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A Reanalysis of Gender Differences in IQ Scores Following Unilateral Brain Lesions

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Meta-analyses of gender differences in the consequences of unilateral brain lesions have reported a positive correlation between the percentage of men in studies and the magnitude of the difference between Verbal and Performance IQ. Such findings are limited by both the indirectness of the methodology and the focus on V–P differences rather than on the separate effects of brain lesions on VIQ and PIQ. We conducted a repeated-measures analysis of studies that reported separate VIQ and PIQ means for men and women with unilateral lesions. Women showed lower IQ scores following lesions to the hemisphere thought to be nondominant for each function.

Gender differences in the effects of unilateral brain lesions on intellectual performance have been observed for more than 25 years (Lansdell, 1962). Male patients appear to experience greater lateralized intellectual deficits following unilateral lesions, as measured by greater discrepancies between Verbal and Performance IQ scores. Such a gender difference is potentially important because of its implications for fundamental questions of functional brain organization in men and women, and because differences between VIQ and PIQ have been used as psychometric signs of lateralized brain damage (e.g., Lawson & Inglis, 1983).

This gender difference has received renewed attention since Inglis and Lawson (1981, 1982) reported a correlation of 0.48 between Verbal–Performance (V–P) discrepancy and the percentage of men included in 18 samples from 16 different studies. Inglis and Lawson's meta-analysis was replicated, using additional samples, by Bornstein and Matarazzo (1982), Bornstein (1984), and Snow, Freedman, and Ford (1986).

The unusual meta-analytic methodology of correlating V–P discrepancies with the percentage of male subjects in each study was necessitated by the paucity of studies reporting Verbal and Performance IQs separately for male and female subjects. More recently, Kaufman (1990) identified a sample of eight studies that reported V–P discrepancies separately for male and female subjects. In patients with right hemisphere lesions, V–P differences were twice as large in male as in female subjects. In male patients with left hemisphere lesions, mean PIQ was higher than the mean VIQ, whereas in female patients with left hemisphere lesions the mean PIQ was slightly higher.

We believe another brief examination of this literature is warranted. There are now 12 studies that have reported eight separate means for Verbal and Performance IQ in male and female patients with left and right hemisphere lesions. Analysis of these studies will allow gender differences to be studied with greater precision than was possible with the useful but indirect method of correlating study means with percentages of male patients. Moreover, all previous reviews have focused on V–P differences, which may obscure the most basic results of the studies. Effects of lesions on V–P differences are determined by the potentially independent effects of left and right hemisphere lesions on both Verbal and Performance IQ (Humphreys, 1990). Kaufman (1990) has endorsed V–P difference scores as a method for controlling methodological and sampling differences among studies that might result in substantial study effects (i.e., Verbal and Performance IQ would both be relatively high in some studies and relatively low in others). There are, however, more powerful methods of accounting for study effects that do not obscure separate effects on Verbal and Performance IQ. The current report uses repeated-measures analysis of variance as an alternative to analysis of V–P differences.

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Method

Studies included in this meta-analysis were obtained from a comprehensive search of a computerized database and from references in previous meta-analyses. Criteria for inclusion were the following: Wechsler IQ data reported in raw score or scaled score form; number of subjects reported in each of four groups (male and female, left and right hemisphere lesions); IQ score reported separately for male and female patients in the left and right hemisphere groups; and absence of patients with bilateral lesions. The studies included subjects with a variety of etiologies of brain damage, including cancer, epilepsy, surgery, stroke, and trauma. If subtest scaled scores were the only data reported, at least two subtests for both VIQ and PIQ were required, as well as the subjects' ages, to permit calculation of IQs from scaled scores. The 12 studies meeting inclusion criteria are listed in Table 1.

