Neuropsychologia, Vol. 24, No. 3, pp. 341–350, 1986.
Printed in Great Britain.

0028-3932/86 $3.00 + 0.00
Pergamon Journals Ltd.

535

HEMISPHERIC ASYMMETRIES IN PHONOLOGICAL PROCESSING*

G. LUKATELA,† CLAUDIA CARELLO,‡ M. SAVIĆ and M. T. TURVEY§

†University of Belgrade; ‡State University of New York at Binghamton; †University of Belgrade; §University of Connecticut and Haskins Laboratories

(*Accepted* 13 *November* 1985)

Abstract—In Serbo-Croat, lexical decision to phonologically bivalent letter strings is slowed relative to their phonologically unique counterparts. This feature was exploited in order to assess the linguistic capacity of the two hemispheres. Lexical decision to laterally presented words and pseudowords revealed a right visual field advantage for both males and females in words and pseudowords. But the demands of phonological processing were not met in the same way by the two hemispheres, the two hemispheres did not respond in the same way in the two sexes, and the pattern of these differences was opposite for words and pseudowords.

INTRODUCTION

ALTHOUGH it is generally accepted that the left hemisphere is specialized for language, there is some question as to what language capacity, if any, exists in the right hemisphere. For example, among split-brain patients (i.e. those in whom the corpus callosum has been severed so that exchange of information between the two hemispheres is precluded) right-hemisphere language competence appears to vary considerably. With a majority of such patients, left visual field (LVF) presentation (which projects only to the right hemisphere) of verbal stimuli reveals no right-hemisphere language of any kind. In contrast, a few of these commissurotomy patients appear to have a rich semantic system, and a few—who demonstrate syntax and phonology in addition to semantics—appear linguistically sophisticated [13, 23]. Whether such differences indicate different degrees of lateralization or whether they correspond to varying degrees of early presurgical left-hemisphere damage for which the right hemisphere took over, or whether they suggest that only the intermediate level of competence represents a 'normal' right hemisphere, is a subject of considerable debate (e.g. [13, 17, 27]).

With respect to patients with left-hemisphere damage, Coltheart argues that the acquired reading disorder known as deep dyslexia provides several parallels to the intermediate level reading performance of two split-brain patients, N.G. and L.B. [6, 7]. These include failures to read a word that is, nonetheless, understood [24, 18]; an inability to generate a phonological code for written pseudowords; and a deficiency in judging the homophony of two printed pseudowords [7, 28]. Such results have been taken to indicate a right-hemisphere deficit in deriving phonology from orthography [23].

*The research was supported in part by National Institute of Health Grants HD-08495 to the University of Belgrade, Yugoslavia, and HD-01994 to Haskins Laboratories.

§Requests for reprints should be sent to: M. T. Turvey, Haskins Laboratories, 270 Crown Street, New Haven, CT 06511, U.S.A.

Indications of lateralization within normal populations are sought in visual field advantages. With an intact corpus callosum, each hemisphere has access to the other's information, but the 'specialist' ought to demonstrate a superiority in its domain. In lexical decision tasks, for example, in which a subject must simply decide whether or not a given letter string is a word, a right visual field (RVF) advantage is typically found [2, 3]. Unfortunately, this may be the only straightforward result. When interactions with visual field are investigated, the findings tend to be equivocal. We will review these and suggest how the disparate observations might be clarified.

For example, the RVF superiority may be greater for accepting words than rejecting pseudowords. This interaction is found when the pseudowords are chosen to preserve the 'structure and shape of the words employed' [2] but not when the pseudowords are homophonic with real words [3]. In the latter case, the error analysis of the right-handed subjects revealed the same tendency, however—fewer errors were made on words when they appeared in the RVF while fewer errors occurred for pseudowords in the LVF. But even this error pattern changed when nonwords (orthographically illegal letter strings) were used, yet they seem as suited to rejection by right-hemisphere visual analysis as pseudohomophones.

