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DISCIPLINARY DIFFERENCES IN RESEARCH PERFORMANCE BY FEMALE ACADEMICIANS: THE EFFECT OF THE PROPORTION OF WOMEN

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BIOGRAPHY

Douglas S. Rebne studied Industrial Relations and Personnel Management at the London School of Economics & Political Science. Previously, his research and publications have been concerned with technological change and its effects on worker participation and productivity. This is his first study of women at work. Mr. Rebne is currently a Ph.D. Candidate at the Graduate School of Management, UCLA.

INTRODUCTION

As rates of female participation in the labor force continue to rise, it is increasingly important to understand women's experience of work (e.g. Treiman & Hartmann, 1981; Crocker, 1984; Larwood, Stromberg & Gutek, 1985; Gutek, Larwood & Stromberg,1986). This is especially true in industries such as higher education, where women have long been under-represented. Better understanding of the factors governing women's success as academicians is important for public policy as well as effective human resource management. To the extent that our understanding of women's issues proceeds from general theory, we may also hope to augment current thought on individual outcomes in other industrial populations .

The purpose of this study is to provide evidence of

occupational/ disciplinary differences in women's research production and to examine these differences from various theoretical perspectives. It is clear that research performance is central to advancement in the profession and is, therefore, an important area of inquiry (e.g. Blackburn et a1,,1978; Smart & McLaughlin,1978; Weiss & Lillard,1982). It is also clear that women tend to be less .productive in research than men and generally do not fare as well in terms of career outcomes (Astin, 1978,1984; Cole,1979; Reskin,1978). Given the importance of research performance in the typical academic career, knowledge about occupation-specific performance differences is important to women who are engaged in (or aspire to) careers in academe.

Evidence of performance differences by field would also be of interest to those charged with the efficacious application of faculty development programs and the development of equitable reward systems. The latter issue, of course, has been the source of many legal actions and considerable debate on public policy (eg. Fogel, 1983,1985; Treiman & Hartmann, 1981).

Theoretically, female research production should vary substantially by field. A large body of theory suggests that social processes influence developments in scholarly research (eg. Bess, 1978; Hagstrom, 1965; Mulkay, 1969,1972). It is also thought that the effect of such processes on an individual's performance will vary with the size of the demographic group to which one belongs (eg. Kanter, 1977a; Wagner, Pfeffer & O'Reilly, 1984, South et al,, 1982). Women, while under-represented in academe as a whole, are more often found in areas such as the social sciences than in physics or mathematics. While the effect of the proportion of women on female performance is unknown, a number of hypotheses have been offered. Thus, two questions are to be asked: (1) "Does female performance vary by academic occupational group?" and, if so, (2) "Do theories concerning the effect of the proportion of women help account for such differences?".

REVIEW OF THE LITERATURE AND HYPOTHESES

Studies of research production generally examine personal characteristics brought to the academic worksite and/or the nature of that worksite at the institutional level. This is as true of general studies of research performance as it is of those concerned primarily with women . Where the matter of occupational differences does appear, it is generally treated as a methodological problem to be controlled through sampling techniques (eg. Blackburn et al.,l978; Cole,1979). This deficiency in the literature was previously observed by Clark & Corcoran, who recommended that future studies seek to determine the fields in which women experience "greater discrimination" (1986:27).

This, of course, invites the question, "Are women, in fact, discriminated against in the reward system of higher education, or are they simply subjected to the sanctions which lower research production implies?". This question is the starting point for a brief review of the literature on women's performance as researchers.

In his oft-cited book Woman's Place in the Scientific

Community (1979), Jonathan Cole concluded that there is little empirical evidence of discrimination against women in the scientific community. Non-work factors such as marital/family responsibilities could not explain differences in research production or the lower professorial ranks held by women. Indeed, Astin (1978) has shown that marriage has a positive impact on women's research production. Nor did the disproportionate placement of women in teaching-oriented colleges account for the differences. Women produce less published research than men, both in colleges and research- oriented universities. Also, given training of equal quality (which they are likely to have), women take junior posts in strong departments at a proportional rate (Cole,1979).

