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Masculinity, Femininity, Androgyny, and Cognitive Performance: A Meta-Analysis

[Review Articles]

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Abstract

Nash has argued that individuals will perform better on cognitive tasks when their self-concepts match the gender stereotyping of the tasks. To evaluate this hypothesis, we reviewed studies on the relation between gender self-concept and performance on spatial, mathematical, and verbal tasks. Meta-analytic techniques were used to estimate the average effect sizes and to determine the significance of the combined probabilities. The influence of subjects' sex and age, date of study, type of spatial task, and type of self-concept measure on these associations was also examined. In general, the results from spatial and mathematical tasks, which are usually stereotyped as masculine, supported Nash's hypothesis. Higher masculine and lower feminine self-concept scores were associated with better performance. These relations were observed more consistently for female than for male subjects. Most notably, there was some evidence of better spatial and mathematical performance among adolescent boys who described themselves as feminine. Nash's hypothesis was not

supported for verbal tasks. Finally, there was no evidence that androgyny, defined either as high masculine and high feminine scores or as a balance between masculine and feminine scores, is associated with better cognitive performance.

In a review of the literature on sex roles and cognitive performance, Nash (1979, p. 292) concluded that individuals will perform better on cognitive tasks when the masculinity and femininity in their self-concepts is consistent with the gender stereotyping of the tasks. In her own research, for example, Nash (1975) asked sixth and ninth graders whether they would rather be male or female. Girls and boys who expressed a preference for being male performed better on a spatial test than did those who expressed a preference for being female. Nash's position is consistent not only with Kohlberg's (1966) cognitive-developmental approach to gender typing, but also with more recent schematic-processing explanations for the acquisition and maintenance of gender stereotypes (e.g., Bem, 1981; Martin & Halverson, 1981). One of Kohlberg's central arguments is that individuals will tend to value things that are like the self, and will therefore seek out self-consistent activities and avoid self-inconsistent activities. The schematic-processing models lead to similar predictions about the cognitive and behavioral effects of one's gender self-concept. Material inconsistent with the self will be processed more slowly and forgotten more easily. Self-inconsistent activities will be avoided when possible, or performed with discomfort (see reviews by Bem, 1985; Martin & Halverson, 1981).

The importance of Nash's (1979) hypothesis lies in its original purpose—as a socialization explanation for sex differences in cognitive performance. According to the schematic-processing models, sex differences in cognition would be linked to self-concept in the following manner. Individuals of both sexes who view themselves in stereotypically masculine terms should do better on masculine tasks than feminine individuals, whereas individuals of both sexes who view themselves in stereotypically feminine terms should do better on feminine tasks than masculine individuals. Huston (1983) concluded in her review that by adolescence, spatial, mechanical, and mathematical skills are stereotyped as masculine, whereas verbal skills are stereotyped as feminine (p. 404). These stereotypes have also been noted among college students (e.g., McMahan, 1976; Ruble, 1983; Signorella & Vegega, 1984). Thus, the frequently observed sex differences in performance favoring girls and women on verbal tasks and favoring boys and men on spatial and mathematical tasks (e.g., see Hyde, 1981; Wittig & Petersen, 1979) may be partly a function of the much-documented tendencies for girls and women to view themselves in stereotypically feminine terms and for boys and men to view themselves in stereotypically masculine terms (e.g., Bem, 1974; Hall & Halberstadt, 1980).

Despite Nash's (1979) review and similar arguments by other authors (e.g., Antill & Cunningham, 1982; Jamison & Signorella, 1980; Milton, 1957), no consensus has developed on the nature of the relation between gender stereotyping in self-concept and cognitive performance, particularly with regard to spatial tasks. It is common to find reviewers asserting that findings on the relation between masculinity-femininity and cognitive performance are inconsistent and therefore that no conclusions about the relation can be made (e.g., Harris, 1981; Keyes, 1983). A more specific criticism of Nash's position is that there may be different relations for girls and women than for boys and men, particularly during adolescence. For example, Kogan and Marcuse (1981) argue that Nash's conclusion is premature because studies exist showing better spatial performance in feminine rather than masculine boys and men. Newcombe (1982, p. 237) suggested that for adolescent boys, excelling at intellectual tasks may not be viewed as entirely masculine. This possibility is not necessarily at variance with Huston's (1983) conclusions about the gender stereotyping of specific tasks. Huston noted that some studies with elementary school children showed that school objects were viewed as feminine, even though in other studies some specific skills were stereotyped as masculine (p. 404). Thus, for boys entering adolescence, there may be a conflict between their view of school in general and of some skills in particular.

An additional complication occurred when androgynous self-concepts were added to the psychological literature on masculinity and femininity. Before 1974, most gender-related self-concept measures were constructed with the assumption that masculinity and femininity were two poles of the same trait (e.g., see Constantinople, 1973). Thus, one could score as masculine or feminine, but not both. In contrast, the new self-concept measures included independent masculinity and femininity scales (e.g., Bem, 1974). On these new measures, an androgynous person is one who endorses both stereotypically masculine and feminine traits as self-descriptive, as indicated either by high scores on both types of traits or by relatively equal scores on both types of traits (see Taylor & Hall, 1982). When Bem (1975) began her research on the consequences of androgynous self-concepts, she proposed androgyny as a form of nontraditional sex typing associated with superior functioning in cognitive as well as other areas. Nash (1979, p. 292) combined Kohlberg's (1966) cognitive-developmental approach to sex typing with Bem's new formulation and predicted that androgynous as well as masculine persons should perform well on masculine tasks, whereas androgynous as well as feminine persons should perform well on feminine tasks. Nash also suggested that some persons classified as cross-sex typed (i.e., masculine girls and women and feminine boys and men) on old masculinity-femininity measures might score as androgynous on Bem's (1974) or similar androgyny measures. This possibility at least offers a hypothesis for inconsistencies in the findings on self-concept and spatial performance. If Nash is correct, androgyny rather than masculinity or femininity should predict better spatial performance when an androgyny measure is used. The relation between androgyny and cognitive performance, however, has not been reviewed.

There also have been changes in the size of cognitive sex differences. Hyde (1981) calculated the average magnitudes of sex differences in spatial, quantitative, and verbal abilities, using studies from Maccoby and Jacklin (1974). Based on the median *d* values she reported, her analysis shows that sex accounted for about 1% of the variance in verbal ability and 4% in quantitative and spatial abilities. After reanalyzing Hyde's data, both Rosenthal and Rubin (1982) and Becker and Hedges (1984) concluded that over time, girls and women have gained in performance relative to boys and men in all areas. Consequently, any review of the literature must consider the study's date as a potential moderator variable.

Yet another concern is the question of homogeneity of spatial abilities. Linn and Petersen (1985) examined sex differences in spatial tasks using studies done since Maccoby and Jacklin's (1974) review. They concluded that there appear to be three types of spatial tasks, each showing different patterns of sex differences. Spatial visualization tasks (e.g., embedded figures) do not show sex differences at any age. Spatial perception tasks (e.g., horizontality) show sex differences at all ages, although the differences are not significant until age 18. Mental rotation tasks show significant sex differences as soon as children can be tested. Thus, the relation of self-concept to spatial performance should be examined separately for each type of spatial task.

In summary, an examination of the usefulness of gender-related self-concepts in understanding sex differences in cognitive performance should address the following questions. First, was Nash (1979) correct in concluding that individuals will perform better on cognitive tasks that are consistent with the self? It is possible, as the critics have suggested, that enough inconsistent or null findings exist in the literature to invalidate Nash's conclusion. Second, does Nash's generalization apply to both sexes and to all ages, or is there a different pattern for adolescent boys? Third, does including androgynous as well as masculine and feminine persons change the relation between self-concept and cognitive performance? Will androgynous persons perform as Nash suggested on gender-stereotyped cognitive tasks, or will their performance exceed that of any other self-concept group? Fourth, have the patterns of relations changed? Perhaps as girls and women gain in cognitive performance relative to boys and men, the relation of masculinity and/or femininity to cognitive performance will lessen. Fifth, is self-concept related to all types of spatial tasks, or only to those for which there are reliable sex differences?

