Sex Differences in Variability

David H. Schroeder

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ABSTRACT

A substantial body of research has demonstrated mean sex differences for a number of cognitive abilities such as structural visualization and verbal fluency (Halpern, 2000; Statistical Bulletin 1990-2). In recent years, sex differences in variability of scores have also been proposed as an explanation for the differential representation of males and females in STEM (Science, Technology, Engineering, and Mathematics) and other fields. In this study, sex differences in variability are examined for the aptitudes and knowledge areas that the Foundation studies.

For Foundation examinees tested in 2008-10, there were mean sex differences in line with the previous research literature. For variability, the sex differences were fairly modest, with a small trend toward greater variability among males. Regarding scores in the top 5% (the "right tail"), the ratio of the proportions of males and females in this range was 2.49 (in favor of males) for Structural Visualization and 0.46 (favoring females) for Silograms and 0.49 for Ideaphoria. When mean sex differences were statistically controlled, however, there were only small differences in the right-tail proportions, with most of the ratios between 0.92 and 1.26.

The results for 1998-2000 and 1988-90 were generally similar to those for 2008-10: (a) fairly small differences in variability, (b) right-tail differences for tests with well-established mean differences, and (c) relatively equal right-tail proportions when mean differences were accounted for—in other words, the right-tail differences did not appear to be due to differences in variability, for the most part.

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ACKNOWLEDGMENTS

This report is based on a paper titled *Gender Differences in Variability in Ability Factors Over Time*, which the author presented at the annual meeting of the International Society for Intelligence Research in 2012 (Schroeder, 2012a). In addition, the author presented related findings for the Foundation's 2004-2007 bargraph database at the annual meeting of the Association for Psychological Science in 2012 (Schroeder, 2012b).

As with many Foundation research projects, this study was made possible by the creation and maintenance of the Research Department's bargraph database over the last several decades. This database has been the result of the efforts of the Foundation's testing staff, who collected the data, and the Research Department's professional and support staff over the years, and the author is pleased to acknowledge their contributions.

INTRODUCTION

In recent years, considerable attention has been directed toward the under-representation of women in some STEM (Science, Technology, Engineering, and Mathematics) fields (Ceci & Williams, 2010a; Wang, Eccles, & Kenny, 2013). For example, only 7.1% of full professors in mathematics departments in the top 100 U.S. universities are female, as are just 4.4% of full professors in mechanical engineering departments (Nelson & Brammer, 2010). Among the factors that have been investigated in relation to the STEM issue are the distributions of males and females on various cognitive-ability dimensions. Although measures of general ability have shown little mean sex difference, there are well-established mean differences on a number of group factors and specific abilities, such as structural visualization (Halpern, 2000; Statistical Bulletin 1990-2).

In addition to mean differences, investigators have recently proposed that sex differences in variability may account for differing proportions of males and females in relatively selective positions (Ceci & Williams, 2010b; Johnson, Carothers, & Deary, 2008). To illustrate this issue, Figure 1 shows the distributions of stanine scores for a hypothetical ability for which there is no mean sex difference, but the male standard deviation is 1.5 times the female standard deviation. As can be seen, in the middle of the distribution, there are more females than males, and as one goes toward the extremes, there are increasing proportions of males in relation to the females. For Category 9, with the top 4% of the scores, there are 83% males and 17% females. If you keep going to, say, the top 1% or the top ½%, the disproportion gets even greater.

In the present study, sex differences in variability will be examined for the aptitudes and knowledge areas that the Foundation studies. Particular attention will be directed toward scores at the upper end of the distributions (the "right tails") and whether disproportions of males and females are due to mean differences or differences in variability. The Foundation's testing population is a reasonably fair sample on which to study these issues because its male and female subpopulations tend to be about equally selective and to come from similar educational and socioeconomic backgrounds.

METHOD

Samples

The samples for this study consisted of unselected paying clients (examinee code = 0) of the Foundation. Foundation examinees were selected from three time periods—2008-2010, 1998-2000, and 1988-1990—in order to determine if the trends observed in recent years were also present in previous periods. The 2008-2010 sample consisted of 8,391 males and 6,909 females. The examinees in the sample ranged in age from 14 to 65[1] with about one-third in high school, one-third college-age, and one-third adults (M = 24.3, SD = 10.5). In most cases, the examinees took the Foundation's battery for the purpose of gaining information about their aptitudes that they could use in making educational and occupational decisions. The Foundation's testing population tends to be more highly educated and more likely to be in professional occupations than the general U.S. population (Statistical Bulletin 2006-1) and further description is provided in Statistical Bulletin 2012-12.

The 1998-2000 sample was generally similar to the 2008-2010 sample, with 6,045 males and 6,079 females and an age range of 14 to 65 (M = 26.8, SD = 10.9). Finally, the 1988-1990 sample was similar to the other two samples, with 11,316 males and 10,191 females and an age range of 14 to 65 (M = 27.5, SD = 10.1).