The dependent variable in the meta-analysis was IQ, which was analyzed as a function of three dichotomous independent variables: gender, hemisphere of lesions, and type of test (Verbal or Performance). Accordingly, eight mean IQs were included for each of the 12 studies. All but one of the correlations among the eight means were positive, suggesting that a substantial study effect is present (Kaufman, 1990). Therefore, a repeated-measures analysis of variance was performed. Such an analysis fits a model containing a grand mean for all studies, an individual mean for each study, three main effects of the repeated measures (gender, laterality, and test), three two-way interactions, and a three-way interaction. Our primary hypothesis was that a

Table 1
Mean Verbal IQ (VIQ) and Performance IQ (PIQ) Scores for 12 Studies

		Men				Women				Etiology			
		Left		Right		Left		Right					
Study	*n*	VIQ	PIQ	VIQ	PIQ	VIQ	PIQ	VIQ	PIQ	1	2	3	4
Anderson et al. (1990)	22	92.6	89.6	100.8	89.6	94.0	90.7	92.3	90.8	15	0	7	0
Bornstein (1984)	63	83.2	88.2	93.4	82.9	80.8	86.3	89.3	78.3	17	0	25	10
Herring & Reitan (1986)	96	87.0	97.0	106.0	95.0	98.0	103.5	93.0	94.0	62	0	34	0
Inglis et al. (1982)	80	84.1	99.4	107.4	87.8	89.8	89.6	100.9	96.4	0	0	80	0
Kimura & Harshman (1984)	270	96.8	97.5	104.6	91.5	99.6	99.4	98.8	94.1	—	—	—	—
McGlone (1977)	92	87.1	110.3	98.9	99.1	98.0	94.5	97.4	94.0	30	0	62	0
Meyer & Jones (1957)	31	86.7	97.5	97.4	94.2	80.4	82.3	109.5	102.5	—	—	—	—
Snow & Sheese (1985)	45	104.0	90.1	103.9	84.1	97.2	89.2	101.5	78.8	0	0	45	0
Sundet (1986)	83	93.3	91.7	106.8	93.4	91.6	93.9	101.5	98.4	22	24	27	10
Warrington et al. (1986)	65	96.9	103.4	109.2	96.9	91.0	93.5	102.8	91.4	389	0	163	0
Whelan & Walker (1988)	64	97.2	94.5	104.5	94.1	87.3	86.5	102.2	88.3	48	16	0	0
Yeo et al. (1984)	72	83.9	88.1	103.5	80.2	83.4	77.1	94.2	91.8	14	0	51	7
M		91.1	94.6	104.0	90.3	91.0	90.8	99.3	90.7				
SD		6.7	5.0	4.8	5.4	6.9	7.4	5.3	7.7				

Note. Dashes indicate that etiologies were not reported. Etiology 1 = cancer; Etiology 2 = epilepsy; Etiology 3 = stroke; Etiology 4 = trauma.

three-way interaction, indicating gender effects on the difference between the effects of left and right hemisphere lesions on VIQ and PIQ, would be present. The analysis was conducted both unweighted and by weighting each study by its sample size. The results were highly similar, so only the unweighted analysis will be reported.

Table 1 shows the means for each study and the overall means and standard deviations.

The repeated-measures analysis revealed a significant main effect for laterality ($p < .008$): Across genders and tests, left hemisphere lesions produced greater deficits ($M = 91.9$) than did right hemisphere lesions ($M = 96.1$). The main effect for gender was also significant ($p < .03$): Across tests and laterality, female patients had lower IQs than did male patients (*M*s = 92.9 and 95.0, respectively). Finally, the mean effect of test was significant ($p < .004$), with the mean VIQ equal to 96.3, compared with a mean PIQ of 91.6 across genders and laterality.

The interaction between test and side was also significant, as expected ($p < .0001$). Left hemisphere lesions produced greater VIQ than PIQ deficits, whereas right hemisphere lesions produced greater PIQ than VIQ deficits.