Cole's summation suggested that affirmative action programs had effectively eliminated discrimination against women in higher education. Attempting to plot his results against the future, Cole implied that so-called "reverse discrimination" against men was a realistic prospect [1]. To summarize this important work, one can say that neither native abilities, quality of graduate education, institutional type, nor non-work roles were sources of discrimination against female academicians. Research production-- in itself a non- discriminatory basis for reward allocation-- was found to be the basis of differential treatment (1979:119).

As part of a conditional hypothesis of discrimination, Cole makes two important points. First, he noted that his aggregate analyses might have masked outcome differences to be found amongst "distinct subgroups of scientists" (1979:75). Second, he argued that sex discrimination in advancement would be more likely to occur in situations which offered no or few relevant criteria for performance evaluation. Drawing on these points, Cole assessed the effect of gender on academic advancement among faculty without publications. Here, he found slight evidence that women were treated unfairly in the allocation of rewards.

Given that 25-40". of Astin's 1968 sample of women cited experiences of discrimination in hiring, salaries, or promotion, it is not surprising that Cole's study has not laid the issue to rest. Recent attempts to explain sex differences in research production emphasize social processes which are likely to work against women. One such line of reasoning is the thesis of "cumulative advantage" (eg. Clark & Corcoran,1986; Merton,1957; 2uckerman,1977). Broadly, this approach suggests that scientists are socialized into accepting patterns of success and failure at early, even pre-doctoral, stages of their careers. In a related argument, it has been suggested that success as a researcher is largely a function of the so-called "invisible college"-- a social network comprised of prominent researchers and those most likely to join them (eg. Reskin,1979).

If true, the socialization- advantage thesis suggests an explanation for women's lower productivity which, in turn, accounts for numerous career differences (eg. lower salaries, rank, & prestige). These outcomes would be the effects of social-psychological processes rather than individual characteristics or organizational constraints, per se.

These studies raise at least two questions. First, if Cole is right in concluding that women's lower research production

cannot be attributed to differences in ability, training or institutional placement, from whence come the differences? Cole (1979:7) anticipates greater discrimination against women in fields in which they are relatively well-represented (eg. the social sciences and humanities). Here they would constitute a visible threat to the interests of men, who are also pursuing the scarce resource of professional recognition. Cole's hypothesis assumes that men fear having to share the rewards of academic success with women and thus will treat them as economic competitors-- a premise which also underlies much of the literature on sex-based occupational segregation and wage determination (eg. Bergmann, 1974; Blalock, 1982).[2]

A second question left unanswered might be put as follows: 'If social processes and the accumulation of advantage/ disadvantage are important to research success, can we deduce the conditions under which they would be most virulent-- and thus most detrimental to women's performance?'. Here it would seem that an alternative hypotheses is in order; namely that women can expect to be more productive in fields in which they are better represented. In these fields, discrimination would be more visible and women, as a group, would be more difficult to exclude from key social networks (Clark & Corcoran:1986:28).

A positive relationship between female representation and research production would also be expected by those who argue that individual performance is, in part, a function of the relative size of the demographic group to which one belongs. As the proportion of females increases, women's relative social power should increase. This perspective stem s from Pfeffer's (1983) concept of organizational demography. It has been found to be predictive of turnover among managers (Wagner, Pfeffer & O'Reilly, 1984).

Thus, the literature in this area produces two competing hypotheses. The economic competition argument implicit in Cole's position anticipates a negative relationship between numbers of women in a field and their performance as researchers (Figure 1-A). The social group power perspective (exemplified by the thesis of cumulative disadvantage for women) anticipates a positive relationship (Figure l-B). In both instances the reasoning is essentially economic. It is assumed that men and women act as members of competitive interest groups. Relative group size influences the male majority's capacity to control scarce production resources including channels of informal communication [3].

In terms of the shape of these relationships, there are at least two other theoretical positions which would predict nonlinearity between the proportion of women in a disciplinary group and their performance as researchers.

