equal to unity if one intends to consider only the second of the two partial correlations for either theoretical discussion or social action. On the other hand, when the two partial correlations are compared, there are possible outcomes that allow one to reject the null hypothesis of no discrimination in salary based on sex for a given definition of merit.

It is inaccurate for McLaughlin to characterize Birnbaum's approach as atheoretical and his own as theoretical. Both are theoretical in a sense, but McLaughlin's methodology is itself faulty theoretically. Birnbaum, on the other hand, has a reasonable theoretical basis for his formulation.

REFERENCES

Birnbaum, M. H. Is there sex bias in salaries of psychologists? *American Psychologist*, 1979, *34*, 719–720. (Comment)

McLaughlin, S. D. Atheoretical partialing in survey research. *American Psychologist*, 1980, *35*, 851. (Comment)

Reply to McLaughlin: Proper Path Models for Theoretical Partialing

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The traditional method for investigating salary equity has been to compare the salaries of persons with equal merit. For example, Solmon (1978) reported that women psychologists are paid less on the average than men with the same background characteristics. Birnbaum (1979a) criticized traditional regression methods and argued that a diagnostic test should compare the merits of persons with equal salaries. Evidence to reject the null hypothesis of no bias would consist of finding that the underpaid group is overqualified relative to persons with equal salaries. Birnbaum (1979b) reanalyzed the data discussed by Solmon and found that women psychologists are lower in merit (e.g., have less experience and fewer publications) on the average than men with the same salaries. Therefore, Solmon's data do not require rejection of the null hypothesis that the salary differential between the sexes is a regression artifact and not due to bias.

McLaughlin (1980) challenged Birnbaum's (1979a) conclusions, defended traditional practice, and charged that Birnbaum's recommendations were theoretically unjustified. Birnbaum's (1979b) theoretical treatment, which McLaughlin did not cite, is outlined in this comment by using path diagrams for comparability with McLaughlin (1980). These analyses show that the traditional regression approach is not appropriate to test for evidence of salary bias.

The null hypothesis of no bias can be expressed as follows:

$$\begin{tikzcd} & \text{Measured qualifications merit (M)} & \arrow[l] e_2 \\ \text{Sex (X)} \arrow[r, "P_X"] & \text{Quality of performance} \arrow[u, "P_M"] \arrow[r, "P_\$"] & \text{Salary (\$),} \\ & e_1 \arrow[u] & e_3 \arrow[u] \end{tikzcd} \tag{1}$$

where P_X, P_M, and $P_\$$ are the correlations between quality of performance and the three measured variables, sex (X), measured qualifications (M), and salary ($); and e_1, e_2, and e_3 are mutually uncorrelated residuals. It is assumed that there may be a sex difference in quality of performance; however, once quality of performance is known, there is no systematic sex bias in salaries.

McLaughlin's (1980) path models assume that measured qualifications are perfectly reliable and valid measures of quality of performance and that no other unmeasured causes of salary are present (i.e., $P_M = 1.0$). Such a model is not plausible when variables are not experimentally manipulated. Expression 1 allows measured qualifications to be imperfectly correlated with quality of performance, which is the hypothesized cause of salary.

The formula for the regression coefficient of sex in the standard equation predicting salary from sex and merit is as follows (partial correlations have the same expressions for the numerators and differ only by a positive multiplicative constant):

$$\beta_{\$X \cdot M} = \frac{\rho_{X\$} - \rho_{XM}\rho_{\$M}}{1 - \rho_{XM}^2}, \tag{2}$$

where X, M, and $ are sex, merit, and salary, respectively; $\beta_{\$X \cdot M}$ is the regression weight for sex to predict salary with merit in the equation; and $\rho_{X\$}$, ρ_{XM}, and $\rho_{\$M}$ are the three correlation coefficients.

Under the null hypothesis (Expression 1), the correlation between each pair of variables is the product of the intervening path coefficients. Therefore:

$$\beta_{\$X \cdot M} = \frac{P_X P_\$ (1 - P_M^2)}{1 - \rho_{XM}^2}. \tag{3}$$

Similarly, the coefficient of sex in the equation predicting merit from sex and salary is as follows:

$$\beta_{MX \cdot \$} = \frac{\rho_{XM} - \rho_{\$M}\rho_{\$X}}{1 - \rho_{\$X}^2}. \tag{4}$$

Assuming Expression 1, Equation 4 implies:

$$\beta_{MX \cdot \$} = \frac{P_X P_M (1 - P_\$^2)}{1 - \rho_{\$X}^2}. \tag{5}$$

The partials can be zero only if merit or salary is perfectly correlated with quality, as shown in Equations 3 and 5. Therefore, looking for zero partials is unrealistic. However, if a partial correlation is of the opposite sign as the original correlation (if, for example, women had higher merit than men of the same salary), then the one-mediator null hypothesis can be rejected.

