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Quantitative Analysis of Gender Differences in the Effects of Lateralized Lesions on Verbal and Performance IQ

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Previous studies and meta-analyses have demonstrated that males have larger differences between Verbal IQ (VIQ) and Performance IQ (PIQ) following unilateral brain lesions. Several theories have been proposed as an explanation of this finding, including a greater degree of functional lateralization in males, gender differences in the organization of language centers within the left hemisphere, and differences in problem-solving strategy for PIQ. We apply quantitative methods for analysis of relations between lesion location and behavior to a sample of 64 males and females with unilateral brain lesions. Statistical tests conducted in LISREL-VII suggest that in females, a single model can describe the relationships between lesion location and VIQ and PIQ, with left-hemisphere lesions producing more severe deficits on both measures. In males, separate models of the relationships between lesion location and VIQ and PIQ are required.

Gender differences in the effects of unilateral lesions have been described since Lansdell (1962). Although sometimes viewed in the clinical context of the interpretation of intelligence test profiles (Lawson & Inglis, 1983), in recent years the study of gender differences in structure and function of brain organization has expanded rapidly and become more concerned with the basic scientific issue of gender differences in the functional asymmetry of the cerebral hemispheres (e.g., McGlone, 1980; Witelson, 1989, 1991a, 1991b).

Two major findings were suggested by early studies. Subjects with left-hemisphere lesions have smaller Verbal IQ (VIQ) minus Performance IQ (PIQ) score (VIQ - PIQ) differences than subjects with right-hemisphere lesions, and this difference is greater for males than for females.

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Inglis and Lawson (1981) were the first to use meta-analytic techniques to establish the gender difference in VIQ — PIQ difference scores more generally. Others (Bornstein & Matarazzo, 1982; Kaufman, 1990; Snow, Freedman, & Ford, 1986; Turkheimer & Farace, 1992) have replicated Inglis and Lawson’s analysis as new studies have become available.

Although several recent studies (Bornstein, 1984; Herring & Reitan, 1986; Snow & Sheese, 1985; Whelen & Walker, 1988) have reported negative findings, the meta-analyses cited before have included these negative studies yet continue to show a small but statistically significant effect. It should also be noted that the statistical power of the negative studies has been somewhat limited.

A power analysis of these studies was calculated using the procedures of Cohen (1988) estimating a medium effect size ($f = .25$). A three-way interaction in an analysis of variance design (Gender × Side of Lesion × Type of IQ Test) was performed. Bornstein (1984) had 50% power, Herring and Reitan (1986) had 54% power, Snow and Sheese (1985) had 43% power, and Whelen and Walker (1988) had 50% power to show a true negative result. The relatively small power in all four studies limits confidence in negative findings.

Although we believe that a small but reliable gender difference in the sequelae of unilateral brain lesions has been established, a great many methodological and substantive problems remain. Several of these follow from the difficulty of measuring lesion location in a way that permits sophisticated statistical analysis. Studies that simply compare left- and right-hemisphere lesions, for example, ignore within-hemisphere variation in lesion volume and location (Turkheimer, Jones, Yeo, & Bigler, 1990). Apparent hemispheric differences could result from systematic differences in lesion volume either between the hemispheres or between males and females. Lesion distribution may also vary within hemispheres, and any effects of lesion location within hemispheres cannot be detected by a simple left versus right classification. As Turkheimer (1989) suggested, inferring patterns of localization of function from naturally occurring lesions presents difficult methodological problems. Naturally occurring lesions, especially those detectable on computed tomography (CT) or magnetic resonance imaging (MRI), are large, irregularly shaped, unevenly distributed in the brain, and rarely restricted to single brain structures.

The question of why gender differences occur in the effects of lateralized lesions has not been resolved. At least three major hypotheses have emerged:

1. The lateralization hypothesis suggests that the gender difference reflects a greater degree of functional lateralization in males, who are therefore more susceptible to verbal deficits following left-hemisphere lesions and nonverbal deficits following right-hemisphere lesions (McGloon, 1977).

2. The within-hemisphere hypothesis suggests that the gender difference is a consequence of the intrahemispheric organization of the left hemisphere, with female speech areas more localized in the anterior portions of the hemisphere (Kimura, 1983).