To answer these questions, we reviewed the literature on the relation of masculinity, femininity, and androgyny to spatial, mathematical, and verbal performance. Studies were grouped according to subjects' sex, as well as types of cognitive and self-concept measures used. Within these groupings it was also possible to compare results by subjects' age and time of study. To summarize the findings of the reviewed studies, meta-analytic techniques were used (Rosenthal, 1984). Meta-analysis is especially advantageous in the face of inconsistent findings because it avoids arbitrary judgments about how many contradictory findings constitute “inconsistency” in a body of literature. Probabilities from each of the studies were combined, thus obtaining a probability level for the studies as a group. In addition, effect sizes from each of the studies were averaged to provide an estimate of the magnitude of the relation across studies.

Method

Sample

Our search for relevant articles began with literature reviews on the relation of masculinity and femininity to cognitive performance (Arbuthnot, 1975; Fox, Tobin, & Brody, 1979; Nash, 1979), as well as reviews on sex differences in general (Maccoby, 1966; Maccoby & Jacklin, 1974; Sherman, 1971, 1978). These reviews were then supplemented and updated by hand and computer searches of *Psychological Abstracts, ERIC Index, Social Science Citation Index*, and *Dissertation Abstracts International*.

Included in the sample were studies on nonpsychiatric English-speaking populations. Five studies that did not meet these criteria were excluded. It was decided, however, to include as much unpublished material as could be recovered. Glass, McGaw, and Smith (1981) noted that excluding unpublished material may bias the calculation of the effect size, because effect sizes tend to be smaller in unpublished material. Out of our final sample of 73 studies, 48% were unpublished dissertations or papers.

The cognitive tasks of interest were spatial, mathematical, and verbal. The spatial tasks were classified into Linn and Petersen's (1985) three categories. In the spatial perception category were the Rod-and-Frame Test (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962) and Piaget's water-level (horizontality) task (e.g., Thomas & Jamison, 1975), with 60% of the studies using the former test. In the mental rotation category, 38% of the studies used the Card Rotations Test (French, Ekstrom, & Price, 1963), 31% the Primary Mental Abilities Space Relations Test (Thurstone, 1958), 15% the Mental Rotations Test (Vandenberg & Kuse, 1978), and 15% the Identical Blocks Test (Stafford, 1962). The most heterogeneous category was spatial visualization. Over one-half of the studies used some form of embedded figures (e.g., the Embedded Figures Test or the Group Embedded Figures Test, Oltman, Raskin, & Witkin, 1971; the Hidden Figures Test, French et al., 1963). The remaining studies used such tests as Paper Formboard, Paper Folding, and Surface Development (all from French et al., 1963), Kohs's Block-Design Test (Kohs, 1923), the Differential Aptitude Tests' space relations test (Bennett, Seashore, & Wesman, 1966), the Wechsler Intelligence Scale for Children or the Wechsler Adult Intelligence Scale Block Design subscale (Wechsler, 1955, 1974), General Aptitude Test Space (U.S. Employment Service, 1962), and various mechanical aptitude tests (e.g., Australian Council for Educational Research, 1979). The mechanical aptitude tests were included in the spatial visualization category based on Linn and Petersen's general description of the skills required for spatial visualization tasks. The mathematical and verbal tests came almost exclusively from such standard test batteries such as the Scholastic Aptitude Test, the American College Testing Program Examination, the Stanford Achievement Test, School and College Ability Test, and the Iowa Tests of Basic Skills. A small group of studies used math word problems from Milton (1957). Many of these mathematical and verbal tests are the same ones given in Maccoby and Jacklin's (1974) Table 3.3 and 3.4 (both verbal), and 3.5 (quantitative), and thus represented in Hyde's (1981) data as well.

The self-concept measures included were objective tests in which subjects were asked to describe themselves using gender-stereotyped characteristics. By these criteria, one study using a peer-report measure of masculinity and femininity (Ferguson & Maccoby, 1966) and three studies using the projective IT Scale for Children (ITSC, Brown, 1956) were excluded. The ITSC is so unlike the remaining scales that its inclusion is unwarranted. In addition, the ITSC has been strongly criticized on methodological and theoretical grounds (e.g., Paludi, 1981). The self-concept measures included can be divided into two categories. The first category of measures contains the scales in which masculinity and femininity are assessed jointly. On these bipolar scales, which we call masculinity-femininity (M-F) scales, a person receives one score and is either masculine or feminine but not both. The most commonly used scales of this type are the Gough Femininity Scale (Gough, 1975), the Minnesota Multiphasic Personality Inventory (MMPI) Masculinity and Femininity scale (Hathaway & McKinley, 1951), the Terman-Miles M-

F scale (Terman & Miles, 1936), the Strong Vocational Interest Blank Masculinity and Femininity Scale (Strong, 1959), and the Guilford-Zimmerman Masculinity scale (Guilford & Zimmerman, 1949). Although Constantinople (1973) concluded that the Guilford-Zimmerman Masculinity scale, out of the M-F scales just mentioned, "comes closest to avoiding the problems of bipolarity" (p. 401), it is still more similar to the M-F scales than to the androgyny measures we shall describe. We excluded studies with the MMPI from the sample for two reasons. First, the normative samples for the scale were not the high school or college students used for the other M-F scales (Constantinople, 1973). Second, the reported reliability is very low (.36; Pleck, 1981), in contrast with the other M-F scales, which have reliabilities in the .80s. Only 9 studies were eliminated (Altus, 1958; Cook & Wherry, 1950; Elmore & Vasu, 1980; Fink, 1959; Hathaway & Monachesi, 1963; Holtzman & Bitterman, 1956; Lambert, 1960; Miller, 1953; Silverman, Buchsbaum, & Stierlin, 1973). In a few other studies the MMPI was used in addition to other self-concept scales (e.g., Trumbull, 1953). In these studies, only results from the other scales were used. Finally, in the Welsh and Baucom (1977) study, masculine and feminine groups were formed from scores on four M-F measures, including the MMPI. As the MMPI made only a small contribution to M-F classification, this study was retained.

The second category of self-concept measures contains the scales in which masculinity (M) and femininity (F) are assessed separately. Individuals thus receive one score for M and one for F. Because this latter category of measures provides for the assessment of androgyny in relation to cognitive performance, we call these scales the androgyny measures. The two most frequently used androgyny scales are the Bem Sex-Role Inventory (BSRI; Bem, 1974) and the Personal Attributes Questionnaire (PAQ; Spence, Helmreich, & Stapp, 1974). Reliabilities for the BSRI are .86 (M) and .80 (F; Bem, 1974). Reliabilities for the PAQ are .85 (M) and .82 (F; Spence et al., 1974). Most of the studies with androgyny measures used the BSRI.

Procedure

As all research on the relation between self-concept and cognitive performance must be correlational (i.e., nonexperimental), *r* was chosen as the measure of effect size. For about one-half of the studies, *r* was the statistic reported. For many of the remaining studies, means and standard deviations were used to calculate *t* (Glass & Stanley, 1970; Equation 14.3), which was then converted to *r* (Rosenthal, 1984, Equation 2.16). For a few studies *t*, *F* (*df* = 1), and chi-square (*df* = 1) were converted to *r* using the formulas in Rosenthal (1984, Equations 2.16, 2.17, and 2.15, respectively). For two studies only *p* values were available. The corresponding *Z* was used to obtain *r* (Rosenthal, 1984, Equation 2.18). Finally, a few studies reported means and *F*s for *df* < 1. Nicholson and Berman (1983) provide the formula for estimating the within-group standard deviation from the reported *F* values (Equation 3). The means were used with this standard deviation to calculate *d*, which was then converted to *r* (Rosenthal, 1984, Equation 2.19). For studies in which a nonsignificant relation between self-concept and cognitive performance was reported, but no further information was provided, the *r* was set at zero (Cooper, 1979).

