HEMISPHERIC SUPERIORITY IN REACTION TIME TO FACES: A SEX DIFFERENCE[1]

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Introduction

In the course of studying the functional organization of the two cerebral hemispheres in humans, several authors have suggested that both spatial (Lansdell, 1962; Kimura, 1969; McGlone and Davidson, 1973; McGlone and Kertesz, 1973; Baken and Putnam, 1974) and verbal (Lansdell, 1961; Hannay and Malone, 1976; Lake and Bryden, 1976) cognitive processes may be more lateralized in men than in women. Other researchers using similar tasks have reported no sex difference in degree of lateralization (Bryden, 1965; Kimura, 1969; Ehrlichman, 1972; Borowy and Goebel, 1976) or have even proposed that some functions are more lateralized in women than in men (Buffery and Gray, 1972). The experimental findings of a sex difference in hemispheric specialization are inconsistent with observations that: (a) no clear sex difference has been apparent in the cognitive disturbances due to a temporary blocking of the function of one hemisphere for diagnostic or therapeutic reasons (Pratt and Warrington, 1972; Milner, 1976); and (b) neuropsychological tests for localizing brain damage on the basis of specific cognitive deficits are apparently as accurate in women as they are in men (Personal experience of one of the authors, H.A.B.; see also Vinken and Bruyn, 1969).

The discrepancy within the experimental literature, and between some experimental findings and the results of clinical or neuropsychological tests, may derive from the way the mechanisms are tested rather than from their degree of lateralization. That is, specialized cognitive mechanisms may be lateralized to the same extent in men and women, but their activation may

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depend on stimulus or experimental variables which affect the two sexes differently.

As evidence in support of this conjecture, we present here results of a reaction time experiment with face recognition.

Material and Method

Subjects

The subjects were sixteen University of Parma students; 8 male and 8 female. All were unaware of the purpose of the experiment and were right-handed on the basis of a standard questionnaire (Oldfield, 1971). They were paid a modest fee for participating.

Procedure

The basic experimental situation has already been described in detail (Rizzolatti, Umiltà and Berlucchi, 1971). The subjects learned during a practice session to recognize black and white photographs of 4 faces (see Rizzolatti, Umiltà and Berlucchi, 1971) which subtended 7° 30′ of visual angle and which were back-projected on a tangent screen. During 4 subsequent test sessions, the faces appeared one at a time at 5° to the left or right of a central fixation point and subjects had to press a key as quickly as possible following presentation of two of the faces ("positive" faces) while refraining from pressing when the other two faces were shown. The intertrial interval was about 5 sec. Each session consisted of four blocks of 5 practice — and 40 test — trials, each block containing one of the four possible combinations of visual field (left or right) and responding hand (left or right). The order of stimuli was quasi-random and the order of experimental conditions was balanced according to a latin square design. A warning signal preceded the stimulus by two sec. and apart from the practice session there was no feedback about accuracy or speed of response. The time taken from stimulus onset to key pressing was measured electronically in msec. and eye position was continuously monitored by closed circuit T.V.

In each session the median reaction time to each of the positive faces was calculated and the average of the two medians was found. This resulted in four means per session corresponding to the four combinations of visual field and responding hand, and these four means for each subject were averaged across sessions and used for data analysis.

Results

Figure 1A shows the results with stimulus presentation of 100 msec. An analysis of variance (Myers, 1966) taking as primary sources Visual Field, Hand, and Sex, showed that the only significant sources of variance were Visual Field ($F = 10.408$; d.f. 1, 14; $p < 0.01$) and Sex-Field Interaction ($F = 9.609$; d.f. 1, 14; $p < 0.01$).

Although these results suggested no hemispheric lateralization in this task for females, we still believed on the basis of the clinical evidence cited above that also in our experimental conditions a hemispheric difference should be demonstrable in females. Therefore we modified the task in such a way as to amplify the hemispheric difference in males, expecting thereby to bring into evidence a hemispheric difference in females as well. This was done by reducing the exposure time from 100 msec. to 20 msec. A new group of 8 male and 8 female students of the University of Parma was selected according to the same criteria as in the 100 msec. condition, and they were tested in the same way.