There is also some suggestion that RVF superiority may be greater for males than females, at least for right-handed subjects [3]. This difference disappears when the letter strings reoccur in the second half of the experiment, suggesting that the right hemisphere of females may be involved in language processing of unfamiliar material only [2]. But in a modified lexical decision task in which subjects had to decide whether or not a pseudoword was homophonic with a real word, the interaction of sex and visual field was not significant (although BRADSHAW *et al.* [3] noted that 75% of their subjects of both sexes showed visual field differences in the expected direction in Experiment 2). In their Experiment 1, BRADSHAW and GATES [2] found a sex by lexicality by visual field interaction in the error analysis (with the RVF advantage for words being greater in males than females). If different types of pseudowords and nonwords show differential degrees of RVF superiority (contrast [2] with [3]) and if the lexicality–visual field interaction differs for the sexes (suggested in BRADSHAW and GATES [2, Experiment 1]), then some types of pseudowords might be expected to obscure the interaction of visual field and sex. Orthographically regular, nonhomophonic pseudowords may be important to revealing sex by visual field interactions.

Of course, if one considers the lexical decision task to represent a fairly unsophisticated linguistic skill, then any hemispheric differences so revealed may be irrelevant to the language capacity of the right hemisphere. Indeed, the ability to perform lexical decision has been found in left-hemisphere stroke patients who are globally aphasic [14]. Investigations of the phonological capacity of the two hemispheres, therefore, may be more to the point. In this regard, a RVF advantage (in terms of accuracy of report) has been found for pronounceable (defined as orthographically legal) letter strings but not for unpronounceable (orthographically illegal) strings, even though both were reported as a series of letters [25]. In a naming task (in which response latency to pronounce a letter string is measured) the RVF advantage was greater for pseudohomophones than for either words or nonhomophonic pseudowords [2, Experiment 4]. No such interaction was found, however, for the lexical decision-like task that compared homophonic pseudowords with nonhomophonic pseudowords (despite its mention in the general discussion [2]). Finally, in lexical decision tasks some investigators find a pseudohomophone effect for RVF presentation only [5], but others find such an effect for both RVF and LVF presentations [1].

Although phonology is an important property in defining language ability, the complex script–sound relationship in English makes it a tricky property to manipulate [22]. Pseudohomophones are somewhat suspect as an adequate test of whether or not phonological analysis is taking place [11, 21]. Investigations of phonological effects are more straightforward in Serbo-Croat, a Slavic language used by the majority of Yugoslavs. Where English uses word order as its primary grammatical device, Serbo-Croat uses inflection. There is another interesting contrast with English: due to deliberate alphabet reform in the last century, the Serbo-Croatian orthography is phonologically shallow—a given grapheme has only one pronunciation. In addition, the single spoken language is transcribed in two distinct scripts, both of which can be read by educated Yugoslavs. The Cyrillic script (predominant in the East) and the Roman script (predominant in the West) were modified to map onto the same 30 sounds. In the uppercase, printed form, most of the letters are unique to one or the other alphabet, seven are common (i.e. receive the same phonetic interpretation in Roman and Cyrillic) and, importantly, four are ambiguous (i.e. receive one interpretation in Roman but a different interpretation in Cyrillic). Combinations of unique and common letters produce phonologically unambiguous letter strings (e.g. ЛОЗА/loza/means 'vineyard' in Cyrillic but cannot be read in Roman; NOGA/noga/means 'leg' in Roman but cannot be read in Cyrillic). Combinations of ambiguous and common letters yield phonologically ambiguous or bivalent letter strings (e.g. POTOP means 'motor' in Cyrillic/rotor/but 'flood' in Roman/potop/; BEHA means 'vein' in Cyrillic/vena/ but is a nonword—though orthographically legal—in Roman/bexa/).