Exact probabilities for the *r* values for small degrees of freedom were calculated from the corresponding *t* s. The *Z*s were then obtained from a table of *Z* values. For large degrees of freedom the approximation of *Z* was obtained using Rosenthal's (1984) Equation 5.15. For chi-square ($df = 1$), *Z* was obtained from the square root of chi-square (Rosenthal, 1984).

Tables 1, 3, 4, 6, 7, 9, 10, 12, 13, and 15 list the studies identified through the literature search. Tables 1 and 3 contain the studies on spatial perception, Tables 4 and 6 those on mental rotation, Tables 7 and 9 those on spatial visualization, Tables 10 and 12 those on mathematical skills, and Tables 13 and 15 those on verbal skills. Within each table, results are presented separately for female and male subjects and are further grouped by the subjects' ages (i.e., adults [usually college students], adolescents [Grades 7–12], and children [usually Grades 5 and 6]). For each of the cognitive areas, one table contains the results for M-F scales and the other for androgyny measures (M and F scales). The table entries for each study are the estimated *r*s and their associated *Z* values, with positive *Z*s indicating support for Nash's (1979) hypothesis. Note that some columns have no entries. In some studies, the subjects were of only one sex. Quite infrequently only the M or the F scale from an androgyny measure was analyzed (e.g., Cramond, 1983). If the same study contained results from more than one of the same type of self-concept measure (e.g., two M-F measures), results from the measures were averaged, thus maintaining independence among studies within each column of a table (Glass et al., 1981; Rosenthal, 1984). Occasionally both M-F and androgyny measures were used in the same study, and therefore such studies are represented in both tables. Similarly, studies that included data on more than one of the three cognitive variables are included in all pertinent tables. As with the self-concept measures, when multiple measures of one cognitive variable (e.g., several spatial visualization tests) were used in a study, the tabled *r* for that study is the average (using Fisher's *z*) of the *r*s for the several measures. However, when the results from more than one sample or age group were reported in an article, *r*s and *Z*s are reported for each group.

Table 1 Relation of Masculinity-Femininity to Performance on Spatial Perception Tasks

Table 1
Relation of Masculinity–Femininity to Performance on Spatial Perception Tasks

Study	Boys and men *df*	Boys and men *r*	Boys and men *Z*	Girls and women *df*	Girls and women *r*	Girls and women *Z*
Adults						
Arbuthnot & Gruenfeld (1969)	36	.00[a]	0.00			
Fiebert (1967)	27	.00[a]	0.00	30	.44	2.52
Gruenfeld & Arbuthnot (1968)	53	−.05	−0.36			
Gruenfeld & Arbuthnot (1969)	53	−.05	−0.36			
Hanson, Jamison, & Signorella (1982)[b]	15	.30[a]	1.17	22	.20[a]	0.93
Hyde, Geiringer, & Yen (1975)	33	.02	0.11	44	−.06	−0.40
Jamison & Signorella (1980)[b]	25	.38	1.96	34	.45	2.76
McWay (1976)[b]	66	.15[d]	1.22	66	.00[a]	0.00
Popiel & DeLisi (1984)[b,e]	86	.04[d]	0.37	86	.04[d]	0.37
Rosenberg (1976)	51	.20	1.43	47	.21	1.45
Signorella, Jamison, & Krupa (1985)[b]	82	.17[a]	1.58	65	.12[a]	0.96
Signorella et al. (1985)[b]	45	−.10[c]	−0.71	36	.34[a]	2.12
Vaught (1965)[b,e]	162	.25[d]	3.24	162	.25[d]	3.24
Witecki (1978)	48	.04	0.28	48	.16	1.11
Adolescents						
Arbuthnot (1975)	108	−.22[d]	−2.31			
Jamison & Signorella (1979)	17	−.55	−2.44	8	.72	2.35
McGilligan & Barclay (1974)[e]	34	.38[d]	2.30	34	.38[d]	2.30
Orloff (1977)	28	−.03	−0.16	28	.64	3.81
Signorella & Jamison (1978)[b]	29	−.12[c]	−0.67	22	.61[c]	3.08
Weissman (1972)	17	.22	0.91	19	−.23	−1.01

Note. Positive *r*s and *Z*s indicate a relation between more masculine masculinity–femininity scores and better spatial perception performance.
[a] *r* derived from *p* value or verbal description. [b] Androgynous (balanced) or middle group eliminated. [c] *r* derived from chi-square. [d] *r* derived from *t*, *F*, or *M*s and *SD*s. [e] Separate estimates for the sexes were not reported; thus values were taken from the combined samples.

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Table 3 Relation of Masculine and Feminine Scales (From Androgyny Measures) to Performance on Spatial Perception Tasks

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Table 4 Relation of Masculinity-Femininity to Performance on Mental Rotation Tasks

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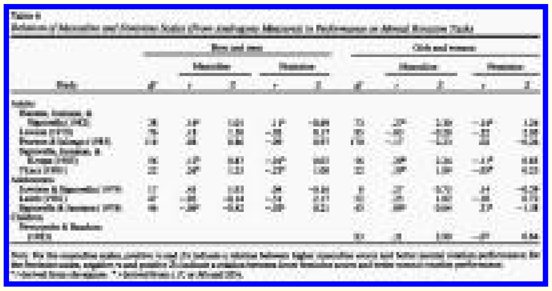

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Table 6 Relation of Masculine and Feminine Scales (From Androgyny Measures) to Performance on Mental Rotation Tasks

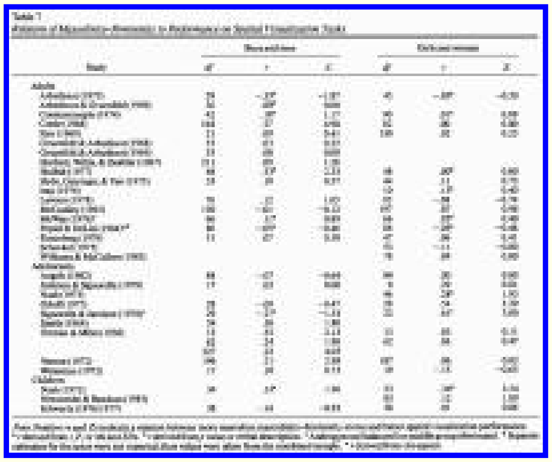

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Table 7 Relation of Masculinity-Femininity to Performance on Spatial Visualization Tasks

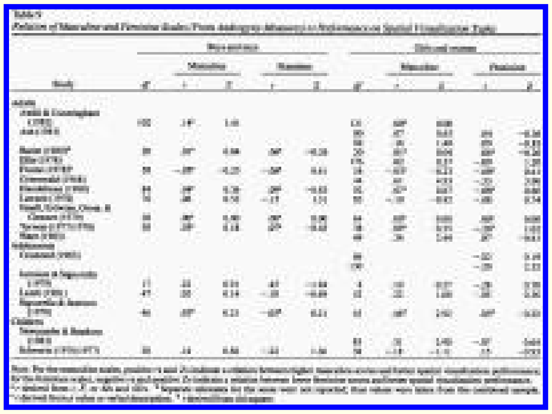

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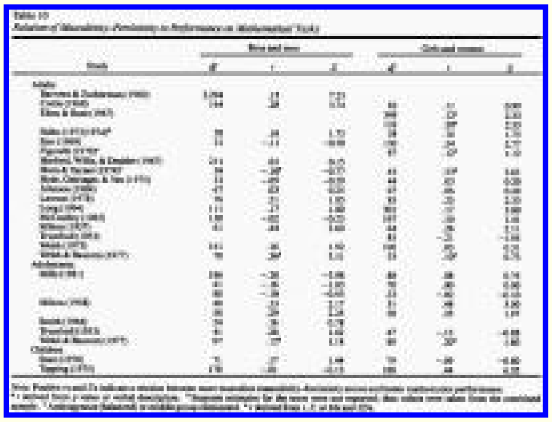
Table 9 Relation of Masculine and Feminine Scales (From Androgyny Measures) to Performance on Spatial Visualization Tasks

