Dimensions important to the hearing subjects provide clues to the natural visual categories into which the sign movements fall. Apparently, repetition of movement, plane of movement, degree of arcness, and direction of movement are salient psychophysical properties to observers for whom these stimuli are not part of a phonological system. These natural visual categories are of different perceptual salience, however, to deaf signers who have acquired ASL as a first and primary language. The difference in perception of sign movement is dramatically illustrated by the complete separation of the groupings of deaf and hearing subjects (Fig. 2B). The differences between deaf and hearing subjects (Fig. 2A) indicate that some psychophysical dimensions (for example, repetition) are more perceptually salient to deaf subjects, whereas others are less so. Thus, experience with a visual-gestural language can modify natural visual categories for some meaningless formational elements of ASL. Whether forms acquire distinctiveness or similarity remains to be investigated. However, effects of linguistic experience on natural perceptual categories are modality-independent consequences of language acquisition, whether spoken or signed.

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Sex Differences in the Effects of Unilateral Brain Damage on Intelligence

Abstract. *A sexual dimorphism in the functional asymmetry of the damaged human brain is reflected in a test-specific laterality effect in male but not in female patients. This sex difference explains some contradictions concerning the effects of unilateral brain damage on intelligence in studies in which the influence of sex was overlooked.*

For some 30 years neuropsychologists have reported contradictory findings concerning deficits in performance on the intelligence tests of patients who have suffered unilateral brain damage. Investigators such as Andersen (*1*) found that left hemisphere damage significantly reduces scores on verbal tests and right hemisphere damage significantly reduces scores on nonverbal tests; we call this the positive case of the test-specific laterality effect. Other investigators such as Reitan (*2*) reported a significant effect only in the case of left hemisphere damage on verbal test scores; this is an example of the equivocal case. Still others, such as Smith (*3*), failed to find any differential effects of lateralized brain damage on either verbal or nonverbal cognitive test performance; this we call the negative case. Some of these apparent contradictions can be resolved by taking the sex of the patients studied into account. This has not been the practice, with the exception of some work by Lansdell (*4*).

McGlone (*5*), however, reported that only the male patients in her studies showed a significant lateralized effect of brain damage, those with left hemisphere damage being impaired on the Verbal Scale and those with right hemisphere damage being impaired on the Performance Scale of the Wechsler (*6*) intelli-

Table 1. The composition of the patient groups in the positive and equivocal or negative cases of the test-specific laterality effect of brain damage.

References	Male patients		Female patients	
	Left lesion	Right lesion	Left lesion	Right lesion
Positive cases				
Andersen (*1*)	15	15	0	0
Klove and Reitan (*7*)	19	28	3	8
Klove (*8*)	33	33	9	4
Fitzhugh, Fitzhugh, Reitan ("current" cases) (*9*)	15	21	3	4
Fields and Whitmyre (*10*)	18	23	0	0
Total	100	120	15	16
Equivocal or negative cases				
Meyer and Jones (*11*)	11	5	9	6
Fitzhugh, Fitzhugh, Reitan ("chronic" cases) (*9*)	7	12	13	13
Klove and Fitzhugh (*12*)	12	19	12	16
Fitzhugh and Fitzhugh (*13*)	14	11	14	13
Dennerll (*14*)	11	22	18	9
Meier and French (*15*)	8	14	7	11
Zimmerman, Whitmyre, Fields (*16*)	23	31	0	0
Reitan and Fitzhugh (*17*)	15	15	0	0
Todd, Coolidge, Satz (*18*)	45	27	23	19
Total	146	156	96	87

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gence test. The female patients did not show selective deficits on these scales after comparable brain damage in one cerebral hemisphere or the other.

In light of McGlone's results, we investigated two possibilities. First, in those cases in which significant verbal and nonverbal deficits have been reported in groups with left and right brain damage, respectively (that is, in the positive case), there should be many more male than female patients. Conversely, in studies with either equivocal or negative outcomes there should be a greater proportion of female patients; because the test results obtained from women with brain damage do not show lateralized effects, they would mask the trends found in men.

Many investigators in this area neglected to describe the sex distribution of their patient groups. Table 1 shows the composition of positive studies (*1, 7–10*) and of equivocal and negative studies (*9, 11–18*) for cases in which the sex of the patients was reported. This tabulation bears out our first expectation. With only two exceptions (*16, 17*), the balance of the sexes is quite different in the two groups, with a much greater ratio of male to female patients in the group of positive cases.