The first is a variation on the demographic group power theory. Here, it is argued that a large minority (eg. 16-35% female) would constitute '"a greater perceived threat to the economic and political security of the [male] majority" (South et al., 1982:587), thus evoking discriminatory action by men. This relationship would be curvilinear- with a positive effect being followed by a distinctly negative effect as women come to form a large minority in the 16-35% range (Figure 1-C). This position is essentially a hybrid of structural and economic theories. Emerging female social networks will enhance women's performance

until the number of women begins to constitute a perceived economic threat for men. Thereafter, women should fare worse as men begin to engage in discriminatory activities in the manner expected by Cole (South et al.,1982).

A second nonlinear hypothesis is suggested by Kanter's theory of tokenism (1977a,b). In this view, women can expect to fare worse in "skewed" social groups where they represent fewer than 15% of the workforce and have "token" status. in such settings, male-female social contact is thought to be cursory and based on stereotypes. Women are effectively isolated from the social networks which influence personal success. However, as the proportion of women rises to a range of 16-35% ("tilted" groups) they can affect the culture of the entire group. They become "differentiated from one another, as unwell as differentiated from the majority"(1977b:966)

The general form of the relationship, then, would be positive, with a marked effect taking hold as women move from token to nontoken status (representing more than 15% of the occupational group) (Figure 1-D). Tests of Kanter's theory have produced mixed results. Alexander and Thoits (1985) found that "token" representation reduced the performance of female students. South et al. (1982) detected no isolating effect for token females in the interaction patterns of civil servants.

To summarize, the literature suggests several competing hypotheses concerning the effect of the proportion of women on research performance. They are distinctive in terms of directional and/or functional form of the effect. The underlying theories share the premise that social interaction patterns are, in part, functions of demographic group size. Social interaction, in turn, is thought to influence individual research production.

THE DATA SET AND VARIABLES

The data set used in this study was collected by the UCLA Higher Education Research Institute in 1980, and made available by Professor Helen Astin. The analyses reported herein utilized approximately 1,800 responses to closed-end questions concerning personal characteristics, work activities and responsibilities, publication record, types of research conducted, and attitudes values and goals concerning education and academic work. The initial sampling units were institutions, with respondents being drawn from a nationally representative sample of 98 colleges and universities. The sample is representative of the institutional population in terms of size, control (public & private), region, and selectivity. All academic personnel at these institutions were asked to complete the questionnaire. The number of women in the sample (13%) appears to be correspond to the faculty population as a whole (Cole, 1979).

Previously, the data set has been used to examine relationships between research production and faculty rewards, with particular reference to sex differences and career patterns of female scholars (eg. Davis 6 Astin, 1985, l987).

This data set offers a critical advantage to the current study. It is sufficiently large to allow for gender-based comparisons of performance across a fairly comprehensive range of academic occupational groups. This is a luxury most students of

female academicians have not had.

The results reported here reflect research production by faculty holding either the doctorate or the masters degree. The latter comprised 24% of the sample. Female faculty are somewhat less likely to have a doctoral. degree, with the result that estimates of women's performance relative to men will tend to have a downward bias. However, masters-level faculty do produce an appreciable portion of the published research-- approximately 15- overall, even for the 1978-80 period. Analyses performed for Ph.D's only (not here reported) had little effect on the results.

All available measures of research production were employed: (1) cumulative books, monographs and technical reports, (2) cumulative articles published and (3) a composite measure of publications for the period 1978-80 [4]. The composite two-year measure can be viewed as a simple measure of productivity (output/labor input). These ratio scale measures did not control for quality. However, in the absence of indications from the literature that faculty differ by discipline in this regard, this weakness of the data set was not thought to be critical. In general, publication quantity has been found to correlated highly with quality (eg. Cole, 1979).

Independent variables used for the regression analysis consisted of the following: (1) a dummy variable for females, (2) average weekly hours spent on research , (3) age, (4) federal/national research funding (dummy for recipients)[5] and (5) number of graduate students currently being taught. Intercorrelations among these variables ranged from --.ll to .32 for the overall sample. These, of course, are self-reported data and may have undetectable biases.