The alternative hypothesis is that there is an additional path from sex to salary (bias, *B*) above and beyond the path via the mediator of quality of performance. This model can be diagrammed as follows:

$$\begin{tikzcd} & e_1 \arrow[d] & \text{Measured qualifications} & \arrow[l] e_2 \\ \text{Sex} \arrow[r, "P_X"] \arrow[drr, dashed, "B"'] & \text{Quality of performance} \arrow[ur, "P_M"] \arrow[dr, "P_\$"] & & \\ & & \text{Salary} & \arrow[l] e_3 \end{tikzcd} \tag{6}$$

Inspection of these formulas indicates that when all of the correlations are positive, a negative partial correlation would be impossible, assuming the null hypothesis (Expression 1). Therefore, if females have a lower mean salary than men of the same merit *and* lower average merit than men of the same salary, the null hypothesis of Expression 1 cannot be rejected. However, if females have *more* merit on the average than men of the same salary, it will be possible to reject the null hypothesis of Expression 1, in favor of Expression 6.

Because Expression 1 implies that both partials in Equations 2 and 4 should be positive (assuming positive correlations), it follows that a negative partial correlation between sex and merit with salary partialed out would refute Expression 1. However, it does not follow that Expression 6 guarantees a negative partial. The partial will be negative when

$$\rho_{\$X} > \rho_{XM}/\rho_{\$M}. \qquad (7)$$

From Expression 6, this is interpreted as follows:

$$B > P_X(1/P_\$ - P_\$), \qquad (8)$$

that is, if B is small it could go undetected. Equations 7 and 8 show that the higher the correlation between salary and quality the smaller the possible magnitude of B that could go undetected by this analysis.

For example, if the correlation between measured qualifications and salary is .90 and the correlation between sex and measured qualifications is .2, then the null hypothesis of Expression 1 requires that the correlation between sex and salary be between .180 and .222. If the observed correlation were .25, for example, it would be possible to reject Expression 1 in favor of Expression 6, where the bias parameter, B, would be greater than zero. If the observed correlation were inside this region, then B could not exceed .042. Birnbaum (1979a, 1979b) reanalyzed three studies of salary equity. In two cases Expression 1 was found to be acceptable, and in one case Expression 1 could be rejected.

Roose and Doherty (1978) reported a study of salary equity that can also be reanalyzed by Equations 7 and 8. They asked judges to assign salaries to hypothetical faculty as a function of background and merit variables, and they developed an equation to predict these judged salaries. This equation was then used to calculate the merit of real faculty members. It was found that this index of merit correlated .84 with actual salary, and calculated merit had a correlation of .22 with sex (males coded with higher score). The null hypothesis (Expression 1) would allow a correlation between salary and sex as large as .262 or as small as .185. A correlation outside of this interval would refute the one-mediator null hypothesis. The observed correlation between sex and salary was .24, which is inside the acceptable region. Therefore, the data of Roose and Doherty do not show evidence of bias in salaries.

Although Roose and Doherty (1978) concluded that their results showed a differential sex bias, they recommended that adjustments be made for both males and females who were underpaid by their analysis. Thus, their recommendation would increase the merit–salary correlation without using discriminatory raises.

Figure 1 illustrates the regression paradoxes by using scatterplots. Panel A shows Galton's paradox, that one cannot invert the regression equations predicting Y from X to predict X from Y. Panel B illustrates Lord's paradox, a significant partial correlation between sex and weight, with initial weight partialed out, even though neither group gained weight in a before–after study. (These cases are discussed in greater detail by Birnbaum, 1979b.) Panel C shows Birnbaum's paradox: women are paid less on the average than men of the same merit, and simultaneously, women have less merit on the average than men of the same salary. Solid lines show regression lines predicting salary from measured merit with a separate curve for each sex. The vertical spread between the curves is proportional to $\beta_{\$X \cdot M}$ (see Equations 2 and 3). The dashed curves show regression lines predicting merit from salary for each sex. The horizontal spread between the dashed curves is proportional to $\beta_{MX \cdot \$}$ (Equations 4 and 5). Table 1 of Birnbaum (1979a) can also be plotted in this fashion to further illustrate this paradox.

Panel D shows hypothetical evidence against the null hypothesis of Expression 1, predicted by Expression 6 with $B > 0$. In this case, women have higher merit on the average than men of the same salary. The shaded area of Figure 1 depicts individuals of both sexes with higher merit than average for their salary *and* lower salary than the average for others of the same merit. The individuals in the shaded region seem most deserving of equity adjustments in salary.

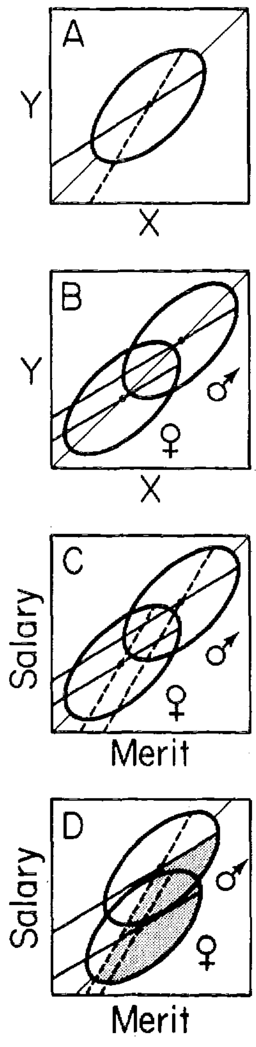

Figure 1. Regression paradoxes. (A) Galton's paradox, (B) Lord's paradox, (C) Birnbaum's paradox, (D) Evidence for salary bias: females' centroid is to the right of the males' regression line predicting merit from salary (dashed line). Thus, females have higher merit than the average male with the same salary.