The second possibility we investigated was that the data from studies with equivocal and negative outcomes would show test-specific laterality differences between the male patients with left and right hemisphere damage if test results were reexamined. We carried out such an analysis for cases of left- and right-sided temporal lobectomy reported by Meyer and Jones (*11*). They had tested patients on the Wechsler-Bellevue scales (*19*) 1 week before and 1 month after temporal lobectomy and found that only the patients with left-sided temporal lobectomy showed a significant deficit on the Verbal Scale. Although these authors did not examine the influence of sex, they specified the sex of each patient as well as the individual test results both before and after surgery. We reanalyzed their data for differences by sex by calculating the expected postoperative IQ scores on form 2 of the Wechsler for each patient, using that patients' preoperative scores from form 1. These calculations are based on the test-retest regression data provided by Gibby (*20*) and Gerboth (*21*). The differences between the expected scores and the scores actually obtained by the patients upon retesting were then tabulated, taking into account both the sex of the patient and the laterality of the surgical lesion (Table 2).

The male patients with left-sided brain lesions showed a statistically significant deficit in Verbal Scale IQ (VSIQ), and right-sided lesions produced a statistically significant Performance Scale IQ (PSIQ) deficit in the men. No such patterns are apparent in the data from the female patients. Women with left hemisphere damage in this study suffered a statistically significant decline on both the Verbal and the Performance scales, but these postoperative deficits were not test-specific. The women with right-sided brain lesions did not show a statistically significant change on either scale.

Using data from studies in Table 1 (*7–9, 11, 13–18*) as well as McGlone's data (*5*), we plotted the actual values of the differences between VSIQ and PSIQ against the percentage of males in each group with either right or left hemisphere brain damage (Fig. 1). We omitted those studies that did not provide the actual discrepancies between Verbal and Performance scale scores.

This distribution (*22*) (Fig. 1) represents a rank-order correlation of + 0.51 ($P < .01$) between the magnitude of the discrepancy scores and the percentage of men in each group. Such a high degree of correlation is striking in view of the great heterogeneity of the groups of patients under consideration.

Bryden (*23*) and McGlone (*24*), who reviewed studies on sex-related differences in cerebral organization, including studies of dichotic listening, tachistoscopic perception, and sensorimotor performance, concluded that sex-related differences in the functional asymmetry of the human brain do exist, but neither reviewed the results of the studies described in this report.

We believe that the studies we examined, upon reanalysis, unequivocally support McGlone (*5*) insofar as they confirm that lateralized brain lesions produce very different effects on the intelligence test scores of men and women. Our data further demonstrate that such sex differences influenced the results of earlier investigations. These findings indicate the need for the reevaluation of

Table 2. Mean discrepancies between expected and actual postoperative Verbal Scale and Performance Scale IQ's and their associated standard errors (S.E.). Negative scores indicate a deficit; **P .01; *P .05; N.S., not significant. [Data from (*11*)]

Scale	Male patients				Female patients			
	Left lesion (N = 11)		Right lesion (N = 5)		Left lesion (N = 9)		Right lesion (N = 6)	
	$\bar{X}$	S.E.	$\bar{X}$	S.E.	$\bar{X}$	S.E.	$\bar{X}$	S.E.
VSIQ	−10.73**	3.20	−3.40 (N.S.)	3.50	−12.00**	3.48	+7.00 (N.S.)	3.02
PSIQ	−4.64 (N.S.)	2.25	−5.80*	2.01	−12.89*	3.90	+2.67 (N.S.)	2.95

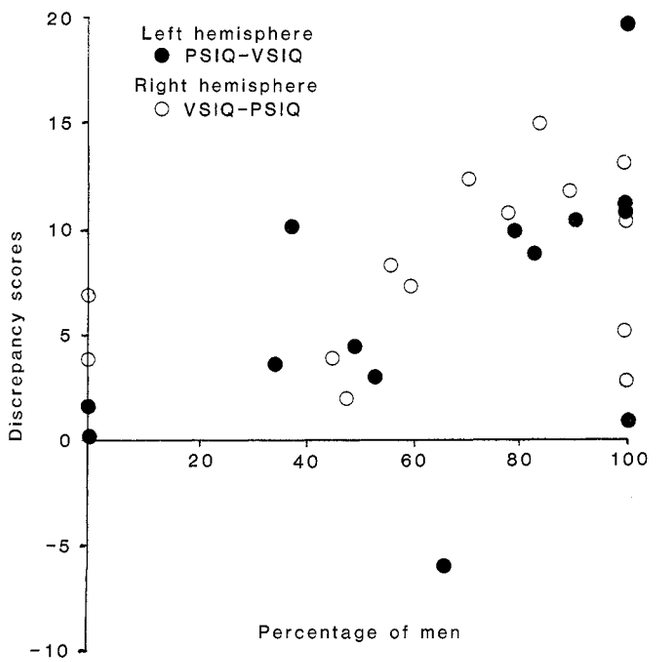

Fig. 1. Scattergram of Verbal Scale IQ and Performance Scale IQ discrepancy scores for cases of left hemisphere brain damage (*PSIQ − VSIQ*) and right hemisphere damage (*VSIQ − PSIQ*).

much of the work on the cognitive effects of unilateral cerebral damage as well as the need for future investigations to take into account the sex of the patients studied.