Finally, the three-way interaction among test, laterality, and gender was significant ($p < .02$). Figure 1 illustrates the interaction. Male and female patients showed roughly equal scores on VIQ following left hemisphere lesions, but female patients with left hemisphere lesions had lower PIQ scores. Male and female patients with right hemisphere lesions had roughly equal PIQ scores, but female patients had lower VIQ scores.

Discussion

Like previous reviews of this literature, we found smaller V–P differences in female than in male subjects following unilateral lesions. Analysis of V–P differences does not provide a complete account of studies of Verbal and Performance IQ following left and right hemisphere lesions, however. The pattern of results in the current meta-analysis suggests that the gender effect on V–P differences results from distinct effects of lateralized lesions on VIQ and PIQ. Left hemisphere lesions produce substantial and roughly equal VIQ deficits in male and female patients, but lower mean PIQ scores in female than in male patients; right hemisphere lesions produce PIQ deficits in both genders, but lower mean VIQ scores in female patients. The primary effect, therefore, appears to be that female patients are more sensitive to lesions in the hemisphere opposite to that thought to be "dominant" for a function.

This account is consistent with earlier reports in that it predicts greater V–P differences in male patients, but previous investigations have usually explained the V–P difference finding in terms of greater sensitivity in male patients to lesions to the dominant hemisphere (McGlone, 1980). Our analysis of means, however, shows no difference between male and female patients in the effects of left hemisphere lesions on VIQ or right hemisphere lesions on PIQ.

The pattern of results, with brain-damaged female patients showing lower mean IQ scores across tests and hemispheres, in addition to lower mean scores following lesions to the hemisphere opposite to the "dominant" hemisphere for each function, is consistent with a model positing a greater degree of bilateral processing in women. Such a gender difference could result from differences in the degree of hemispheric lateralization (McGlone, 1980), from differences in problem-solving strategy (Inglis & Lawson, 1982), or from differences in callosal function (Witelson, 1989).

It should be emphasized that although gender differences in brain-damaged populations can be used to make inferences about the functional organization of male and female brains, the slightly lower mean IQ scores in brain-damaged female patients do not imply that similar "deficits" exist in normal subjects. Instead, the gender differences in brain-damaged populations suggest that, on average, "normal" male and female subjects use somewhat different approaches to solving IQ items, a difference that may be determined in part by differences in brain organization.

Several limitations of the analysis should be mentioned. The sample of studies included was small, so the statistical power of