Measures

The examinees in each of the samples took the Foundation's standard battery of aptitude and vocabulary tests. In this study, the 16 cognitive-ability scales in the battery were studied, and these scales are described in Table 1 in terms of the variables that they measure and their reliability coefficients. Because there are sizable age differences on many of the scales that were taken (see, e.g., Statistical Bulletins 2010-4 and 2010-5), all scores were partialled for age in terms of both linear and curvilinear (second- and third-order) effects.

In terms of statistical factors, the Foundation's standard battery yields four group factors—Spatial Ability, Speed of Reasoning, Numerical Ability, and Memory—in addition to a general factor (Haier et al., 2009). The score for the Spatial Ability factor was formed by summing standardized scores (z-scores) for Wiggly Block and Paper Folding; Speed of Reasoning was the sum of z-scores for Inductive Reasoning and Analytical Reasoning; Numerical Ability was the sum of z-scores for Number Series and Number Facility; and Memory was the sum of z-scores for Silograms and Number Memory; while the general factor was the sum of the factor scores for the four group factors.

[1] Fifteen examinees from 2008-2010 with ages greater than 65 years were deleted because of the difficulty of adjusting for age effects in that range. Similarly, 15 examinees were deleted from the 1998-2000 sample, and 9 examinees older than 65 and 5 13-year-olds were deleted from the 1988-1990 sample.

RESULTS

2008-2010 sample

The mean sex differences for the 2008-2010 sample for the individual scales and factors are shown in Table 2 and Figure 2. The pattern of mean differences in this sample replicates the pattern found in previous research (Halpern, 2000; Statistical Bulletin 1990-2). In terms of Cohen's d, which assesses the mean difference in standard-deviation units (Cohen, 1988), the largest male advantages were observed for the Spatial factor (d = .40) and for the scales related to the Spatial factor: Structural Visualization (.37), Wiggly Block (.38), and Paper Folding (.34). The largest female advantages were observed for Ideaphoria (d = -.41), Silograms (-.41), the Memory factor (-.30), and Observation (-.28). In Cohen's terms, these effects are all in the range between small effects (d = .20) and medium effects (.50). The differences on all the scales and factors are statistically significant (α = .05) except for the differences on Analytical Reasoning, Number Facility, English Vocabulary, and the General factor.

The sex differences in variability are expressed in terms of variance ratios in Table 2 and Figure 3. Each ratio consists of the male variance on the given measure divided by the female variance. As can be seen, there is a modest trend toward greater variability among the males, but the differences are fairly small, with the greatest ratio being 1.25, for the Spatial Ability factor, Paper Folding, and Mathematics Vocabulary. The largest difference in the direction of greater female variability was for Number Series, a ratio of 0.96. The ratios that were between 0.97 and 1 and between 1 and 1.05 were not significantly different from 1.

Skewness and kurtosis values on the scales and factors were generally low and similar for the two sexes.

Another way to examine differences in variability is in terms of right-tail ratios, which have been utilized to a considerable extent in research on giftedness (Wai, Cacchio, Putallaz, & Makel, 2010). For the 95th percentile, the right-tail ratio is the ratio of the proportion of males scoring at the 95^{th} percentile and above to the proportion of females scoring at the 95^{th} percentile and above.[2] For example, for the Spatial factor, 7.0% of males scored at the 95^{th} percentile and above, as did 2.7% of females, and so the right-tail ratio is .070/.027, which is 2.62.

[2] For this study, the 95^{th} percentile was defined as the raw-score value (partialled for age) that denotes the 95^{th} percentile in the given sample, as opposed to the 95^{th} percentile in the Foundation norms in use at the time of the study.

The right-tail ratios for the 95th percentile for the various scales and factors are shown in Table 2 and Figure 4. As can be seen, the tests that show mean sex differences generally show differences in the right tail of the score distributions. As noted, the Spatial factor shows 2.62 males for each female in the top 5% of scores, while the Memory factor shows only 0.57 males for each female in the top 5%. In line with the findings for factors, Structural Visualization, Wiggly Block, and Paper Folding show male advantages in the right tail (ratios of 2.49, 2.49, and 2.19, respectively), while Silograms shows a female advantage (0.46), as do Ideaphoria (0.49) and Foresight (0.68). The general factor shows a modest male advantage in the right tail (1.28) even though it shows essentially no mean sex difference (d = .02). The right-tail ratios of .86 or less and 1.15 or more are significantly different from 1.

A crucial issue in interpreting the right-tail findings is whether the sex differences that were found are due to mean differences or to differences in variability. To investigate this issue, the right-tail ratios were recalculated with the mean differences statistically controlled—for example, for the Spatial factor, a constant value of one-half of the mean sex difference was added to the female scores and a similar value was subtracted from the male scores, such that the means for the resulting scores were the same. To the extent that the mean-controlled right-tail ratios approach 1, then, it appears that the right-tail differences between the sexes are due to the mean differences; to the extent that the right-tail ratios still deviate from 1, then it appears that the right-tail differences are due to other differences, presumably differences in variability.