Table 10 Relation of Masculinity-Femininity to Performance on Mathematical Tasks



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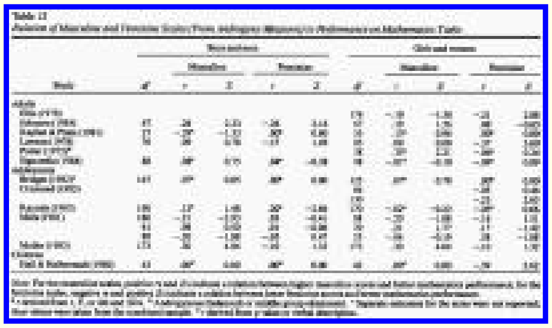

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Table 12 Relation of Masculine and Feminine Scales (From Androgyny Measures) to Performance on Mathematics Tasks

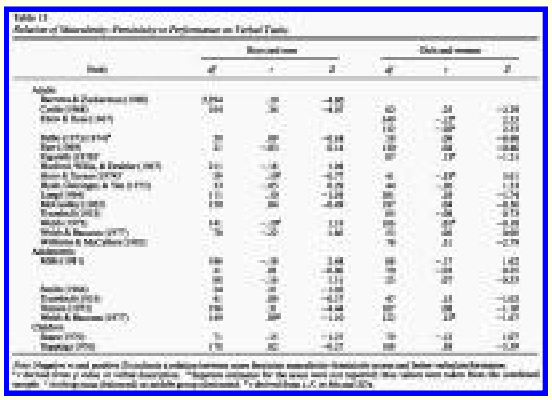

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Table 13 Relation of Masculinity-Femininity to Performance on Verbal Tasks

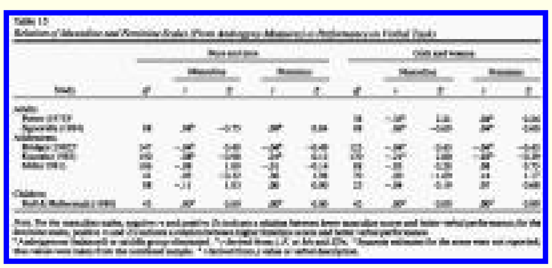

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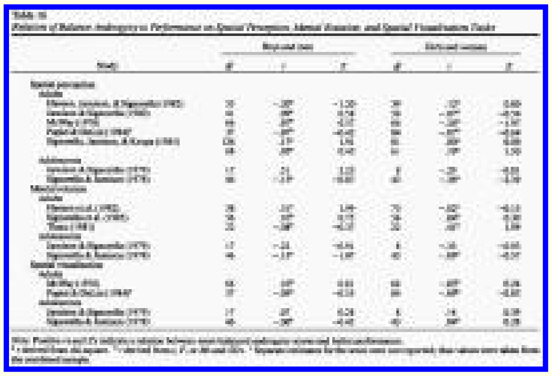
Table 15 Relation of Masculine and Feminine Scales (From Androgyny Measures) to Performance on Verbal Tasks

In a few studies (e.g., Elton & Rose, 1967) subjects were classified according to the discrepancy in their math and verbal scores (e.g., high math/low verbal). The values from these comparisons were included in both the math and verbal tables. Occasionally there was a middle group that had to be eliminated because it did not make sense to combine it with either of the extreme groups. A similar problem arose in a few M-F studies (e.g., Vaught, 1965), in which three groups of M-F were formed. In these cases as well, the middle group was excluded.

Some problems arose in classifying self-concept measures into the M-F or androgyny category. As noted earlier, both the BSRI and the PAQ have independent M and F scales. The PAQ, however, also has an M-F scale. Thus, any PAQ M-F results were included in the M-F category. For the BSRI, the original scoring system consisted of subtracting M scores from F scores (Bem, 1974). Taylor and Hall (1982) have argued that this signed difference score is most comparable to the score obtained from the earlier M-F scales. In their view, the only way to use a difference score to test the hypothesis that androgynous persons show superior functioning is to use the absolute value of the F-M difference to see whether smaller differences (i.e., a balance between M and F) are associated with superior functioning. Two of the studies in our sample contained information on the absolute value of the difference between F and M, and this information is discussed in the Results section (see Table 16). Those studies that used the signed difference scoring method on an androgyny measure were included in the M-F category. For some of these studies the signed difference score was simply correlated with cognitive performance. In a few of these studies, however, the signed difference score was used to form three self-concept groups: masculine, androgynous (balanced), and feminine. In these latter cases the androgynous subjects had to be excluded from any test of M versus F effects because the formulas for calculating effect sizes allow for only two groups of subjects. Androgynous subjects cannot be combined legitimately with either the feminine or masculine subjects. In those studies in which an M-F score was available from the BSRI or PAQ as well as from an older measure, the BSRI or PAQ was used. The remaining studies with androgyny measures provided independent assessments of M and F effects. For such studies another androgyny hypothesis can be tested—that persons high in both M and F will perform better than other persons (Taylor & Hall, 1982). The published versions of our first studies (Jamison & Signorella, 1980; Signorella & Jamison, 1978) contained only the difference score from the BSRI. We also calculated the independent M and F effects from our data and included them in the androgyny tables.

Table 16 Relation of Balance Androgyny to Performance on Spatial Perception, Mental Rotation, and Spatial Visualization Tasks



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Meta-analytic calculations were performed separately for the male and female values in each table using the arithmetic functions in SPSS (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975). The results of these calculations are contained in Table 2, Table 5, Table 8, Table 11, Tables 14 and 17. The average *r*s were calculated using Fisher's *z*. We used the adding *Z*s method to combine the probabilities (Rosenthal, 1984, Equation 5.4). Rosenthal (1984) described this as the most widely applicable method, and it seems to be used most frequently by meta-analysts. As a check on these results, three other methods were also used: adding weighted *Z* s, testing mean *p*, and testing mean *Z* (Rosenthal, 1984, Equations 5.5, 5.6, and 5.7, respectively). In almost all cases, the four methods agreed. Any cases in which adding *Z*s produced significant combined probabilities but the other methods did not are noted. The mean *Z*s were used to make the “file drawer” calculation (Rosenthal, 1984, Equation 5.17). The value obtained from the file drawer calculation indicates how many studies hidden in file drawers and averaging no effect would be necessary to drop the combined *p* value to .05.

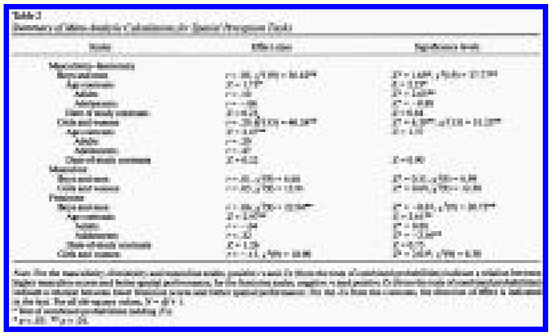

Table 2 Summary of Meta-Analytic Calculations for Spatial Perception Tasks

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Table 5 Summary of Meta-Analytic Calculations for Mental Rotation Tasks

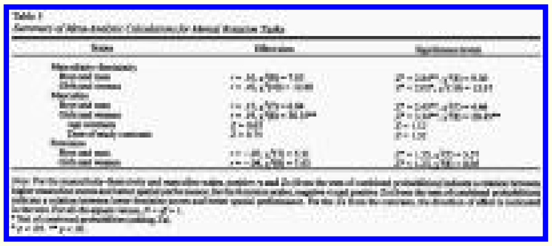

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Table 8 Summary of Meta-Analytic Calculations for Spatial Visualization Tasks

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[Help with image viewing]

Table 11 Summary of Meta-Analytic Calculations for Mathematical Tasks

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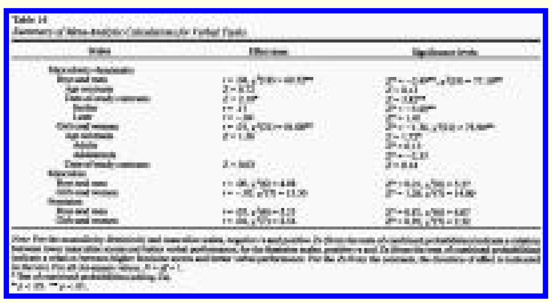