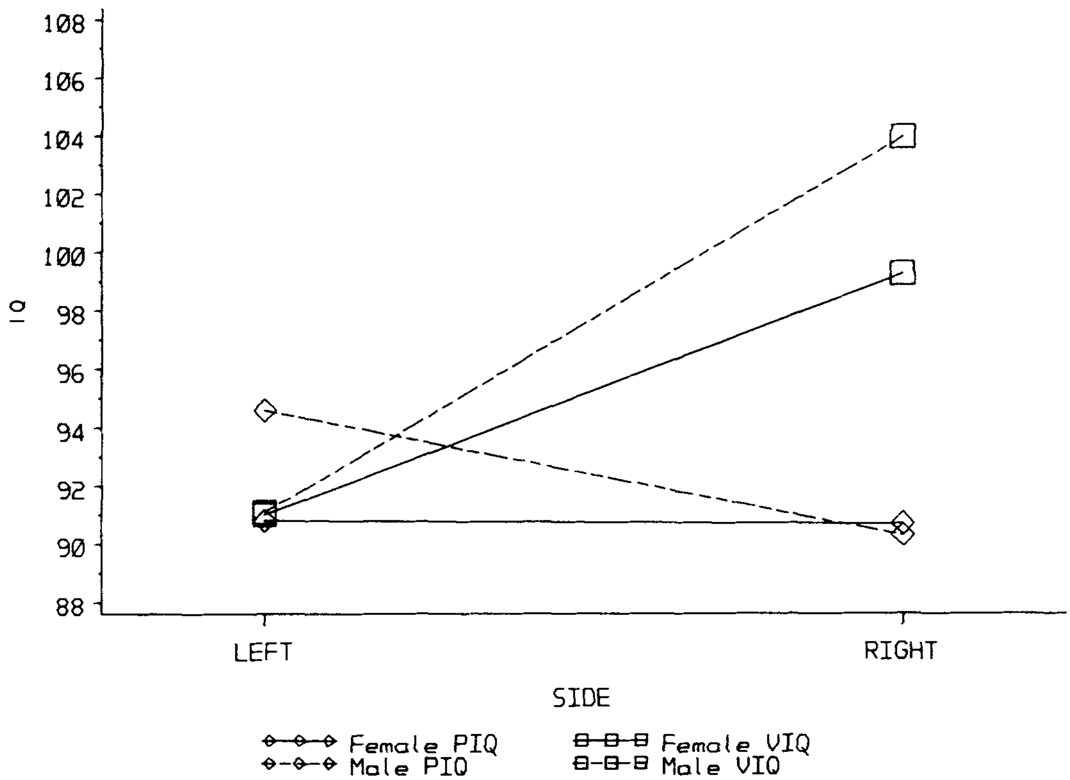

Figure 1. Plot of the interaction between laterality and IQ in men and women. (PIQ = Performance IQ; VIQ = Verbal IQ.)

our analyses was low. This consideration does not affect confidence in our significant results, but negative findings must be interpreted with caution. The studies included varied on a wide range of variables, including potentially important determinants of outcome such as lesion etiology and age of subject. Previous meta-analyses have not shown such variables to produce systematic effects on study outcome, however.

Other cautions follow from limitations in the original empirical studies. The most crucial of these concerns premorbid IQ scores, which are usually unknown in studies of brain-damaged populations. Attributions of postlesion differences in level or pattern of IQ scores to differences in functional brain organization assume that groups had equal mean IQs before their injury, without systematic differences in VIQ–PIQ patterns. There is little reason to expect gender differences in mean VIQ and PIQ in normals, because the standardization of the instrument was designed to prevent them (Wechsler, 1981); a careful examination of the standardization sample of the WAIS-R (Matarazzo, Bornstein, McDermott, & Noonan, 1986) failed to reveal any gender differences in VIQ–PIQ discrepancies. In the current analysis, we found no differences between male and female subjects for either age (male, $M = 46.7$; female, $M = 48.8$, $n = 9$ studies) or education (male, $M = 11.3$; female, $M = 11.1$, $n = 7$ studies), two variables that might be expected to be associated with premorbid IQ differences.

Studies of group differences in lesion effects have also assumed that there are no systematic group differences in lesion volume or intrahemispheric location. We have proposed statistical methods for lesion analysis (Turkheimer, Yeo, Jones, & Bigler, 1990) that permit inferences about functional organization without assuming equality of lesion volume or location. Recently, we have applied this method to lesion data in a brain-damaged population of men and women (Turkheimer, Farace, Yeo, & Bigler, 1992).

Future studies could do a great deal to clarify this small but reliable gender difference. Most previous studies have been retrospective, based on clinical testing of patients who may have been selected for unknown characteristics related to IQ. A prospective study of a consecutive series of pretested patients would be extremely useful. The wide availability of brain-imaging procedures such as computerized tomography (CT) and magnetic resonance imaging (MRI) allow lesion parameters to be measured with much greater accuracy. Most studies have only included information about the hemisphere of lesions, ignoring lesion size and intrahemispheric location, both of which may be important determinants of deficit (Turkheimer et al., 1990).

Finally, the WAIS-R is probably not an ideal measure for the study of this phenomenon. The Wechsler scales have been widely studied, not because of their theoretical suitability for the study of either gender or hemispheric differences but because IQ tests are widely available in clinical populations. Indeed, when the WAIS-R was developed, any items showing gender differences were omitted. Performance IQ reflects attentional and motoric abilities that would probably not be included in a more specific measure of right hemisphere function.

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