3. The PIQ hypothesis suggests that the gender difference results from a tendency for females to experience greater PIQ deficits than males following left-hemisphere lesions. Inglis and Lawson (1982) attributed this finding to gender differences in problem-solving strategy, although, as will be discussed later, we do not believe such an explanation is the only one supported by available data.

The existence of gender-related differences in the sequelae of unilateral brain lesions, combined with recent reports of sexual dimorphisms in cerebral morphologies (Witelson, 1991a), suggest that the question of how naturally occurring lesions affect intellectual ability in males and females deserves study in much greater detail. Previously, Turkheimer et al. (1990) described a quantitative method for analysis of covariation between locations of naturally occurring brain lesion and psychometric test scores. In this article, we apply this method to the problem of gender differences in VIQ and PIQ following unilateral lesions.

**METHOD**

**Subjects**

Archival data were obtained for 64 patients examined in a neurological clinic who met the following criteria:

1. A CT scan had been performed;
2. A lesion was visible on the scan and was limited to one hemisphere;
3. The Wechsler Adult Intelligence Score (WAIS; Wechsler, 1955) had been administered;
4. The patient was right-handed;
5. The patient was over 15 years of age; and
6. The patient had no history of psychiatric disorder or drug abuse.

The sample included 33 males, 17 with right-hemisphere lesions and 16 with left-hemisphere lesions, and 31 females, 20 with right-hemisphere lesions and 11 with left-hemisphere lesions. The mean age was 55 years (range = 17–79). Of the 60 subjects from whom information on education was available, 13 had less than a high school degree, 25 had a high school degree only, 9 had some college education, 9 had a college degree only, 1 had some graduate education, and 3 had graduate degrees. Etiologies consisted of stroke, tumor, focal trauma, and abscess.

**CT Analysis**

CT scans were placed on a light box, and the outer perimeter of the cortex and the lesioned area on each slice were traced onto tracing paper. Slices were then
A behavioral measure such as an IQ score is posited to have a latent importance function that defines the importance of each point in the brain to the behavioral measure. For any point \((x, y, z)\), high values of the importance function indicate that the point is important to the behavioral measure, and low values indicate that the point is unimportant. According to the model, the expected deficit for each subject is equal to the integral of the importance function over the lesioned area of the brain. An integral of a function over a region is essentially a sum of the values of the function in the region. Subjects with large deficits in important regions will thus have large expected deficits, whereas subjects with small lesions in unimportant regions will have small expected deficits. In a study of the relationship between lesion location and a measure of behavior, one is given the extent of each subject's lesion and a score measuring each subject's behavior. The goal is to use this information to derive the latent importance function for the measure of behavior.

Suppose the importance function for a measure is represented by a cubic polynomial, \(I(x, y, z)\), of the form,

\[
I(x, y, z) = b_1 x^2 + b_2 y^2 + b_3 H(x) + b_4 y + b_5 xy + b_6 xy + b_7.
\]

The third term in the importance function, \(H(x)\), takes a value of \(-1\) for negative values of \(x\) (in the left hemisphere) and \(+1\) for positive values of \(x\). It is included to code for mean differences in importance between the hemispheres.

The expected deficit \(D_n\) for each subject \(n\) is equal to an intercept minus the integral of \(I(x, y, z)\) over the lesioned volume, \(L_{(n)}\):

\[
D_n = b_8 - \int_{L_{(n)}} I(x, y, z). \tag{2}
\]

On each slice, the lesioned area is estimated as a rectangle extending from \(x_1\) to \(x_2\) along the left–right dimension and from \(y_1\) to \(y_2\) along the anterior–posterior dimension, so the integral on each slice equals:

\[
\int_{x_1}^{x_2} \int_{y_1}^{y_2} I(x, y, z) dx \; dy. \tag{3}
\]