A comparison of lexical decision time for a phonologically ambiguous string that is a word in Cyrillic (BEHA), for example, with the latency for that same word written in unique Roman (VENA) provides a measure of the effect of phonological ambiguity (with lexicality, frequency, meaningfulness, orthographic structure, and so on, controlled). Where more than one phonological code is assembled, it is argued that this retards either lexical search or lexical activation time see [12] and [18] for a summary of the arguments). Indeed, the effect has been shown to be quite robust (of the order of 300 msec) as phonological analysis appears to be nonoptional for readers of Serbo-Croat [4, 12, 25].*

This cleaner manipulation of phonology would make it easier to evaluate phonological involvement in the two hemispheres. The logic is similar to that used to evaluate reading strategies employed by good and poor readers: those who are more reliant on phonology ought to be slowed more by phonological bivalence. With respect to reading skill, this turns out to be the good readers [11]. With respect to language specialization, we would expect a larger effect in the left hemisphere (RVF). Moreover, if females show less of a difference between the hemispheres than males in general, then the phonological ambiguity effect in particular ought to be larger in the females' LVF than the males' LVF.

The present study uses Serbo-Croatian letter strings in a lexical decision task in an effort to clarify a number of issues raised here. In general, we expect shorter latencies for RVF presentations. But this will be examined in light of the lexical status of the items (i.e. is the

*An ambiguous letter string takes longer to decide about than an unambiguous letter string when the former is (i) a word, though different, in both readings; (ii) a pseudoword, though different, in both readings; and (iii) a word in one reading and a pseudoword in the other (where the affirmative lexical decision dictates that the unambiguous control be a word) [18, 19]. The effect is more pronounced with words than pseudowords [12, 19]. The greater the number of ambiguous letters in the string, the longer lexical decision takes [10, 12]. While attempts to bias subjects toward a Roman reading by instructions or task (i.e. uniquely Cyrillic letters never appear) did not eliminate the effect, the presence of a single unique character did [10, 19]. Finally, the effect is more pronounced in good readers than in poor readers [11], suggesting that those who more effectively exploit the phonologically analytic strategy are harmed more by ambiguity.

RVF advantage more dramatic for words than pseudowords?), and sex of the subject (i.e. are males more lateralized than females?). In addition, irrespective of lexicality we will look at the influence of phonological ambiguity on processing in the two hemispheres. Response latency to a phonologically ambiguous Cyrillic word (e.g. BEHA/vena/) which is a pseudoword in Roman (/bexa/) ought to be longer than latency to that same word written in pure Roman (VENA/vena/).* Similarly, a phonologically ambiguous pseudoword (HABA) which has both a Cyrillic (/nava/) and a Roman (/xaba/) interpretation ought to take longer to reject than that same pseudoword written in pure Roman (NAVA/nava/). Of interest is whether or not the phonological ambiguity effect is larger for RVF presentations. It should be underscored that we are looking at sensitivity to phonological ambiguity as indexed by the degree of increase in latency *relative to the unambiguous base line*. Thus, if phonologically ambiguous letter strings show less of a RVF advantage than unambiguous letter strings, it does not mean that the right hemisphere is more involved in processing the former. Rather, it suggests that the left hemisphere is more sensitive to ambiguity in phonological interpretation.

METHODS

Subjects

Fifty-six male undergraduates from the Faculty of Electrical Engineering at the University of Belgrade and 56 female high school seniors from the Sixth Belgrade Gymnasium served voluntarily as subjects. All had normal or corrected to normal vision, and none had had previous experience with visual processing experiments.

Procedure

A subject sat with his/her head in a chin rest at the viewer of a two-channel, wide field-of-view tachistoscope specially constructed by Dr M. Gurjanov of the Faculty of Electrical Engineering at the University of Belgrade. Subjects were instructed to fixate a small, bright, centrally located point of light, which was visible throughout the experiment. Each trial was preceded by a ready signal from the experimenter. Stimuli were presented unilaterally (varied pseudorandomly) for 150 msec with an intertrial interval of approximately 3 sec. The subjects' task was to decide, as rapidly as possible, whether or not a letter string was a word by either its Roman or Cyrillic reading. Decisions were indicated by depressing a telegraph key with both thumbs for a 'No' response or by depressing a slightly further key with both forefingers for a 'Yes' response. Latency was measured from the onset of a slide. A blank field immediately preceded and followed the display interval. Each subject viewed 76 slides which included 16 practice trials.

