Nam, 1995).

In view of these behavioral processing differences, a natural question that can be raised is whether the two scripts are also differentially processed by the two hemispheres. To date there have been two laterality investigations using Korean: Endo et al. (1981) reported a right field superiority for Hangul and kana words in Japanese readers fluent in the two scripts. Jin (1988) also reported a right field superiority for Hangul word identification but a left field superiority for Hanzza identification in native Korean readers. While the latter study in particular argues for script-specific differences in laterality, it should be noted that neither it nor the study by Endo et al. manipulated processing demands of the task.

PRESENT STUDY

In view of the findings of Sasanuma et al. (1980) with Japanese readers, the present study sought to compare the relative contribution of script- and task-related processing parameters in determining patterns of brain lateralization in the reading of Korean. In our study, native Korean readers were tested on Hangul and Hanzza script on two different tasks: a phonetic matching task (deciding if a previously spoken word matched a subsequently presented written word in sound) and a visual judgment task (deciding if the word

was written in Hangul or Hanzza). Based on previous studies using similar phonetic tasks (e.g., Sasanuma et al., 1980; Leong et al., 1985), we expected a right field superiority for the phonetic matching condition. For the visual task, the only analogous study we could find—that of Umilta, Sava, and Salmoso (1980), involving letter classification for letters differing in type-face—led us to expect either a left field advantage or an absence of visual field differences (see also Bryden & Allard, 1976). To ensure that the effects we observed could be attributed to properties of the tasks per se, the stimuli used across the two tasks were identical.

HYPOTHESES

If stimulus-related properties (such as type of script) are sufficient to engage the two hemispheres differentially, then a script by visual field interaction should be obtained, with a larger right visual field superiority being expected for Hangul (the more phonetic script) than for Hanzza (the more visual script).

If, on the other hand, the critical basis for hemispheric differences relates to how stimuli are processed rather than to the nature of the stimuli per se, then a right field advantage should obtain on the phonetic matching task and no visual field differences (or a left field advantage) should be found on the visual classification task for both scripts.

METHOD

Subjects. Sixteen native Korean college students at a southwestern university in the United States served as volunteer subjects. All were screened for right-handedness on the Edinburgh Inventory (Oldfield, 1971) and all had normal or corrected to normal vision.

Stimuli and apparatus. The stimuli were 80 commonly occurring Korean words selected from a core lexicon containing words judged to be equally likely to be written in Hangul or in Hanzza in normal usage. For the purposes of the experiment, two separate lists were constructed, such that half of the words per list contained words in Hangul and half contained words in Hanzza; a given word presented in Hangul in List 1 appeared in Hanzza in List 2.

For each list, stimuli were written in black ink on white cards, with the beginning of the word subtending a visual angle of 1.13 degrees to the left or to the right of center at a viewing distance of 76 cm. Each word per list was presented once in each visual field in a fixed random order, yielding a total of 160 trials.

A Gerbrands three-field tachistoscope was used to present the stimuli for an exposure duration of 100 msec. Manual response latencies were recorded using a Gerbrands reaction time apparatus (Model G1360) and a Lafayette digital timer with millisecond precision.

Procedure. Subjects were instructed that they would have to make speeded judgments of rapidly presented Korean words. Each subject was seated with the head positioned in the viewing hood of the tachistoscope to ensure a constant viewing distance. A central fixation point was first presented for 1 sec and was followed immediately by a unilaterally presented word.

Subjects participated in two conditions, with the order of conditions counterbalanced. In the Script Classification condition, subjects had to identify whether the word was written in Hangul or in Hanzza. They were to signal their response by pressing one of two designated

TABLE 1
Mean Response Latencies (in Msecs) and Standard Deviations per Condition

	Hangul		Hanzza	
	RVF	LVF	RVF	LVF
Visual task	718 (99)	724 (87)	730 (102)	739 (96)
Phonetic task	754 (159)	780 (146)	853 (156)	942 (197)

response buttons using their left or right index finger. In the Phonetic Matching condition, subjects had to decide if the unilaterally presented word matched in sound a word orally presented during the fixation interval; they were to press a designated key depending on whether the laterally presented word was in Hangul or Hanzza. (No responses were required if the word did not match the orally presented word.)