If \(I(x, y, z)\) is given by Equation 1, the definite integral in Equation 3 can be solved analytically, resulting in an equation that expresses subjects’ deficits as a linear function of known lesion parameters \((x_1, x_2, y_1, y_2, z)\) and the unknown parameters of the importance function \((b_1, b_2, b_3, b_4, b_5, b_6, b_7)\). The expected deficit for each subject is the value of these integrals summed over the \(k\) slices lesioned for each subject.
\[ D_n = \sum_{i=1}^{k} \left[ b_1 y_2(x_2 - x_1)(y_2 - y_1) + b_2 y_1(x_2 - x_1)(y_2 - y_1) + b_3 y_2(x_2 - x_1)(x_2 - x_1) \right] \]

The estimated IQ for a subject is equal to the intercept \( b_8 \) minus the expected deficit:

\[ IQ_n = b_8 - D_n. \]

Although Equation 4 appears formidable, estimating the parameters is actually a simple matter of linear regression. Each term of Equation 4 consists of a parameter to be estimated \( b_1 \) to \( b_7 \) multiplied by an expression in terms of the first, second, and third powers of the four observed lesion parameters \( x_1, x_2, y_1, y_2 \), summed over each of the \( z \) slices. For example, the first term consists of a parameter \( b_1 \) multiplied by the expression, \( b_1 y_2(x_2 - x_1)(y_2 - y_1) \). The latter expression may be calculated for each subject on each slice and summed over slices, resulting in a numerical variable for each subject. The same procedure may be followed for each of the other terms in Equation 4. The parameters \( b_1 \) to \( b_8 \) can then be estimated by regressing the observed IQ score on the computed variables.

LISREL-VII (Jöreskog & Sörbom, 1988) was used to estimate the parameters of the importance function. LISREL-VII is a computer program that estimates linear statistical relations (such as regressions) using maximum likelihood (as opposed to the more familiar least squares) estimation. Although LISREL-VII is often used for models involving unmeasured (latent) variables, all variables in our regression analysis were measured. The model in Equation 4 was estimated separately for VIQ and PIQ in males and females. We then used LISREL-VII to test the following set of hypotheses concerning theories of gender differences in the consequences of unilateral lesions.

The lateralization hypothesis suggests that the crucial gender difference is in the degree of functional difference between the left and right hemispheres, with males showing greater hemispheric differences. In the importance function fit to the data, only the term for \( H(x) \) produces a difference in mean importance between the hemispheres. Therefore, the lateralization model can be evaluated by testing whether the estimated coefficients for \( H(x) \) differ between the genders for either VIQ or PIQ. The within-hemisphere hypothesis suggests that the importance function for VIQ should differ between the genders, especially in terms representing the anterior–posterior axis. The PIQ hypothesis suggests that the importance functions for VIQ and PIQ should be similar for females, but not for males.

LISREL-VII was used for estimation because it makes testing of statistical hypotheses of equivalence of regression models across tests and groups relatively simple. In LISREL-VII, one can compare the fit of an unrestricted model in which all importance functions are independent to restricted models in which certain parameters are constrained to be equal across tests and groups. The decrement in fit resulting from the constraint can be expressed as a chi-square with degrees of freedom equal to the number of parameters constrained.

RESULTS

To examine the reliability of our method of measuring lesion location, we selected 10 scans to be reevaluated by an independent judge. We then used these measurements (total length and width of each slice, left–right and anterior–posterior extent of the lesions) to recompute the numerical terms of the regression in Equation 4. These terms were then correlated with those produced by the original measurements. All correlations were greater than .90, ranging from .91 (for anterior–posterior location) to .98 (for left–right location).

Figure 2 shows mean VIQ and PIQ scores for males and females with left- and right-hemisphere lesions. Table 1 gives the results of the four unconstrained LISREL-VII analyses. The first column gives the value of the intercept \( b_8 \) in

![Figure 2. Means of VIQ and PIQ for males and females with left- and right-hemisphere lesions.](image-url)
TABLE 1