Stimuli

For the critical comparison, defined across two groups of subjects, two types of words and pseudowords were included. Phonologically ambiguous (10 words and 10 pseudowords) consisted of CVCVC strings in which vowels and the middle consonant were common to the two alphabets but the initial and final consonants could receive different phonetic interpretations in Roman and Cyrillic (Group 1). Unambiguous items were pure Roman versions (10 words and 10 pseudowords) of the bivalent letter strings (Group 2). In addition, subjects saw two types of filler items. Pure Cyrillic letter strings (10 words and 10 pseudowords) were included in Group 2 to balance the number of Cyrillic items shown to the two groups (Group 1 saw the pure Roman version of these). Additional pure Roman letter strings (20 words and 20 pseudowords were included in both groups in an attempt to bias the reading of the bivalent items and thereby enhance the phonological ambiguity effect. The available evidence suggests however that such long term bias (i.e. defined over the course of the experiment) has little influence on the size of the effect (compare [18] with [19]).

All words were selected from the mid-frequency range of word frequencies for Serbian elementary school children [20]. Pseudowords were derived from the words by replacing one or two consonants in the letter string. All letter

*Phonologically ambiguous letter strings (OBOJICA) that are a word in Roman ('both'/obojitsa/) but a pseudoword in the Cyrillic reading (/ovojisa/) do not occur in sufficient numbers to allow experimentation with appropriate control on frequency and structure. It should be emphasized that the phonological ambiguity effect does not simply reflect alphabet differences, however. Comparisons of a word (e.g. 'leg') written in pure Roman (NOGA/noga/) or pure Cyrillic (HOΓ A/noga/) reveal little, if any, difference [12]. Moreover, a phonological ambiguity effect is found completely within alphabet—that is, when phonologically bivalent Cyrillic words are compared to different words written in pure Cyrillic [19].

strings were printed in uppercase Roman or Cyrillic (IBM Gothic). Each string of five letters was arranged horizontally to the left of center of a 35 mm slide for RVF presentation and to the right of center (on a complementary set) for LVF presentation. Stimuli subtended a horizontal visual angle of 2°, commencing 1° to the left or right of the midline of the slide.

Design

The major constraint of the design of the experiment was that a given subject never encountered a given word or pseudoword more than once. This was achieved by a further subdivision of groups with respect to hemifield presentation. Group 1a saw half of the words and half of the pseudowords in the LVF and the other halves in the RVF. For Group 1b, the reverse was true. The same pattern occurred for Groups 2a and 2b. Equal numbers of males and females were in each subgroup.

RESULTS

Minimum and maximum acceptable latencies were set at 350 and 3500 msec, respectively (these are fairly long to allow for the difficulty of judging phonologically ambiguous stimuli presented unilaterally). The data (Figs 1 and 2) were first subjected to an analysis of variance by Sex, Visual Field, and Lexicality, collapsing the phonologically ambiguous letter strings and their unambiguous equivalents. The main effect of Field was significant [$F(1,110)=20.53$; $MSe=303212$; $P<0.001$] with the right visual field (936 msec) being faster than the left (988 msec). Words were accepted faster (885 msec) than pseudowords were rejected (1038 msec), $F(1,110)=48.20$; $MSe=2606988$, $P<0.001$. But neither the main effect of Sex [$F(1,110)<1$] nor any interaction was significant (all $F<1$ except Field × Lexicality, $F(1,110)=1.81$, $MSe=26893$, $P>0.15$).