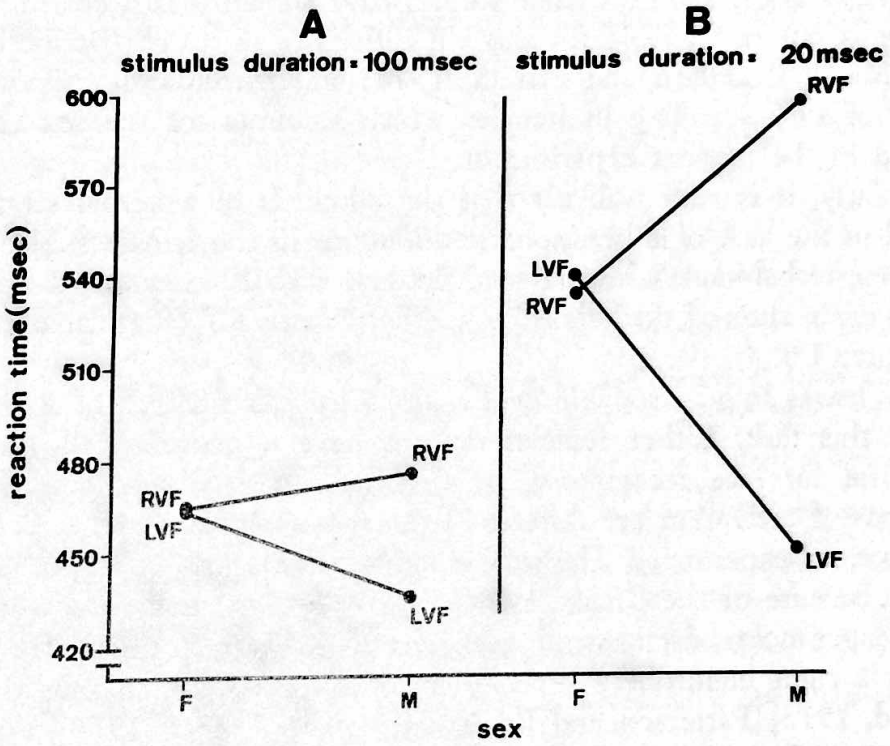

Fig. 1 — *Mean reaction times to faces presented for 100 msec. (A) and 20 msec. (B) to female (F) and male (M) subjects. RVF, right visual field presentation; LVF, left visual field presentation.*

Figure 1B shows that the hemispheric difference in males was markedly increased as compared with the 100 msec. condition, but that there was still no evidence of lateralization in the female subjects. An analysis of variance again showed a significant Visual Field effect ($F = 13.949$; d.f. 1, 14; $p < 0.005$) and a Sex-Field interaction ($F = 16.139$; d.f. 1, 14; $p < 0.005$). All males were faster when the stimulus was presented to the right hemisphere whereas there was no consistent hemispheric dominance among the females, and this lack of a consistent trend among the females was also reflected in their session-to-session performance. Six of them had a mixture of superiorities in the four sessions, sometimes the response to left visual field presen-

tation being faster, and vice versa. The other two subjects showed a consistent mild right visual field superiority. In contrast, all male subjects in every session showed a strong left visual field superiority.

Discussion

These data confirm the earlier findings that in male subjects the right hemisphere is superior to the left hemisphere in choice reaction time to physiognomic material (Rizzolatti, Umiltà and Berlucchi, 1971; Geffen, Bradshaw and Wallace, 1971). Earlier studies have shown that a possible bias in scanning is not responsible for the VF difference in males (Berlucchi, Brizzolara, Marzi, Rizzolatti and Umiltà, 1974) and therefore it cannot be the absence of such scanning in females which accounts for the sex difference observed in the present experiments.

Similarly, it is very unlikely that the adoption of a verbal strategy has resulted in the lack of a hemispheric difference in the female subjects, since even when verbal materials were used (letters) with 20 msec. exposure, female subjects again showed no hemispheric difference in RT (Rizzolatti and Buchtel, in prep.).

This leaves two reasonable explanations for our findings of a sex difference in this task. Either females do not have a neurologically lateralized mechanism for face recognition, or they have such a mechanism but the conditions of activation are different from those of males and were not met in the present experiment. The second explanation seems more probable than the first because of the clinical evidence already cited and because there are a few experiments demonstrating that with other experimental conditions there *is* a right hemisphere superiority for faces in normal female subjects (Hilliard, 1973; Patterson and Bradshaw, 1975; Teuber, 1976; Young and Ellis, 1976). The experimental procedure in these latter experiments usually involves a double presentation and therefore longer total exposure of the stimulus material and one may hypothesize that the lateralized mechanisms in females requires more information than that of males in order to be activated (This hypothesis is difficult to test using a single presentation of a lateralized image since one must keep presentation time below the latency of eye movements). If these temporal and informational conditions are not met, it appears that each hemisphere alone is still capable of analysing physiognomic material, although this is done more slowly and somewhat less accurately than by the specialized mechanism located in the right hemisphere. (Although errors were few, between 10-15%, and there was considerable variability from subject to subject, the males tended to make fewer errors than females, and the male right hemisphere was the most accurate of all). Consistent with this conclusion is the fact that true

prosopagnosia, as distinct from a subtotal deficit in face recognition following right hemisphere damage (De Renzi and Spinnler, 1966; Warrington and James, 1967; Benton and Van Allen, 1968; Tzavaras, Hécaen and Le Bras, 1970). is probably found only with bilateral cerebral damage (Meadows, 1974).

Summary

In males but not females, reaction time to faces is faster when stimuli are presented to the right hemisphere than when presented to the left hemisphere. The complete lack of a hemispheric difference in females suggests that with brief exposure and immediate judgement, a lateralized mechanism specialized for faces can be activated only in males.

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