Results of Unrestricted Regression Analyses

<table>
<thead>
<tr>
<th></th>
<th>Intercept</th>
<th>Observed M</th>
<th>Observed SD</th>
<th>R²</th>
<th>Lesion Effect</th>
<th>Residual SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIQ</td>
<td>103.8</td>
<td>96.2</td>
<td>21.1</td>
<td>0.33</td>
<td>-7.6</td>
<td>17.2</td>
</tr>
<tr>
<td>PIQ</td>
<td>90.6</td>
<td>84.5</td>
<td>16.3</td>
<td>0.40</td>
<td>-6.1</td>
<td>12.7</td>
</tr>
<tr>
<td>Females</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIQ</td>
<td>94.2</td>
<td>90.1</td>
<td>14.3</td>
<td>0.17</td>
<td>-4.1</td>
<td>13.1</td>
</tr>
<tr>
<td>PIQ</td>
<td>87.7</td>
<td>81.5</td>
<td>15.7</td>
<td>0.26</td>
<td>-6.2</td>
<td>13.5</td>
</tr>
</tbody>
</table>

n = 33.

The model. This is the IQ predicted by the model for a subject with no lesion. The next two columns give the observed means and standard deviations. R² is the percentage of observed variance explained by the model. The next column, lesion effect, gives the difference between the intercept and the observed mean, which is the estimated mean reduction in IQ resulting from the subjects’ lesions. The final column is the standard deviation of the residual errors. It should be noted that one would not expect the lesion model to account for all of the variance in IQ, because IQ varies in subjects without lesions. The mean residual standard deviation (the square root of the mean residual variance) is 14.2, which is close to the expectation of 15 for the Wechsler (1955) scales.

Table 2 shows observed and predicted means broken down for males and females with left- and right-hemisphere lesions, in order to examine how well the unrestricted models accounted for lateralized deficits. The first row of the table gives the observed mean IQ for each group, and the second row gives the predicted mean IQ for each group. The next row gives the intercepts in each model. As in Table 1, these intercepts represent the predicted score for a subject with no lesion. The next row, predicted lesion effect, is the difference between the intercept and the predicted mean. This value estimates the mean predicted effect of the lesions in each group. The next row, nonspecific lesion effect, is the difference between the intercept and the expected population mean of 100. Intercepts less than 100 indicate either the presence of lesion effects unrelated to lesion size and location, or premorbid IQs that were less than 100. The next row, error, is the difference between actual and observed means.

An examination of Table 2 reveals that the model accounted for most of the effects of left-hemisphere lesions on VIQ in both males and females. For example, the model for males with left hemisphere lesions had an estimated intercept of 103.8, and predicted a mean loss of 13.2 points resulting from the lesions, resulting in a predicted mean of 90.6; the actual mean was 87.9. Right-hemisphere lesions did not have any observable effect on mean VIQ in males; females with right-hemisphere lesions had a reduction in mean IQ that was not explained by the model. For PIQ, the model accounted for about half of the large mean deficits shown by males with right-hemisphere lesions and females with right-hemisphere lesions. The somewhat smaller deficits in left-hemisphere males and right-hemisphere females in mean PIQ were not explained by the model. Females had larger nonspecific lesion effects than males.

Table 3 shows the results of statistical tests evaluating the three hypotheses about the basis of the gender difference. First, an unrestricted model was fit as described before, with four separate importance functions estimated to predict male and female VIQ and PIQ. Then, the lateralization model was tested by forcing the H(x) term to be equal across genders for VIQ and PIQ. Because H(x) is the only source of a mean difference in importance between the hemispheres,

TABLE 2

Observed and Predicted Means for Males and Females With Left- and Right-Hemisphere Lesions

<table>
<thead>
<tr>
<th></th>
<th>VIQ</th>
<th>PIQ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observed</td>
<td>87.9</td>
<td>104.1</td>
</tr>
<tr>
<td>Predicted</td>
<td>90.6</td>
<td>101.5</td>
</tr>
<tr>
<td>Intercept</td>
<td>103.8</td>
<td>103.8</td>
</tr>
<tr>
<td>Predicted Lesion Effect</td>
<td>-13.2</td>
<td>-2.3</td>
</tr>
<tr>
<td>Nonspecific Lesion Effect</td>
<td>+3.8</td>
<td>+3.8</td>
</tr>
<tr>
<td>Error</td>
<td>-2.7</td>
<td>+2.6</td>
</tr>
<tr>
<td>n</td>
<td>16</td>
<td>17</td>
</tr>
</tbody>
</table>