A second analysis focused on the relationship between phonological ambiguity and lexicality in the two visual fields. Again, the main effects of Field [$F(1,110)=20.59$; $MSe=303212$; $P<0.001$] and Lexicality [$F(1,110)=54.51$; $MSe=260988$; $P<0.001$] were

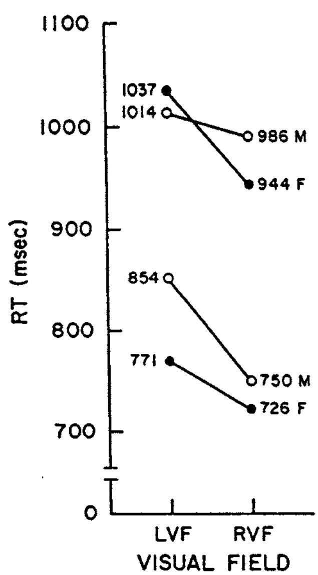

FIG. 1. Average lexical decision times (in msec) to phonologically ambiguous words (upper lines) and their unambiguous equivalents (lower lines) presented to the left and right visual fields for males and females.

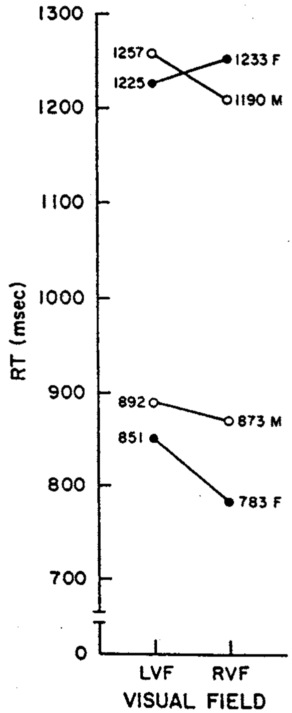

FIG. 2. Average lexical decision times (in msec) to phonologically ambiguous pseudowords (upper lines) and their unambiguous equivalents (lower lines) presented to the left and right visual fields for males and females.

significant, as was Phonology [$F(1,110)=60.13$; $MSe=9943366$; $P<0.001$] with ambiguous strings being slower (1111 msec) than their unambiguous controls (813 msec). In addition, the Lexicality × Phonology interaction was significant [$F(1,110)=1439$; $MSe=688367$; $P<0.001$] with pseudowords suffering more (376 msec difference) than words (319 msec). No other interactions were significant: Field × Lexicality [$F(1,110)=1.81$; $MSe=26893$; $P>0.015$], Field × Phonology and Field × Phonology × Lexicality ($F<1$).

The words and pseudowords were then analyzed separately for Field by Phonology by Sex effects. Since variances were not homogenous in a first analysis, a square root transform was performed on the latency data. For Words, significant main effects were obtained for phonology [$F(1,108)=52.89$; $MSe=739$; $P<0.001$; ambiguous words averaged 995 msec, unambiguous averaged 775 msec] and Field [$F(1,108)=17.03$; $MSe=66$; $P<0.001$; LVF=919 msec, RVF=852 msec], but not for Sex [$F(1,108)=1.26$; $MSe=18$; $P<0.25$]. The Field × Phonology × Sex interaction was marginally significant [$F(1,110)=3.63$; $MSe=14$, $P<0.056$; the phonological ambiguity effect in the LVF was larger for females than males but approximately equivalent for the two sexes in the RVF—Table 1]. This interaction was significant in the error analysis [$F(1,108)=5.28$; $MSe=3$; $P<0.02$] but in the opposite direction (the increase in errors for bivalent items relative to their Roman controls was greater in the RVF for females but in the LVF for males—Table 2. The error analysis also revealed main effects of Phonology [$F(1,108)=20.73$; $MSe=26$; $P<0.001$; on average, 1.2 errors—out of 5 per visual field—were made on ambiguous words, 0.5 on

Table 1. Difference (in msec) between phonologically ambiguous words and their unambiguous equivalents in the two visual fields for males and females