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Table 14 Summary of Meta-Analytic Calculations for Verbal Tasks

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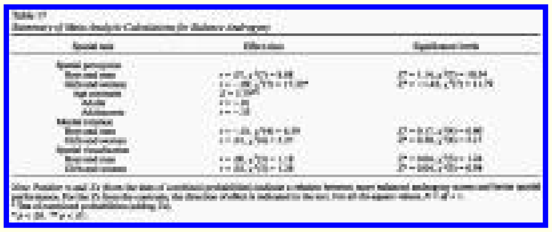
Table 17 Summary of Meta-Analytic Calculations for Balance Androgyny



[Help with image viewing]

For each group of studies, the homogeneity of the effect sizes (Rosenthal, 1984, Equation 4.15) and of significance levels (Equation 4.14) were tested. If significant heterogeneity was obtained, the samples were subdivided according to the factors identified in the introduction (i.e., subjects' age and time of study). Orthogonal contrasts were performed on both the *r*s (Rosenthal, 1984, Equation 4.27) and the *Z*s (Equation 4.26) to determine whether there were differences between results for adults versus adolescents and according to the date of the study. On the age contrasts, children's results were included with those of adolescents, as most of the children in these studies were fifth and sixth graders. On the date-of-study contrasts, the weight used was the study date minus the average study date (Rosenthal & Rubin, 1982).

Results

Spatial Tasks

Tables 1, 3, 4, 6, 7, and 9 contain the *r*s and associated *Z* values for the relations of M-F, M, and F to performance on spatial perception, mental rotation, and spatial visualization tasks. Tables 2, 5, and 8 contain the average *r* s; the values from the tests of combined probabilities, homogeneity of effect sizes, and significance levels; and age and date-of-study contrasts. Positive *r* values indicate a relation between better spatial performance and higher M-F scores (more masculine and less feminine), higher M scores, or higher F scores. Positive *Z* values in the data tables and from the tests of combined probabilities indicate that better performance is associated with higher M-F scores, higher M scores, or lower F scores, whereas negative *Z* values indicate that better performance is associated with lower M-F scores, lower M scores, or higher F scores. Thus, positive *Z*s in the data tables and from the tests of the combined probabilities should be interpreted as support for Nash's (1979) hypothesis. To avoid any confusion resulting from multiplying positive and negative contrast weights with positive and negative *Z*s or *r* s, all *Z*s for the contrasts are reported as positive, and the direction of the effect is indicated in the text. All *p* values reported are one-tailed.

Spatial perception

For the M-F measures (Tables 1 and 2), there was support for the Nash hypothesis among girls and women. The average correlation between M-F and spatial perception was .29 and the test of the combined probabilities was significant. According to the file drawer calculation, 226 studies with an average effect of zero would be necessary to reduce the *p* to .05. As there was significant heterogeneity among both effect sizes and significance levels, age and date-of-study contrasts were calculated. The age contrast on effect size was significant, and the average *r* for adolescent girls (*n* = 5) of .47 was considerably larger than the .20 for women (*n* = 11). The direction of the age effect on significance level was the same as on effect size, although only marginally significant. Neither of the date-of-study contrasts was significant.

For boys and men, there was a weaker although significant relation between M-F and spatial perception (average *r* = .05). Adding only one study with no effect would reduce the *p* to .05. There was significant heterogeneity in effect sizes and significance levels. The adult versus adolescent contrast was significant on both effect size and significance level. Among the men (*n* = 14), the average effect size was .10, the combined probabilities were significant, and the file drawer number was 22. In contrast, among adolescent boys (*n* = 6) there was a small association between better performance and more feminine scores (average *r* = - .06), although the combined probabilities were not significant. Examination of these latter studies suggests that averaging may not be the most appropriate way to summarize the results. Two studies show an association between masculinity and better performance and four show an association between femininity and better performance. Note that one of the studies showing a relatively large relation between masculinity and better spatial perception has an estimate of effect size based on the sexes combined (McGilligan & Barclay, 1974). Although no significant interaction with sex was reported, it is still possible that the effect for boys alone was not as strong as for girls alone. The date-of-study contrasts on effect size and on significance level were not significant.

On the androgyny measures (Tables 2 and 3), weaker associations with spatial perception for girls and women were found than on the M-F measures. On the M scales, with an average *r* of .05, the combined probabilities were not significant. In addition, there was homogeneity of effect sizes and significance levels. For the F scales (average *r* = - .13), however, there was a significant association between better performance and lower F scores. The file drawer number of 5 shows that this is not a robust relation. The tests for homogeneity of effect sizes and significance levels were not significant.

Among boys and men, with an average *r* of .01, there was no association between M scores and spatial perception performance. There was also homogeneity of effect sizes and significance levels. On the F scales, with an average *r* of .06, the combined probabilities were not significant either. Unlike the findings for the M scales, there was heterogeneity of effect sizes and significance levels. The age contrast was significant for both effect size and significance level. A pattern similar to that for boys and men on the M-F measures emerged, suggesting better performance by adolescent boys with feminine self-concepts. Among adults (*n* = 7), with an average *r* of - .04, there was no significant association. Among adolescents (*n* = 3), the average *r* was .31. The combined probabilities were significant, although the file drawer number was only 4. The date-of-study contrasts were not significant for effect sizes or significance levels.

Mental rotation

For the M-F measures (Tables 4 and 5), the association between better performance and more masculine M-F scores was .16 for boys and men and .10 for girls and women. In both cases the combined probabilities were significant. In addition, there was homogeneity of effect sizes and significance levels for both sexes. Only 18 studies with boys and men or 6 studies with girls and women averaging no effect would be necessary to reduce the combined probabilities to .05.

The same pattern as on the M-F measures emerges on the androgyny measures (Tables 5 and 6). Among boys and men, the average *r* for M scales was .15 and for F scales was - .07. For M scores, the combined probabilities were significant, the file drawer number was 10, and there was homogeneity of effect sizes and significance levels. For F scores, the combined probabilities were not significant, and there was homogeneity of effect sizes and significance levels.

The mental rotation results for girls and women on androgyny measures were similar to those for boys and men, with average *r*s of .19 and - .04 for the M and F scales, respectively. The combined probabilities were significant for M scores, with a file drawer number of 28. There was also heterogeneity of effect sizes and significance levels. Both age and date-of-study contrasts were performed, but nothing significant emerged. The combined probabilities for F scores were not significant. There was homogeneity of effect sizes and significance levels.

Spatial visualization

On the M-F measures (Tables 7 and 8), there was an average correlation of .10 with spatial performance for both sexes. For boys and men, there was a significant combined probability, with a file drawer number of 167. There was, however, heterogeneity of effect sizes and significance levels. The age contrasts were not significant, but the date-of-study contrasts were highly significant, indicating bigger effects (i.e., larger positive associations with M-F scores) among earlier studies. To illustrate, studies before the median study date of 1974 had an average *r* of .19 and significant combined probabilities (file drawer number = 139), compared with an average *r* of .02 and nonsignificant combined probabilities for the more recent studies. For girls and women, the overall combined probabilities were significant as well, with a file drawer number of 59. There was homogeneity of effect sizes and significance levels.[1]

For girls and women on the androgyny measures (Tables 8 and 9), a pattern similar to that on the M-F measures was observed. The average *r* for the M scales and spatial visualization performance was .13. The combined probabilities were significant, with a file drawer number of 85. There was, however, heterogeneity in effect sizes and significance levels. The age contrasts of adults versus adolescents were not significant, but the date-of-study contrasts were. The direction of the date-of-study effect indicated that earlier studies had bigger effects. However, when the sample was split at the median study date (1980), later studies averaged slightly larger effects than earlier studies. In addition, for both earlier and later studies, the tests of the combined probabilities were significant. The date-of-study effect appears to have been caused by two particularly large effects among the earlier studies. On the F scales, the average *r* was - .08. The test of the combined probabilities was significant, with a file drawer number of 19. There was homogeneity of effect sizes and significance levels.