The theories discussed in Section Two have been tested in a variety of system contexts: departmental (Spangler et al., 1978), organizational (Kanter, 1978; Wagner, Pfeffer & O'Reilly, 1984), occupational (Pfeffer & Davis-Blake, n.d.), and at the community level (Blalock, 1957; Frisbie & Niedert, 1977). Among academicians, relevant units of analysis might include the local disciplinary department, the discipline as a whole, or disciplinary clusters. Ideally, this decision would be based on a sociometric analysis of research-oriented interaction patterns. In the absence of such information, 1 have chosen to consider clusters of disciplines (eg. the social sciences, biological sciences, management). These are likely to constitute rather generous boundaries of discourse in some instances, while being too conservative in others. On the other hand, this level of analysis does reflect the limited literature on disciplinary differences in participation rates for females (eg. Bernard, 1964).

The specific conceptual framework used to differentiate between academic occupational groups is drawn from the work of Biglan (l973a,b). Biglan asked academicians to sort disciplines according to subject matter similarity/dissimilarity, then to account for the differentiation using sets of bipolar adjectives. Distance-scaling of the similarity data produced a solution of three dimensions: "hard-soft", "pure-applied" and "life-nonlife". The resultant disciplinary clusters (and distribution of the current sample) are shown in Appendix A.

The Biglan clusters appear to offer a theoretical refinement of Kuhn's (1962) concept of "paradigm-strength". Previously,

faculty occupations have been disaggregated by distinguishing, somewhat vaguely, between "hard" and "soft" fields (e.g. Lodahl & Gordon, 1972; Thompson & Brewster, 1978). However, a considerable body of theory in industrial sociology suggests that the Biglan clusters constitute an appropriate taxonomy of academic occupations, one which captures important differences in job characteristics (e.g. Leavitt, 1964; Perrow, 1965, 1967; Thompson, 1967). I have suggested elsewhere (Rebne,1986) that the three dimensions of fields previously identified by Biglan underlie the Kuhnian concept of paradigm-strength: task (pure versus applied), technology ("hard","soft"), and subject matter (life,nonlife). The concept of the research paradigm, in turn, has been used as a partial explanator of women's performance as academicians. For example, Laws (1978) has argued that the continued existence of "male-dominated paradigms" has had a negative impact on women's ability to win acceptance of their research interests.

The Biglan framework also been empirically validated numerous times (eg. Creswell 6 Bean, 1981; Eison, 1976; Smart & Elton, 1975) and has been used successfully as a predictor of a variety of individual outcomes, including publications of books versus articles (Biglan, 1973b; Pebne, 1986) end reward systems (Smart R McLaughlin, 1978). Finally, it can be used to differentiate among fields at administratively meaningful levels [eg. engineering (HAN), business (SAN), humanities (SPN)].

ANALYSES AND RESULTS

Table One presents a breakdown of male/female research production patterns in the disciplinary groups. As expected, women produced fewer publications than men in all fields. However, the performance ratio varies markedly by area. For cumulative production of articles, the female/male ratio ranges from a low of .26 in managerial fields (SAN) to .74 in the biological sciences (HPL). With respect to cumulative production of books and monographs, the fernale/male ratio ranges from .30 in management (SAN) and education (SAL) to .86 in the non-life physical sciences (HPN). On the two-year measure (all publications, 1978-80), the female/male ratio was as low as .49 in management (SAN), increasing to .88 and .93 in the biological sciences (HPL) and humanities (SPN).

Turning to the question of women's representation, it can be seen from Table One that female representation differs greatly by field, from a mere 2%. in agriculture (HAL-AG) to 34% in education (SAL). The relationship between proportion of females and relative research performance is positive for both cumulative articles and overall publications, 1978-80. There is no discernable pattern for production of books and monographs [6]. Figure Two presents this relationship graphically. Female performance is generally much better in the four disciplinary groups with the highest proportions of females-- the biological sciences, humanities, social sciences and education. Fitting the data to the hypothesized effects (Figure One), there is some support for Kanter's hypothesized nonlinear effect, with women in "tilted" occupational groups faring better than women in highly

"skewed" groups (Figure 1-D).