Sex	Visual field Left	Right
Male	160	236
Female	266	218

Table 2. Difference (in average number of errors per 5 items) between phonologically ambiguous words and their unambiguous equivalents in the two visual fields for males and females

Sex	Visual field Left	Right
Male	1.0	0.4
Female	0.5	0.8

unambiguous words], and Sex [$F(1,108)=4.15$; $MSe=5$; $P<0.05$; females committed fewer errors (0.7) than males (1.0)]. There was also a field by sex interaction [$F(1,108)=7.03$; $MSe=4$; $P<0.01$; females committed fewer errors in the LVF than in the RVF, males committed more LVF errors than RVF errors].

For Pseudowords, as with Words, significant main effects were obtained for Phonology [$F(1,108)=54.71$; $MSe=1768$; $P=0.001$; ambiguous pseudowords averaged 1226 msec, unambiguous averaged 850 msec] and Field [$F(1,108)=6.11$; $MSe=17$, $P<0.01$; LVF = 1056 msec, RVF = 1020 msec], but not for Sex ($F<1$). And, once again, the Field × Phonology × Sex interaction was significant [$F(1,108)=5.02$; $MSe=14$; $P<0.025$]. This time, the direction of the interaction was reversed—the ambiguity effect in the RVF was larger for females than males and approximately equivalent in the LVF (Table 3). Due to the small number of errors on pseudowords, an error analysis could not be performed.

Table 3. Difference (in msec) between phonologically ambiguous pseudowords and their ambiguous equivalents in the two visual fields for males and females

Sex	Visual field Left	Right
Male	365	317
Female	374	450

DISCUSSION

The experiment was designed in an effort to clarify some disparate findings with regard to the differential language capacity of the two hemispheres in normal subjects with undivided commissures. With laterally presented verbal material, a left-hemisphere (RVF) advantage was found irrespective of an item's lexical status (word or pseudoword) or phonological interpretation (ambiguous or unambiguous). This was as true for females as it was for males. We did not find an interaction of visual field with either sex or lexicality. These results are consistent with the patterns found with naming latencies [2, Experiments 3 and 4] and identification proportions [26] but differ somewhat from other lexical decision studies. BRADSHAW and GATES [2] found the RVF advantage to be greater for words than structurally similar pseudowords (Experiment 1) but this was really only true of their female subjects. A lexicality by field interaction did not obtain for word–pseudohomophone [3] or pseudohomophone–nonhomophone comparisons [2, Experiment 2]. Word–nonword (consonant string) comparisons were mixed, depending on sex and handedness [3].

Bradshaw and his colleagues suggest that the RVF advantage is greater for males than females but, in fact, this difference was not absolute—it was true of right-handers but not left-handers [3] and it disappeared when stimuli were presented a second time [2]. Although their field by sex interaction was not significant, BRADSHAW and GATES [2] attribute this to a few subjects since 75% of the males showed a RVF superiority and 75% of the females showed a LVF superiority. We did not find this trend, though, as 69% of the males and 65% of the females showed a RVF superiority. Again, this is consistent with the naming and identification studies which did not obtain field differences for males and females. This is not to dispute hemispheric differences between the sexes but to point out that their appearance in three-way interactions with selected tasks may indicate that we are looking at quite subtle but potentially more interesting nuances of suspected differences in language skill.

In the present study, these interesting differences begin to appear in an examination of the phonological ambiguity effect. The general slowing of responses to ambiguous strings relative to their unambiguous equivalents [10, 12] was replicated. The effect was larger for pseudowords, however, which is counter to the usual finding with centrally presented letter strings [12, 19].

Of particular interest, of course, are the Sex × Phonology × Field interactions. If one looks just at the latency differences for words (Table 1), two cognate descriptions can be given. First, the phonological ambiguity effect in the left hemisphere (RVF) is comparable for the two sexes but in the right hemisphere (LVF) it is greater for females. Second, the phonological ambiguity effect in females is larger in the right hemisphere than in the left; in males, it is larger in the left hemisphere than in the right. This pattern is consistent with suggestions in the literature that if the right hemisphere is linguistically competent (particularly with respect to something as sophisticated as phonology), then it is more likely to be so in females. It is then conjectured that this 'extra' language capacity in the right hemisphere underlies the traditional female verbal superiority (and spatial inferiority) as spatial processing space has been usurped by language [3].