TABLE 3

LISREL Tests of Hypotheses About Lesion Models

<table>
<thead>
<tr>
<th>Model and Test</th>
<th>x²</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unconstrained Test</td>
<td>0</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>Lateralization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H(x) Male VIQ = H(x) Female VIQ and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H(x) Male PIQ = H(x) Female PIQ</td>
<td>2.25</td>
<td>2</td>
<td>.325</td>
</tr>
<tr>
<td>Within-Hemisphere</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male VIQ = Female VIQ</td>
<td>4.92</td>
<td>7</td>
<td>.67</td>
</tr>
<tr>
<td>PIQ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male VIQ = Male PIQ</td>
<td>29.08</td>
<td>7</td>
<td>.000</td>
</tr>
<tr>
<td>Female VIQ = Female PIQ</td>
<td>11.14</td>
<td>7</td>
<td>.133</td>
</tr>
<tr>
<td>Final</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male VIQ = Female VIQ = Female PIQ</td>
<td>17.90</td>
<td>14</td>
<td>.212</td>
</tr>
</tbody>
</table>
this restriction amounts to a test of the null hypothesis of no overall difference in importance between the left and right hemispheres. The resulting loss of fit did not approach statistical significance, suggesting that gender differences in lateralization do not play a key role in explaining lesion deficits.

Next, the within-hemisphere model was tested by requiring the importance function for VIQ to be identical in males and females. Again, no significant loss in fit occurred, suggesting that a single model can account for VIQ deficits in males and females.

Finally, the PIQ model was evaluated by estimating two models, one in which the importance functions for VIQ and PIQ were forced to be the same in males, and one in which they were forced to be the same in females. Consistent with the PIQ hypothesis, the restriction resulted in a highly significant loss of fit in males but not in females.

These results suggested that the importance functions for VIQ were similar in males and females and that the importance functions for VIQ and PIQ were similar in females but not males. We therefore estimated a final model in which a single importance function was fit to male VIQ, female VIQ, and female PIQ, with a second importance function fit to male PIQ. The results, given in the last line of Table 3, suggested that this model fit the data relatively well.

Figure 3 shows the estimated importance function for male and female VIQ and female PIQ from the final model. Lighter shading indicates regions where lesions cause greater deficits. Only one slice is illustrated because differences in lesion location along the inferior—superior axis did not contribute to the models. The most important regions are in the lateral-posterior regions of the left hemisphere. Figure 4 shows the estimated importance function for male PIQ. The function is greater in the right hemisphere, especially in the anterior region. There is a secondary region of high importance values in the posterior region of the left hemisphere, although few subjects had left posterior lesions.

**DISCUSSION**

Beginning with the common finding that males with unilateral brain lesions show greater differences between VIQ and PIQ than females, we have endeavored to show that lesion data can be used to evaluate the plausibility of several theories of why the gender difference occurs. The hypothesis that the gender difference is largely the result of differences in the degree of lateralization in males and females cannot account for the results, because a statistical model in which the genders have the same degree of lateralization fits the data as well as a model in which the genders are allowed to differ. Similarly, the hypothesis that the gender difference results from differences in the within-hemisphere organization for ver-
bal skills was not supported, because a single model of lesion effects on VIQ could be fit to males and females without significant loss in fit. Some limitations should be set, however, on the strength of these negative findings considering the relatively small sample size.

The data do appear to fit Inglis and Lawson’s (1982) hypothesis that females use verbal strategies in solving PIQ items. A single model of lesion effects could account for deficits in VIQ and PIQ in females, but not in males. The estimated importance functions suggested that left-hemisphere lateral-posterior lesions caused the most severe deficits for male and female VIQ, whereas the relationship between lesion location and PIQ was considerably more complex for both genders.

Although Inglis and Lawson (1982) emphasized problem-solving strategies, the question of whether the patterns of deficit are the result of differences in strategy, brain organization, or both, will be very difficult to resolve without additional data. The most striking gender difference we observed was for PIQ among subjects with left-hemisphere lesions: females in this group had substantial deficits related to lesion parameters, but males did not. This result could occur because females have more nonverbal abilities relevant to PIQ represented in the left hemisphere or because females use more verbal strategies in solving PIQ items. The ambiguity arises because PIQ comprises more than one cognitive ability. In order to achieve greater clarity about distinctions between problem-solving strategy and localization of function, either problem-solving strategy will have to be controlled experimentally, or PIQ items will have to be decomposed into more basic cognitive tasks that do not permit multiple solution strategies.