Contrasting with the results for girls and women, neither of the combined probabilities for boys and men reached the .05 level. The average *r* was .06, with homogeneity of effect sizes and significance levels. On the F scales, with an average *r* of .01, there was homogeneity of effect sizes and significance levels.

Mathematical Tasks

Tables 10 and 12 contain the *r*s and associated Zs for the relations of M-F, M, and F to performance on mathematical tasks. Table 11 contains the average *r* s, the values from the tests of the combined probabilities, homogeneity of effect sizes, and of significance levels, as well as age and date-of-study contrasts. Positive *r* values indicate a relation between better math performance and higher M-F scores (more masculine and less feminine), higher M scores, or higher F scores. Positive Z values in the data tables and from the tests of combined probabilities indicate that better performance is associated with higher M-F scores, higher M scores, or lower F scores, whereas negative Z values indicate that better performance is associated with lower M-F scores, lower M scores, or higher F scores. Thus, positive Zs in the tables and from the tests of combined probabilities support Nash's (1979) hypothesis. All Zs for the contrasts are reported as positive, with the direction of effect indicated in the text. All *p* values reported are one-tailed.

On the M-F measures (Tables 10 and 11), the average *r* was .11 for boys and men. The combined probabilities were significant, with a file drawer number of 248. As there was heterogeneity of effect sizes and significance levels, the age and date-of-study contrasts were performed. There were large date-of-study effects on both effect size and significance level, with larger effects in earlier studies. To illustrate, studies from the median study year (1970) or earlier ($n = 12$) had an average *r* of .18 and significant combined probabilities (file drawer number = 205), whereas the more recent studies had an average *r* of .03 and nonsignificant combined probabilities. The age contrast was not significant for effect size, but was for significance level. The overall effect described previously was primarily among adults, as the test of the combined probabilities was significant for adults but not for adolescents. Age may interact with the date of study, however. To examine this possibility, the sample was divided at the median date of study and age contrasts were performed on the Z scores for each subsample. For the studies from 1970 or earlier, the age contrast was not significant, $Z = 0.96$, $p = .1685$, although the trend was toward larger effects with adults. For the more recent studies, the age contrast was significant, $Z = 3.58$, $p = .0001$. For adults, the test of the combined probabilities was significant, $Z = 2.95$ and $p = .0016$, with a file drawer number of 16. Better performance was associated with a more masculine M-F score. For adolescents, the test of the combined probabilities was also significant, $Z = -2.19$ and $p = .0143$, with a file drawer number of 4. Better performance was associated with a more feminine M-F score. Thus, among the earlier studies, more masculine M-F scores were associated with better performance for both adults and adolescents. Among the later studies, a pattern similar to that on spatial perception tasks emerged, with masculinity predicting better mathematics performance for adults, but femininity predicting better performance for adolescents.

For girls and women (average *r* = .15), the test of the combined probabilities was significant, with a file drawer number of 447. There was also heterogeneity of effect sizes and significance levels. Nothing significant emerged on the age contrasts or on the date-of-study contrasts. Thus, there is unexplained variability in this sample.[2]

For the boys and men on the androgyny measures (Tables 11 and 12), the average *r* with mathematics performance was .03 on the M scales and - .03 on the F scales. The test of the combined probabilities on the M scales was not significant, but there was heterogeneity of effect sizes and significance levels. The age contrasts were not significant. The date-of-study contrasts indicated that the more recent studies showed a relation between higher M scores and better performance. There is not, of course, a very wide range of study dates in this sample (1978–1984). This effect may be in part the same age effect noted earlier. Three of the five later studies (average *r* = .17) are with adults, whereas four of the six earlier studies (average *r* = - .09) are with adolescents. The small number of studies in the sample precludes any firm conclusions. For the F scales, the test of the combined probabilities was not significant and there was homogeneity of both effect sizes and significance levels.

For the girls and women, the average *r* was .07 for M scales and - .07 for F scales. The test of the combined probabilities was significant for M scales. This is not, however, a robust finding, as indicated by the file drawer number of 8, and by the failure of testing mean *p* and testing mean *Z* to produce significant values. There is also unexplained heterogeneity of effect sizes and of significance levels. Neither the age contrasts nor the date-of-study contrasts even approached significance. The test of the combined probabilities for the F scales was significant, with a file drawer number of 42. Heterogeneity of effect sizes and significance levels was also present, but once again, neither of the contrasts was significant. Inspection of Table 12 reveals no apparent pattern to the variability.

Verbal Tasks

Tables 13 and 15 contain the *r*s and associated *Z* values for the relations of M-F, M, and F to performance on verbal tasks. Table 14 contains the average *r* s, and the values from the tests of the combined probabilities, homogeneity of effect sizes and significance levels, and age and date-of-study contrasts. Positive *r* values indicate a relation between better verbal performance and higher M-F scores (more masculine and less feminine), higher M scores, or higher F scores. Positive *Z* values in the data tables and from the tests of combined probabilities indicate that better performance is associated with lower M-F scores, lower M scores, or higher F scores, whereas negative *Z* values indicate that better performance is associated with higher M-F scores, higher M scores, or lower F scores. Thus, positive *Z*s in the data tables and from the tests of the combined probabilities support Nash's (1979) hypothesis. All *Z*s for the contrasts are reported as positive, and the direction of the effect is indicated in the text. All *p* values reported are one-tailed.

For M-F measures, the average *r* was .04 for boys and men, thus indicating a relation between more masculine M-F scores and better verbal performance. For boys and men, the test of the combined probabilities was significant. This is a questionable finding, as the tests of mean *p* and mean *Z* were not significant. There was heterogeneity of effect sizes and significance levels, which seem to be due to date-of-study differences. Earlier studies tended to have bigger effects (i.e., more positive associations between M-F scores and better verbal performance). Studies from 1972 or earlier (n = 10) had an average r of .11 and significant combined probabilities (file drawer number = 109), whereas the more recent studies (n = 10) had an average r of - .04 and nonsignificant combined probabilities. The age contrasts were not significant.

For girls and women (average r = .01), the test of the combined probabilities was not significant. There was, however, heterogeneity of effect sizes and significance levels. Unlike the situation for boys and men, date of study had no effect on effect size or on significance level. There was an age effect on significance level. The test of the combined probabilities was not significant for adults (n = 14), but it was for adolescents (n = 8, file drawer number = 8), indicating that the relation between more masculine M-F scores and better verbal performance was primarily among adolescents.

On the androgyny measures (Table 15), there were no significant associations for either sex. For boys and men on the M scales, there was an average r of zero and homogeneity of both effect sizes and significance levels. On the F scales, there was an average r of .05 and homogeneity of both effect sizes and significance levels. For girls and women on the M scales, there was an average r of - .05 and homogeneity of both effect sizes and significance levels. Although the chi-square values from the homogeneity tests are close to the .05 level, it is clear from an inspection of Table 10 that there is no apparent pattern to the variability. On the F scales, there was an average r of .04 and homogeneity of effect sizes and significance levels.

Androgyny and Cognitive Performance

As noted in the Methods section, Taylor and Hall (1982) suggested two androgyny hypotheses that could be tested using the new androgyny measures. The first hypothesis is that balanced individuals (i.e., those with little difference in M and F scores) will perform better than masculine or feminine individuals (i.e., those with larger M vs. F differences). In two of the studies in the sample the absolute value of the F-M difference could be related to cognitive performance. There were a few other studies in which the signed F-M difference score was used to form groups of feminine, androgynous, and masculine subjects. The two studies that reported correlations between the signed F-M scores only and cognitive performance (Rosenberg, 1976; Williams & McCullers, 1983) could not be included in this comparison. Tables 16 and 17 contain the comparison of balanced androgynous versus masculine and feminine. For studies in which the data were in contingency tables, the masculine and feminine cells were combined. For studies in which the data were means and standard deviations, contrasts were performed (i.e., androgynous vs. masculine and feminine). Positive *r*s and *Z*s in the data table and from the tests of combined probabilities indicate an association between balanced androgyny and better cognitive performance. All *Z*s for the contrasts are reported as positive, and the direction of the effect is indicated in the text. All *p* values reported are one-tailed.