Turning to pseudowords, the opposite pattern is found. For males, phonological ambiguity is felt more strongly in the right hemisphere. A possible explanation of this outcome for male subjects is to be found in suggestions that the right hemisphere lexicon does not contain all words [2, 8, 9, 15, 16]—but see [23] for a summary of contrary results. To the extent that it does not, unfound letter strings would have to be shuttled to the left hemisphere for further search before negative lexical decisions could be made [23]. Since two or more phonological codes are assembled in the present experiment, a combined search-and-shuttle for each code could be expected to take longer than the more straightforward left-hemisphere search. The contrary result that is observed for females echoes the opposition displayed by the two sexes with regard to words, demonstrating some consistency to their differences.

We must, however, introduce a note of caution in interpreting the word latencies if they are viewed in conjunction with the error data (Table 2). A speed–accuracy trade off becomes apparent for both males and females; smaller latency differences between phonologically ambiguous words and their baseline are accompanied by larger error differences. The possibility remains, therefore, that an emphasis on accuracy might reverse the hemispheric pattern of the phonological ambiguity effect in males and females. For pseudowords (Table 3), in contrast, the error rate was quite low (and positively correlated with latency). Does the lower error rate for pseudowords relative to words mean that the former provide a purer look into language differences in the hemispheres? While this possibility cannot be ruled out we would claim, more conservatively, that strategies used to distinguish words from pseudowords are not homogeneous. (As examples, serial search models distinguish self-terminating and exhaustive searches for words and pseudowords, respectively; parallel activation models contrast exceeding the threshold of a single lexical entry with violating a general deadline for exceeding any item's threshold.) Further understanding of the data presented here awaits an elucidation of the mechanisms underlying lexical decision—recall, for example, that this task can be performed by some global aphasics [14]. But returning to the major question of phonological sensitivity, it can be concluded unequivocally that the demands of phonological processing are not met in the same way by the two hemispheres nor do the two hemispheres respond in the same way in the two sexes.