The same set of stimuli were used across the two conditions in a fixed random order, with the stipulation that a word presented in Hangul in one condition was shown in Hanzza in the other condition. For both conditions, instructions emphasized accuracy as well as speed. The particular finger (right vs. left) used for indicating a particular response (Hangul vs. Hanzza) was counterbalanced across subjects. Only trials yielding correct responses were entered into the data analysis.

RESULTS

Response latencies were entered into a $2 \times 2 \times 2$ (Task by Script by Visual Field) analysis of variance with repeated measures on all factors. Table 1 summarizes subjects' mean performance on the 8 conditions of the experiment. The analysis of variance yielded three main effects and two interaction effects. The main effect of Script [$F(1, 15) = 24.55, p < .0002$] showed that subjects were faster in responding to Hangul than to Hanzza stimuli. The main effect of Task [$F(1, 15) = 12.28, p < .003$] showed that responses were faster on the script classification task relative to the phonetic matching task. The Visual Field main effect [$F(1, 15) = 9.45, p < .008$] indicated an overall right visual field superiority.

With respect to the interaction effects, the interaction of Task $\times$ Script [$F(1, 15) = 23.14, p < .0002$] indicated that response latencies for phonetic matching were longer than those for script classification, but only when words were presented in Hanzza (Tukey's $HSD = 53, p < .05$). Moreover, words written in Hanzza were responded to more slowly than those written in Hangul on the phonetic matching task. See Figure 1.

An interaction of Task by Visual Field [$F(1, 15) = 14.86, p < .002$], illustrated in Fig. 2, indicated a right visual field advantage of 54 msec in the phonetic matching condition; no significant visual field asymmetry was obtained in the script condition; Tukey's $HSD = 53, p < .05$. There were no other effects.

FIG. 1. Task by script interaction.

FIG. 2. Task by visual field interaction.

DISCUSSION

This study was designed to evaluate the relative influence of stimulus- and task-related variables on visual field asymmetries in word recognition. If stimulus-related parameters (in this case, differences related to script type) had been sufficient to determine the pattern of cerebral asymmetries, then a script by visual field interaction should have been obtained. It was not. Instead, a RVF superiority was observed for *both* scripts, suggestive of a left hemisphere dominance. The visual field effect interacted with the task variable indicating that a right visual field advantage was obtained primarily on the phonetic task. While script differences also interacted with task (Hangul words being judged faster than Hanzza words on the phonetic matching task, consistent with previously reported differences between the two scripts, e.g., Park & Vaid, 1995) the script effect did not vary by hemifield. On the visual task (script classification) subjects' performance was equally good for Hangul and Hanzza stimuli and did not differ across visual field. The lack of asymmetry on this task is consistent with the finding by Umiltà et al. (1980) on a similar task involving letter classification on the basis of type-face.

In general, our findings with Hanzza replicate those reported by others, e.g., Sasanuma et al. (1980) with kanji and Leong et al. (1985) with Chinese. These studies also found a right field advantage on a phonetic task and no visual field differences on a visual task. It would thus appear that words written in a so-called logographic script are not by that token more likely to be mediated by the right hemisphere as compared to the same words written in a syllabic script. To that extent these findings support Hasuike et al.'s conclusion that (1986), "the occasionally observed left visual field superiority in recognizing Chinese characters in visual half field experiments does not show any script-specific property in higher cortical function" (p. 283).

In other words, our study suggests that writing systems per se are not differentially lateralized. Rather, hemispheric differences clearly vary according to processing-based demands of the task. Thus, even for the visually more complex Hanzza script, an overall left hemisphere advantage was obtained when the task involved phonetic discrimination; similarly, even for the more phonetic Hangul script, a left hemisphere effect was *not* obtained when the task (script classification) could be performed without recourse to phonetic processing.

The present findings therefore demonstrate that, regardless of the type of script, hemispheric asymmetry is influenced (among other things) by task-related processing differences, such that a task calling for phonetic processing is more likely to activate the left hemisphere than one involving visual discrimination. The research further indicates that task parameters may be more critical than script-related parameters in influencing patterns

of laterality in brain-intact individuals. It remains for further research to explore other linguistic tasks with users of a variety of writing systems.

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