In conclusion, the partial correlation technique suggested by Birnbaum (1979a, 1979b) is based on an algebraic analysis of path models in Expressions 1 and 6. This analysis shows that the diagnostic test for bias is to study whether members of the lower paid group are overqualified relative to the average person of the majority group with the same salary. The models of McLaughlin (1980) are special cases of Expressions 1 and 6 in which measured qualifications are assumed to be perfectly correlated with quality of performance. If a composite of variables such as years of experience and number of publications is not a *perfectly* valid linear function of quality of performance, the traditional regression analysis defended by McLaughlin (1980) will lead to inappropriate conclusions. Therefore, studies of sex bias should report both partials in Equations 2 and 4 and an analysis of the possible magnitude of bias, as in Equations 7 and 8.

REFERENCES

Birnbaum, M. H. Is there sex bias in salaries of psychologists? *American Psychologist*, 1979, *34*, 719–720. (Comment) (a)

Birnbaum, M. H. Procedures for the detection and correction of salary inequities. In T. R. Pezzullo & B. E. Brittingham (Eds.), *Salary equity*. Lexington, Mass.: Lexington Books, 1979. (b)

McLaughlin, S. D. Atheoretical partialing in survey research. *American Psychologist*, 1980, *35*, 851. (Comment)

Roose, J. E., & Doherty, M. E. A social judgment theoretic approach to sex discrimination in faculty salaries. *Organizational Behavior and Human Performance*, 1978, *22*, 193–215.

Solmon, L. C. Attracting women to psychology: Effects of university behavior and the labor market. *American Psychologist*, 1978, *33*, 990–999.

When Not to Comment

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McLaughlin (1980) states that Birnbaum's (1979a) analyses of partial correlation coefficients are without a theoretical base. However, Birnbaum (1979a) explicitly states that the theoretical development is presented in Birnbaum (1979b). Examination of this chapter shows a clear theoretical development and derivation of the partial correlations. These derivations show that the diagnostic test of sex bias is the partial correlation between sex and merit with salary held constant. These derivations also demonstrate that the null hypothesis of no sex bias could be rejected if this partial correlation had the opposite sign (not zero as mistakenly reported by McLaughlin) as the correlation between sex and merit. Birnbaum's (1979a, 1979b) theme is that researchers should understand these theoretical predictions before interpreting partial correlations.

Errors such as McLaughlin's could be avoided if authors would read material cited as containing theory before rushing into print with claims that procedures are "atheoretical."

REFERENCES

Birnbaum, M. H. Is there sex bias in salaries of psychologists? *American Psychologist*, 1979, *34*, 719–720. (Comment) (a)

Birnbaum, M. H. Procedures for the detection and correction of salary inequities. In P. R. Pezzullo & B. E. Brittingham (Eds.), *Salary equity*. Lexington, Mass.: Lexington Books, 1979. (b)

McLaughlin, S. D. Atheoretical partialing in survey research. *American Psychologist*, 1980, *35*, 851.

Psychology and the Health Systems Agencies

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Silverman (September 1980) gives a personal report on his activities as a psychologist involved in health planning in Michigan. It is now fairly common for psychologists to be included in the makeup of health systems agencies (HSAs) as "health provider" representatives. However, Silverman focused his attention on examples of planning for medical health rather than for mental health. He also did not identify the particular problems, needs, challenges, and opportunities for psychology.

The psychologist serving on HSA committees often plays a unique role depending on the proclivities of the individual and the types of policy decisions required. Silverman apparently saw his role as a "citizen" member on issues unrelated directly to mental health. Of course, this is a major function since most proposals come from the medical system. However, the psychologist is a professional representative of psychology and as such has a responsibility to provide the perspective of the discipline on all matters. Additionally, when mental health programming is considered, the psychologist often takes the role of advocate, defendant, information resource, explainer/interpreter of jargon, ally of mental health applicants, and so on.

As a member of the West Alabama Health Council and its project review committee, I have been repeatedly confronted with questions and problems that in all likelihood are raised for all mental health professionals whether serving on the HSA or appearing before it as an applicant. There are established criteria for application reviews of proposed use of federal funds. Questions such as: Is there a demonstrated community need for the proposed health services? and Will the proposed program have an impact on meeting the needs? are asked. Additional difficult questions that get to the core problems of psychology in the health care area are often raised by the board members. I will present a few examples of the tough questions put to psychologists by the consumer majority on the committee made up of persons from business, unions, civic groups, and so on. Many of the business people orient to the cost-containment mandate of the HSA law rather than to the aspects of identification of need and improvement of quality of services. Such questions are raised as: (a) What is your cost/effectiveness ratio of providing psychotherapy in a mental health center? (b) What is the cost per contact?