REFERENCES

1. BARRY, C. Hemispheric asymmetry in lexical access and phonological encoding. *Neuropsychologia* **19**, 473–478, 1981.
2. BRADSHAW, J. L. and GATES, E. A. Visual differences in verbal tasks: effects of task familiarity and sex of subject. *Brain Lang.* **5**, 166–187, 1978.
3. BRADSHAW, J. L., GATES, E. A. and NETTLETON, N. C. Bihemispheric involvement in lexical decisions: handedness and a possible sex difference. *Neuropsychologia* **15**, 277–286, 1977.
4. CARELLO, C. and TURVEY, M. T. Dependence of reading on orthography: investigations in Serbo-Croatian. In *Linguistics, Psychology and the Chinese Language*, H. KAO and R. HOOSAIN (Editors). Hong Kong University Press, Hong Kong, in press.
5. COHEN, G. and FREEMAN, R. Individual differences in reading strategies in relation to handedness and cerebral asymmetry. In *Attention and Performance VII*, J REQUIN (Editor). Erlbaum, Hillsdale, NJ, 1978.
6. COLTHEART, M. A right hemisphere hypothesis. In *Deep Dyslexia*, M. COLTHEART, K. PATTERSON, and J. C. MARSHALL (Editors). Routledge & Kegan Paul, London, 1980.
7. COLTHEART, M. The right hemisphere and disorders of reading. In *Functions of the Right Cerebral Hemisphere*, A. YOUNG (Editor). Academic Press, London, 1983.
8. DAY, J. Right hemisphere language processing in normal righthanders. *J. exp. Psychol., Hum. Percept. Perform.* **3**, 518–528, 1977.
9. ELLIS, H. D. and SHEPHERD, J. W. Recognition of abstract and concrete words presented in left and right visual fields. *J. exp. Psychol.* **103**, 1035–1036, 1974.
10. FELDMAN, L. B., KOSTIĆ, A., LUKATELA, G. and TURVEY, M. T. An evaluation of the "Basic Orthographic Syllabic Structure" in a phonologically shallow orthography. *Psychol. Res.* **45**, 55–72, 1983.
11. FELDMAN, L. B. LUKATELA, G. and TURVEY, M. T. Effects of phonological ambiguity on beginning readers of Serbo-Croatian. *J. exp. Child Psychol.* **29**, 492–510, 1985.
12. FELDMAN, L. B. and TURVEY, M. T. Visual word recognition in Serbo-Croatian is phonologically analytic. *J. exp. Psychol., Hum. Percept. Perform.* **9**, 288–298, 1983.
13. GAZZANIGA, M. S. Right hemisphere language following brain bisection: a 20-year perspective. *Am. Psychol.* **38**, 525–537; and reply to Levy and to Zaidel, 547–549, 1983.
14. GLASS, A. S., GAZZANIGA, M. S. and PREMACK, D. Artificial language training in global aphasics. *Neuropsychologia* **11**, 95–103, 1973.
15. HINES, D. Recognition of verbs, abstract nouns and concrete nouns from left and right visual half fields. *Neuropsychologia* **14**, 211–216, 1976.
16. HINES, D. Differences in tachistoscopic recognition between abstract and concrete words as a fuction of visual half-field and frequency. *Cortex* **13**, 66–73, 1977.

17. LEVY, J. Language, cognition, and the right hemisphere: a response to Gazzaniga. *Am. Psychol.* **38**, 538–541, 1983.
18. LUKATELA, G., POPADIĆ, D., OGNJENOVIĆ, P. and TURVEY, M. T. Lexical decision in a phonologically shallow orthography. *Mem. Cognit.* **8**, 124–132, 1980.
19. LUKATELA, G., SAVIĆ, M., GLIGORIJEVIĆ, B., OGNJENOVIĆ, P. and TURVEY, M. T. Bi-alphabetical lexical decision. *Lang. Speech* **21**, 142–165, 1978.
20. LUKIĆ, V. *Frequency Dictionary of Children.* Belgrade, 1983.
21. MARTIN, R.C. The pseudohomophone effect: the role of visual similarity in non-word decision. *Q. Jl exp. Psychol.* **34A**, 395–409, 1982.
22. Parkin, A. Phonological recoding in lexical decision: effects of spelling-to-sound regularity depend on how regularity is defined. *Mem. Cognit.* **10**, 43–53, 1982.
23. PATTERSON, K. and BESNER, D. Is the right hemisphere literate? *Cognit. Neuropsychol.* **1**, 315–341, 1984.
24. SAFFRAN, E. M. and MARIN, O. S. Reading without phonology: evidence from aphasia. *Q. Jl exp. Psychol.* **29**, 515–535, 1977.
25. TURVEY, M. T., FELDMAN, L. B. and LUKATELA, G. The Serbo-Croatian orthography constrains the reader to a phonologically analytic strategy. In *Orthographies and Reading*, L. HENDERSON (Editor). Erlbaum, London, 1984.
26. YOUNG, A. W., ELLIS, A. W. and BION, P. J. Left hemisphere superiority for pronounceable nonwords, but not for unpronounceable letter strings. *Brain Lang.* **22**, 14–25, 1984.
27. ZAIDEL, E. A response to Gazzaniga: language in the right hemisphere, convergent perspectives. *Am. Psychol.* **38**, 542–546, 1983.
28. ZAIDEL, E. and PETERS, A. M. Phonological encoding and ideographic reading by the disconnected right hemisphere: two case studies. *Brain Lang.* **14**, 205–234, 1981.