For the studies with measures of spatial perception, the average *r* was .07 for boys and men and - .09 for girls and women. The test of combined probabilities for boys and men was not significant, with homogeneity of effect sizes and significance levels. The test of combined probabilities for girls and women was not significant either. There was homogeneity of significance levels but heterogeneity of effect sizes. The variability appears to be due to an age difference. The average *r* was - .01 for adults and - .33 for adolescents, indicating poorer performance among the androgynous adolescents. This effect is probably due to better performances by adolescent girls with more masculine self-concepts, as shown in the earlier analysis (see Table 1).

There was no relation between androgyny and mental rotation performance for either sex. For boys and men, with an average *r* of - .01, there was homogeneity of effect sizes and of significance levels. For girls and women, with an average *r* of .01, there was homogeneity of effect sizes and significance levels.

For spatial visualization as well, there were no significant associations for either sex. For boys and men, with an average *r* of zero, there was homogeneity of effect sizes and of significance levels. For girls and women, with an average *r* of .02, there was also homogeneity of effect sizes and significance levels.

Only one effect size each was available for mathematical and verbal tasks (Figurelli, 1978). In this study (*df* = 178), the association between androgyny and mathematics performance was .01, and between androgyny and verbal performance, .03.

The other androgyny hypothesis is that better performance is associated with high masculine *and* feminine scores. This hypothesis can be tested with the existing data in Table 3, Table 6, Table 9, Tables 12, and 15. As can be seen, they do not support the second androgyny hypothesis.

Discussion

In contrast to the impression left by many commentators on sex differences and self-concept, the results from our meta-analysis showed consistent and significant associations between gender self-concept and cognitive performance. For the most part these associations supported (Nash's (1979) hypothesis. The only outright failure to support Nash's hypothesis occurred among the verbal tasks. For the spatial and mathematical tasks, we found generally that persons who describe themselves as more masculine and/or less feminine do better than persons who describe themselves as more feminine and/or less masculine. This general pattern varied somewhat in relation to the type of spatial task (i.e., Linn & Petersen's, 1985, three categories), subjects' ages, and date of study. In the following paragraphs we summarize our results for each type of cognitive task. We then discuss the implications of the findings for various models of the development of sex differences.

Gender Self-Concept and Cognitive Performance

Verbal tasks

No significant associations emerged between better performance and higher feminine scores. In fact, on the M-F measures there was an association between better verbal performance and higher masculine scores for earlier studies with male subjects, and for studies with adolescent girls. There are several possible reasons for the failure to support Nash's (1979) hypothesis with verbal tasks. One explanation is suggested by the inconsistency in direction of association found in the date-of-study effect that occurred on M-F measures for boys and men. As most of the studies on stereotyping of cognive tasks cited in the introduction are fairly recent (e.g., McMahan, 1976), it may be that stereotyping of verbal tasks has only recently been clearly feminine. This alternative does not, however, explain the association between masculinity and verbal performance in the studies with adolescent girls. Second, the smaller sex differences in verbal performance than in most mathematical or spatial tasks suggests that self-concept may play a much smaller role in the verbal area. Finally, interpretation of the verbal results is hampered by the paucity of studies with androgyny measures. Most of the associations between verbal performance and M and F scores were consistent with Nash's hypothesis, but none of the tests of combined probabilities was significant.

Spatial perception

For girls and women, there was a robust association between more masculine M-F scores and better performance, with particularly large effect sizes for adolescents. A smaller, less robust association of lower F scores and better performance was found with the androgyny measures. For boys and men, the association of more masculine M-F scores with better performance was significant only for adults. The same association was not present for adolescent boys because several studies found better performance by boys with more feminine M-F scores. A similar pattern emerged on the androgyny measures, in that the studies with adolescent boys provided some evidence of an association between higher F scores and better performance. The results for the adolescent boys must be considered only suggestive because of the small sample sizes involved. There was no evidence, however, that boys with high feminine scores were exclusively androgynous, as there was no corresponding association between high M scores and better performance.

Mathematics

The results from the mathematical tasks were similar to the spatial perception results in several respects. For adolescent boys in more recent studies, better performance was associated with more feminine M-F scores. For men, in contrast, better performance was associated with more masculine M-F scores. Neither M nor F scores were related to performance for men and boys, but a date of study effect emerged on the M scores, indicating that higher M scores were associated with better performance in later studies and that lower M scores were associated with better performance in earlier studies. As many of the earlier studies were with adolescents, this may be the same age effect found on the M-F measures. For the girls and women, better performance was associated with more masculine M-F scores, higher M scores, and lower F scores. There were no age differences in the girls' and women's results, but as with the spatial perception tasks, performance was more reliably related to M-F and F scores than to M scores.

Mental rotation

In contrast with spatial perception and mathematical tasks, there were similar patterns for the sexes on the mental rotation tasks. Higher M-F scores and higher M scores were both associated with better performance, whereas F scores were not associated with mental rotation performance. In addition, there were neither age nor date-of-study differences.

It should be mentioned that within Linn and Petersen's (1985) mental rotation category, larger sex differences were found for the Mental Rotations Test than for any other test. In our sample, only Angelo (1982) and Pearson and Ialongo (1983) used the Mental Rotations Test. Although the results for the boys and men in those two studies were consistent with the general mental rotation findings, the results for the girls and women were not. In both of those studies, however, another type of spatial measure was used as well, and in both cases the results for girls and women were again discrepant. The results of the two studies suggest sample rather than test differences, but additional research with the Mental Rotations Test is clearly needed.

Spatial visualization

For boys and men, a significant association of higher M-F scores with better performance occurred only for the earlier studies. With the androgyny measures, which by necessity come from more recent studies, there were no significant associations. For girls and women, higher M-F, higher M, and lower F scores were associated with better performance, with a slight tendency toward bigger effects on the M scales among earlier studies.

As with the mental rotation tasks, we found no age differences for the spatial visualization tasks. The similarity between spatial visualization and mental rotation may result from the rotation component present in many spatial visualization tasks (Linn & Petersen, 1985). The spatial visualization results, however, showed date-of-study effects not present in the mental rotation studies, in that earlier studies had bigger effects. This change may reflect the trend toward better spatial performance by girls and women relative to boys and men (Becker & Hedges, 1984; Rosenthal & Rubin, 1982), and the failure to find significant sex differences in spatial visualization in recent studies (Linn & Petersen, 1985). Why the date-of-study effects emerged more strongly for boys and men than for girls and women is unclear. On the M-F measures, there may have been a better chance of detecting such effects because there were more older studies with male than with female subjects. Comparison of the sexes on the androgyny measures was difficult because, unlike studies of spatial perception or mental rotation, an unusually large number of spatial visualization studies used only one sex.

Explanations for the Relation of Self-Concept to Cognitive Performance

Androgyny

Our meta-analysis provides no support for the hypothesis that androgynous persons perform better on cognitive tasks than nonandrogynous persons. In contrast to the present findings, meta-analyses by Taylor and Hall (1982) and Whitley (1983, 1985) showed positive associations between both higher M and F scores and various measures of mental health. In addition, the M scores in those studies accounted for more of the variance in mental health than did the F scores, a pattern we observed only on mental rotation tasks. Thus, it appears that the models used to explain the mental health findings (e.g., Whitley, 1985) cannot be used to account for the relation of M and F to cognitive performance.

Another problem for the androgyny measures was the finding that the associations of M-F scores to cognitive performance tended to be more robust, as indicated by the file drawer calculations, than those of M or F scores to cognitive performance. We are not, however, advocating a return to the use of the M-F measures. The less robust associations for androgyny versus M-F measures must be at least in part a function of the fewer studies done with the newer measures. For example, for the association between lower F scores and better spatial perception performance for girls and women ($n = 10$), only 5 studies averaging no effect would reduce the combined p to .05. If 10 more studies were available averaging the same size of effect as in the first 10 studies, the file drawer number increases to 41. Given the similarity between the M-F and androgyny results, it seems unlikely that future studies with androgyny measures will change the general conclusions in the spatial and mathematical areas. Nonetheless, the use of independent M and F measures allows for greater conceptual clarity. For example, M-F measures do not allow for the distinction between acceptance of masculinity and rejection of femininity. In the present findings, girls' and women's mental rotation performance was associated with an acceptance of masculinity, whereas their spatial perception performance was associated with a rejection of femininity.