To allow for a more rigorous test of the relationship, controls were added for selected individual and situational performance predictors. As Jacobi & Astin (1985) suggest, female academicians may be younger than men and, thus, in more prolific stages of their careers. If so, this would tend to lower the female/male ratio for cumulative measures while perhaps inflating the ratio for the two-year measure.

Production may also be affected by differential placement within institutions. Women tend to teach fewer graduate students than men (Bayer, 1973; Patterson, 1971; Reskin, 1978). They are also less likely to receive funding for research or spend as much time on it (Jacobi & Astin, 1985). Such factors almost certainly impinge on publication success (eg Blackburn et al., (1978).

The current data suggest that this is the case. Fifty-one percent of the women were aged 45 or younger, while this was true of only 45% of the men. Thirty-seven percent of the women reported having no graduate students, with the corresponding figure for men being 29'. Only 14' of the women had received federal research support in the previous 12 months. This contrasts with a figure of 27% for men. Fully 47% of the women had received no funding from any source; an impediment which was true for only 32% of the men.

Thus, for each disciplinary group, multiple regressions were undertaken to determine whether the pattern of effects for females would remain positive but nonlinear in the presence of selected controls. The results are shown in Table Two. The b coefficients (negative) are generally larger and significant only in fields where women are very few in number. Again, the relationship is positive and in keeping with the structural theory of Kanter. While the control variables selected are far from comprehensive, they are representative of impediments dientified by numerous theorists (eg. Reskin, 1978; Clark & Corcoran, 1986).

DISCUSSION

It has been found that women's performance as researchers does, indeed, vary by occupational group. In agriculture, medicine, business and the non-life physical sciences, women's research production is substantially lower than that of men. However, in the biological sciences, social sciences, humanities, and education, the difference is much smaller and generally not significant. This suggests that it is important to examine women's performance as academicians on an paradigmatic basis.

Theories concerning the effect of numbers of women on performance have been evaluated. The general conclusion is that performance is enhanced when more women are in an occupational group. The positive relationship is consistent with Kanter's theory of tokenism-- women's performance is markedly better in "tilted" occupational areas than in "skewed" groups, though the effect seems to trigger slightly earlier than 15% for academicians. The nonlinear character of this relationship suggests that the demographic composition of social systems is, in and of itself, an important source of female-male performance

differences. Thus, as more women enter the highly-skewed fields, it is reasonable to expect that their performance as a group will improve.

The absence of linearity suggests no support for either non-structural hypothesis (economic competition or social group power); perspectives which rest on a logic of economic competition through discriminatory social systems. The first assumes that the male majority actively discriminates against women, with increasing intensity (and success) as women appear in larger numbers. The second perspective suggests that discriminatory efforts will be less effective as the proportion of women increases. It, too, begins with the premise of competition between demographic groups defined by gender. Kanter's theory, while not denying that competition is a part of academic life, does not oblige us to make the uncharitable assumption that male faculty actively discriminate against women in the manner proposed by the non-structural theories.

In addition, theories of discrimination imply that male-female interaction will decrease as women begin to constitute effective interest groups of their own. While South et al. (1982) found that male-female interaction among clerical workers declined as the proportion of women increased, this may not be true in higher education. Mulkay's evaluation of interaction patterns in academe suggests that social interaction is based on participation in "problem networks" which may be short-lived and are continually changing in membership (1972:35-6). If, as Mulkay suggests, network membership is based on shared theoretical and methodological orientations, long-term adherence to gender-defined networks would be dysfunctional-- except in the unlikely case that such orientations are, themselves, gender-specific. Thus, future research in this area would provide an additional test of demographic group competition arguments as they pertain to higher education.

These results suggest that it is helpful to take a relational view of women's experience at work. It may be that studying gender as an isolated individual attribute is less useful than analyzing the relationship between one's gender-status and that of others in the social system. If so, structural theories such as Kanter's are an important vehicle for understanding the productivity of not only females, but also minority groups in a wide range of industrial contexts.