The quantitative analysis we applied to these data elucidates several methodological considerations that would assist future studies in clarifying the nature of this gender difference. First, the methods we used permit inferences about lesion—behavior relationships to be made while controlling for differences in intrahemispheric lesion location and volume. Second, specification of a formal model of the relationship between lesion parameters and measured behavior allows the experimenter to formulate detailed predictions in accordance with the theories being evaluated. Third, more sophisticated statistical procedures such as these will require more detailed measurement of brain images than the classification by hemisphere or lobe that is typical in studies of lesion effects on intelligence. Fourth, it appears obvious that in order to evaluate the role of problem-solving strategies in gender differences in lesion outcome, data on strategies used by males and females will have to be collected.

A final consideration is whether the Wechsler (1955) scales are ideal for investigations of gender differences in the cognitive effects of lateralized lesions. Lesion effects on VIQ and PIQ have not been studied because of their theoretical suitability for the study of either gender or hemispheric differences, but rather because they are widely available in clinical populations, as was the case in this study. In particular, it should be remembered that items showing gender differences were removed from the item pool during the standardization of the WAIS (Yeo, 1989), although there is evidence that some individual items on the WAIS are still sex biased (Turner & Willerman, 1977). Also, PIQ comprises a number of subtests requiring visuomotor integration and speed that may be peripheral to assessment of right-hemisphere function.

The ideal sample for investigation of this phenomenon would be collected prospectively and tested with ability measures designed specifically for the assessment of gender, hemispheric, and strategic differences. A prospective sample also could receive carefully standardized brain-imaging procedures, thus avoiding difficulties in image standardization. Investigation utilizing more advanced imaging technology than CT, such as MRI, positron emission tomography (PET), and single positron emission computed tomography (SPECT) would result in more clear images. This technology produces more representational images of the functional and structural boundaries of a lesion and how they differ.

The various theories of gender differences in lesion sequelae differ in subtle ways that cannot be evaluated by simple research designs. Detailed measurement and complex analyses of large samples will be required before more significant progress is possible.

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Eliminating the IQ–RT Correlation by Eliminating an Experimental Confound

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Three experiments investigated the relation between visual scanning demands, reaction time (RT), and psychometrically defined intelligence (IQ). Prior studies have shown reliable correlations between RT and IQ in the range of −0.20 to −0.80. However, these studies have confounded the number of possible stimuli (stimulus uncertainty) with the size of the area in which the stimuli may appear (visual angle). Experiment 1 replicated these studies retaining this confound. As the number of stimuli increased from one to eight, the visual angle was permitted to increase as well (from 0° to 30°). The results showed that RT varied in accord with Hick’s (1952) law, and a median correlation between IQ and six RT parameters (subjects’ mean RTs and standard deviations at three levels of stimulus uncertainty) of −0.47 was observed. Experiment 2 removed the confound, varying only stimulus uncertainty, and the median IQ–RT correlation declined to −0.02. Experiment 3 held stimulus uncertainty constant at 1 bit (two stimuli) and varied visual angle; a median correlation of −0.19 was observed. It was concluded that many of the previously reported correlations may not have hinged on speed of information processing alone, but at least in part on subjects’ abilities to scan the display across which the stimuli appeared.

When, over a century ago, Galton (1869) sought to base intellectual attainment in simple perceptual-motor indices, he was unsuccessful. Subsequent attempts to follow through on Galton’s project were deemed failures as well. Consequently, Galton’s approach to the analysis of intelligence was largely abandoned in the face of the success of Binet’s approach, grounded in complex higher level cognitive skills such as problem solving. Yet, during the past decade, a growing body of research has appeared that is more closely aligned with Galton than with Binet, focusing on the relation between psychometric intelligence (IQ) and measures of reaction time (RT), the latter derived from various simple laboratory tasks in the information-processing tradition.

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