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"Self-Awareness" in the Pigeon

Abstract. *Each of three pigeons used a mirror to locate a spot on its body which it could not see directly. Although similar behavior in primates has been attributed to a self-concept or other cognitive process, the present example suggests an account in terms of environmental events.*

The chimpanzee has been said to show signs of "self-recognition," "self-awareness," and a "self-concept" because it can use a mirror to locate an object on its body which it cannot see directly (*1, 2*). According to Gallup (*1*), four chimpanzees showed a variety of self-directed behavior after having been exposed to a large mirror for several days. After 10 days of exposure (approximately 80 hours), "self-awareness" was tested as follows. A chimpanzee was anesthetized and a red odorless dye was painted onto the top of an eyebrow ridge and the upper half of an ear. After recovering from the anesthesia, the animal was observed in the absence of a mirror for 30 minutes and in its presence for 30 minutes. There were few "mark-directed responses" during the first period and between four and ten such responses during the second.

After hundreds of hours of exposure to mirrors, primates other than man and the great apes have shown no such self-directed behavior. This has been said to indicate a "qualitative psychological difference among primates" (*3*). Monkeys fail the task reportedly because they "lack a cognitive category that is essential for processing mirrored information about themselves." More specifically, they are said to lack "a sense of identity" and "a sufficiently well-integrated self-concept" (*4*).

We have found that a pigeon (*Columba livia domestica*) is also capable of using a mirror to locate an object on its body which it cannot see directly, and we offer a nonmentalistic account of this behavior. The subjects were three adult male White Carneaux pigeons, each of which had had a variety of laboratory experience but no previous exposure to mirrors. The pigeons were maintained at about 80 percent of the weight they achieve when feeding without restriction. Sessions up to 2 hours in length were conducted daily in a small (32 by 36 by 42 cm) chamber. A mirror (34 by 21 cm) was positioned about 4 cm behind the right-hand wall, which was made of clear Plexiglas. Blue dots could be presented from behind three openings in the left-hand wall, which was painted white. A dot could also be presented from behind one opening in the rear wall, which was painted gray and white. The pigeon could be given access to mixed grain through an opening in the center of the left-hand wall. The Plexiglas front allowed us to see the bird at all times. We could also insert a clear rod, at the end of which was a blue dot, through a gap at the base of the front of the chamber. We used the rod to present dots at various positions on the left wall and floor of the chamber.

Two repertoires were established over a 10-day period. First, with the mirror concealed, we placed small (1-cm-diameter) blue stick-on dots one at a time on the wings, breast, neck, and abdomen of the bird. We shaped movements of the head toward the dots and then reinforced pecks at them on a rich variable-ratio schedule (between one and five pecks had to occur before food was presented). Having pecked at dots placed in a number of different positions, the pigeon would readily scan its body, locate a dot, and peck it.

Second, with the mirror exposed, we reinforced pecks at blue dots presented one at a time on the left and rear walls and the floor of the chamber. After a few minutes of such training, we presented a dot only briefly and reinforced pecks at the spot where it had been. Finally, a dot was flashed only when the pigeon could see it in the mirror. Food was presented if it then turned and pecked the place where a dot had been flashed. The pigeon now readily faced the mirror and responded appropriately to certain visual stimuli that appeared in it by turning and pecking the corresponding position in real space. Dots were never placed on its body during this condition.

The two repertoires were established in only 3 or 4 hours. The animals were exposed to the mirror for less than 15 hours over the 10-day training period.

We then conducted the following test. A blue dot was placed on the pigeon's breast and a white bib (note that the birds were white) was placed around its neck in such a way that, with the pigeon standing fully upright, we could just see the dot. The bib made it impossible for the bird to see the dot directly. If it lowered its head even slightly, the bib covered it (Fig. 1, A and B). In a control condition (3 minutes for one subject and 5 minutes for the others), the pigeon was placed in the chamber with the mirror covered. If the pigeon could see the dot or locate it using tactile cues, it presumably would peck it at this point. None of the subjects did so. When we uncovered the mirror, each pigeon approached it and, within a few seconds, began repeatedly moving its head downward toward the position on the bib that corresponded to the dot (Fig. 1, C and D). The second