Gender schemas

In the introduction we proposed that the cognitive or schematic-processing approach to gender typing might explain the relations of M and F to cognitive performance. According to such theories, gender stereotyping in self-concept leads persons to choose activities consistent with the self-concept and avoid inconsistent activities. This is a fairly simple model that provides the best fit to the pattern found for mental rotation, where, at all ages and for both sexes, those with higher M scores did better than those with lower *M* scores.

According to the gender schema model, the key to explaining sex differences in mental rotation is to identify those masculine-stereotyped activities that result from a masculine self-concept and that help develop the ability to do mental rotation tasks. Because it appears that sex differences in mental rotation are present before adolescence, demonstrating such relations in children seems critical. Some evidence links activity preferences to spatial performance (see Newcombe, 1982, pp. 238–239; Signorella, Krupa, Jamison, & Lyons, in press). It has been shown, for example, that preferences for space-related activities (e.g., sports, car repair), the majority of which are also masculine-stereotyped, are related to spatial performance (e.g., Newcombe, Bandura, & Taylor, 1983). Many of the studies, however, are with college students. Among those studies with children, many did not use mental rotation measures (e.g., Connor & Serbin, 1977). Newcombe and Bandura (1983) did study sixth-grade girls with a measure of mental rotation, but failed to find an association between spatial performance and spatial activity preferences. This activity measure, however, may not have been suitable for that age. Thus, much more research is needed to substantiate the gender schema model, including the longitudinal studies or path analyses necessary to demonstrate the causal links outlined previously.

As the results of the meta-analysis leave open the direction of the associations, other models should be considered as well. Masculinity and femininity in self-concept may covary with mental rotation performance because both characteristics are caused by another factor, either experiential or biological. For example, the path analysis we suggested might demonstrate that those children with preferences for masculine-stereotyped activities develop masculine self-concepts along with their mental rotation ability. Evaluation of any biological explanations is difficult because so few studies are available. Information on the relations among masculinity and femininity in self-concept, spatial performance, and biological factors is either inconclusive or missing (e.g., Baucom, Besch, & Callahan, 1985; Huston, 1983, pp. 419–420; Linn & Petersen, 1985). Particularly needed are more data on the associations of M and F to biological factors, such as Baucom et al.'s (1985) study on hormone levels and Newcombe and Bandura's (1983) on the timing of puberty.

Model of academic choice

The age differences in the patterns for spatial perception and mathematics suggest a more complex model, such as the model of academic choice outlined by Eccles (Parsons) and her colleagues (e.g., Meece, Parsons, Kaczala, Goff, & Futterman, 1982). In this model the child's self-schemas will be influenced by his or her ability, by cultural values, and by the attitudes and behaviors of parents and teachers, and will in turn influence future achievement-related behaviors. Newcombe (1982) argued that for boys, achievement-related behaviors are inconsistently related to gender self-concept. On the one hand, “it is ‘masculine’ to like math and science, be intellectually inquiring,” but on the other hand, “such individuals may be perceived as ‘sissy’ and may be less likely to be involved in sports or heterosexual social activities” (Newcombe, 1982, p. 237). For boys, then, higher femininity or lower masculinity would sometimes predict better performance during childhood and early adolescence. No such inconsistency occurs for girls, whose masculine interests appear to increase through childhood (Huston, 1983, p. 407). Thus, for girls in childhood and early adolescence, achievement performance would be consistently related to acceptance of masculinity and rejection of femininity. Rejection of femininity would be the more differentiating factor because of the acceptability of masculine interests in girls.

If, as has been argued, adolescence is a time of enhanced sex-role pressures (e.g., Hill & Lynch, 1983; Nash, 1979), the masculine stereotyping of math and spatial skills should have different impacts on boys and girls. The masculinity of self-concepts may increase in boys who excel in math and spatial skills, whereas the skills of boys who were already masculine may increase as well. By adulthood, there would be a relation between masculinity and better performance. The corresponding sex-role pressures on girls during adolescence would lead to increased femininity in their self-concepts and a corresponding loss of interest and/or a failure to improve performance. The result would be a weakening of the relations between self-concept and performance and the emergence of consistent sex differences by middle-to-late adolescence. The speculations about changes in the relations of M and F to spatial perception and math performance from childhood to adolescence need to be tested by cross-sectional, or preferably, longitudinal studies.

A few other things should be noted about the association of self-concept with spatial perception and mathematics performance. Self-concept probably plays a more central role in spatial perception than in mathematics performance. Self-concept accounted for more of the variance in the former than in the latter, and there was unexplained heterogeneity in the mathematics effect sizes and significance levels. For mathematics, other factors in the model of academic choice probably play a more direct role in determining mathematical achievement than does self-concept. Eccles (Parsons), Adler, and Meece (1984) identified the importance or value of mathematics to the child (“subjective task value”) as a major factor in sex differences in math achievement. The impact of gender self-concept on math achievement may be mediated by this task-value factor.

Finally, the model just outlined leaves open the question of the origin of ability differences in spatial perception and mathematics. Whether biological or experiential factors or both are responsible for the initial ability differences, the results of the meta-analysis suggest that the sex-role pressures of adolescence may accentuate initially small differences between the sexes.

Conclusions

To put these findings into perspective, the magnitudes of the relations found between self-concept and cognitive performance should be considered. For example, the two largest effects are the 8% variance accounted for by the association of spatial perception and M-F in girls and women and the 4% variance accounted for by the association of mental rotation and M in girls and women. Cooper (1981), however, suggested that effect sizes must be interpreted within the context of a relevant area of research. Thus, the value of self-concept may be more reasonably judged by comparing the contributions of sex and self-concept. Based on the results of Hyde (1981) and Linn and Petersen (1985), it appears that sex accounts for between 1% and 20% of the variance in the cognitive areas included in this review. The largest effects are on the Mental Rotation Test (20%), which was rarely used in our sample, followed by spatial perception (9%), mathematics (4%), the remaining mental rotation tasks (2%), and verbal tasks (1%). Based on this, self-concept could be an important factor in explaining sex differences in cognition. Another way to interpret effect sizes is to use Rosenthal and Rubin's (Rosenthal, 1984) Binomial Effect Size Display. By their calculations, an r^2 of .04 is equivalent to a change in success rate from 40% to 60%, whereas an r^2 of .08 is equivalent to a change in success rate from 36% to 64%. Thus, for girls and women, a masculine self-concept means a noticeably better chance of performing well on mental rotation or spatial perception tasks.

In any case, a satisfactory explanation for sex differences in cognitive performance has not yet emerged (e.g., see Linn & Petersen, 1985). Certainly, masculinity and femininity in self-concept, either alone or interacting with biological factors, deserve further attention as mechanisms in the development of these differences.

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[1]The ninth-grade boys (n = 25) in Nash's (1975) study were excluded because they all said that they preferred to be boys. These boys, along with the other boys (sixth grade) and girls (sixth and ninth grades) who said that they preferred to be boys had better spatial scores than the boys (sixth grade) and girls (sixth and ninth grades) who said that they preferred to be girls. A sample of male college students (n = 21) from Imp (1976) also had to be excluded because in the primary analysis it was impossible to determine the direction of effect. A secondary analysis performed only on the data from high- and low-scoring female subjects did include complete information. We were also unable to retrieve a dissertation by Gump (cited in Arbuthnot, 1975) that Arbuthnot said showed a relation between masculinity and better performance. [Context Link]

[2]Johnson (1984) cites two unpublished studies by Berry (1958, 1959), one with both sexes and one with men only, which Johnson said showed no relation between M-F and problem-solving performance. [Context Link]

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