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NOTES

l. In support of this argument, Cole cites a study by J.M. Mitchell & R.R. Starr (1973), "Aspirations, Achievement and Professional Advancement in Political Science: The Prospect for Women in the West". in Women in Political Science studies and Reports of the APSA Committee on the Status of Women in. the Profession, 1969-71. Washington,D.C.: American Political Science Association. In their survey, it was found that incidents of sex discrimination are just as likely to be reported by men as by women.

2. See Reskin (1978) for a detailed discussion of the manner in which male-dominated social networks are likely to militate against female academicians.

3. An historical treatment of the issue of occupational segregation in higher education can be found in Margaret Rossiter's Women Scientists in America, 1982. Sylvia Walby presents a comprehensive review of relevant theories in "Occupational Segregation by Sex: Theoretical Issues and Comparative Analysis". UCLA Institute of Industrial Relations Working Paper Series, No. 107, March, 1986.

4. Subjects scores on the interval-scale measures of research production were converted to mid-point values in order to approximate actual output.

5. The data set also included measures of funding from sources other than the federal/national sector (institutional/ departmental, private foundations, private industry and local public agencies). In a preliminary analysis, only the federal/national measure was found to be a significant predictor of research production. While surprising, this result is consistent with previous research (eg. Y. Neumann, "Predictors of Funding in Academic Fields". Research in Higher Education. v9, pp 115-122, 1978.)

6. In general, production of books and monographs is thought to vary with the characteristics of fields (Biglan, 1973a; Blackburn et al. 1978; Rebne, 1986). Books and monographs are

generally more important research channels in "soft"fields (SAN, SPN, SPL & SAL). Here, there is thought to be more theoretical and methodological debate. This often obliges scholars to seek publication venues offering more space than journals generally provide. It is interesting to note that women's relative performance on this measure is somewhat better in fields where books and monographs are less important.

APPENDIX A. The Biglan Disciplinary Clusters and Current Sample.

The three=factor Biglan taxonomy of disciplines produces eight disciplinary groups. The Engineering cluster (Hard-Applied- Non-life) was dropped as the sample contained only three women (1%) holding masters degrees. A second cluster, Hard-Applied-Life) was divided in two, forming HAL-AG (Agriculture and Veterinary Studies) and HAL-MED (Medicine). This was thought necessary for two reasons. First, medical fields were not included in the original Biglan analysis. Thus, there has been no assessment of faculty's perceptions of the similarity/ dissimilarity of these two areas. Second, there appear to be substantially more women in medicine (9% of sample) than in agriculture (2:).

The disciplinary samples included in each cluster were restricted to clearly identifiable fields (eg. respondents who indicated that their primary field of research was "other business fields" were excluded). This was done to facilitate any future research at the disciplinary level.

The resultant sub-samples are shown below.

1. Agriculture (HAL-AG: Hard-Applied-Life) N=136 female n=2
   Agriculture and Forestry

2. Non-Life Sciences (HPN: Hard-pure-Nonlife) N=523 fn=31
   Chemistry Physics
   Geology Mathematics 6 Statistics

3. Medicine (HAL-MED: Hard-Applied-Life) N=76 fn=7
   Medicine

4. Management (SAN: Soft-Applied-Nonlife) N=113 nf=12
   Management Marketing
   Accounting Finance

5. Biological Sciences (HPL: Hard-Pure-Life) N=255 fn=31
   Biology Microbiology
   Biochemistry Botany
   Physiology Zoology

6. Humanities (SPN: Soft-Pure-Nonlife) N=407 fn=73
   History Philosophy
   English Religion

7. Social Science (SPL: Soft-Pure-Life) N=118 fn=25
   Sociology Anthropology
   Psychotherapy Political Science
   Psychology

8. Education (SAL: Soft-Applied-Life) N=l83 fn=62

Education Elementary/Secondary Ed.
Educational Psychology

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