The right-tail ratios with mean sex differences controlled are shown in the last column of Table 2 and Figure 5. As the table and figure show, eliminating the mean difference also eliminates most of the right-tail differences, with the ratios all near one except for Silograms, on which males now show an advantage, with a ratio of 2.50. Thus, in general, it appears that the disproportions of males and females in the top 5% of scores are due mainly to the mean sex differences and not to differences in variability. For Silograms, there are more males than expected in the right tail, but this effect appears to be partially due to an artifact related to the ceiling of the test.

The results for Mathematics Vocabulary show a different pattern than for most of the other tests. Although there is little mean sex difference (d = .06), there is a little more variability among males than females (variance ratio = 1.25), and there are more males than females in the top 5% of scores (right-tail ratio = 1.88). Since there is little mean difference, the mean-adjusted right-tail ratio (1.64) is fairly similar to the unadjusted ratio.

The results for this study can also be illustrated in terms of stanine scores (Anastasi & Urbina, 1997, p. 63; Lohman & Lakin, 2010; Statistical Bulletin 1988-6). Stanine scores are formed by dividing the distribution of scores for a given scale into nine ranges, with the dividing points being the 4th, 11th, 23rd, 40th, 60th, 77th, 89th, and 96th percentiles. The rationale for these dividing points is that they define equal intervals for scores that are normally distributed.

In Figure 6, the proportions of males and females are shown for stanine scores for the Spatial factor, for which there is a mean difference in favor of males. As shown in the figure, there are greater proportions of females in the lower stanine values and greater proportions of males in the upper stanines, with a somewhat more pronounced effect in the upper range than the lower range. In Figure 7, the proportions of the two sexes are shown for stanines for mean-adjusted Spatial scores. The proportions of males and females are very close to .50 for all of the categories except for Stanine 1, for which the mean adjustment results in a substantially greater proportion of males than females. This means that, in the unadjusted scores, there were many more males in the low end of the distribution than one would expect based on the mean sex difference.

In Figure 8, the proportions of the two sexes are shown for stanine scores for the Memory factor, on which there is a mean difference in favor of females. For this factor, there are greater proportions of males in the lower stanine values and females in the upper stanines. In contrast, in Figure 9, the proportions for mean-adjusted Memory scores are shown, and the proportions are all between .44 and .56. The small advantage for males in Stanine 9 appears to be partially caused by the test ceiling for Silograms, as discussed earlier.

1998-2000 sample

The results for the 1998-2000 sample are shown in Table 3, and in general, they are very similar to the results for the 2008-2010 sample. The mean differences show the familiar pattern, with male advantages for Structural Visualization and related scales and female advantages for several scales including Ideaphoria, Silograms, and the Memory factor. The variance ratios indicate only modestly greater variability for males, with ratios ranging from 0.99 (for Number Series) to 1.27 (for Paper Folding, the Spatial factor, and Mathematics Vocabulary). The right-tail ratios (see Figure 10 in addition to Table 3) mirror the effects for the mean differences: There are greater proportions of males in the right tail (i.e., scores in the top 5%) for Structural Visualization (right-tail ratio = 3.62) along with Wiggly Block (3.96), Paper Folding (2.22), and the Spatial factor (3.09), and there are greater proportions of females in the right tail for Silograms (0.46), Ideaphoria (0.52), Observation (0.52), and the Memory factor (0.60). On scales for which there is little mean sex difference, the right-tail ratios are near 1, with a slight trend toward greater proportions of males---for example, the ratio for the General factor is 1.06. When the mean sex differences are statistically controlled (Figure 10), the right-tail ratios are generally near 1.0 except for Silograms and the Memory factor, for which the ratios appear to be artifactual to some extent due to the low ceiling on Silograms (see earlier discussion).

For Mathematics Vocabulary, as with the 2008-2010 sample, there is little mean sex difference (d = .09), there is somewhat more variability among males (variance ratio = 1.27), and there are more males than females in the top 5% of scores (unadjusted ratio = 1.89; mean-adjusted ratio = 1.58).

1988-1990 sample

Finally, the results for the 1988-1990 sample are shown in Table 4, and in general, they are very similar to the results for the 1998-2000 and 2008-2010 samples. The mean differences show the same pattern, with male advantages for the visualization-related scales and female advantages for several scales including Ideaphoria, Silograms, and the Memory factor. In general, the variance ratios indicate modestly greater variability for males, with ratios ranging as high as 1.39 (Paper Folding) and slightly greater variability for females on Foresight (ratio = 0.88). The right-tail ratios (see Figure 11 in addition to Table 4) follow the pattern of the mean differences, with right-tail ratios favoring males for the visualization-related scales and ratios favoring females for Ideaphoria, Silograms, the Memory factor, and also Observation and Number Checking. On the scales for which there is little mean sex difference, the right-tail ratios are nearly equal. When the mean sex differences are statistically controlled (Figure 11), the right-tail ratios are generally near 1.0 although there is somewhat of a male advantage on Silograms that is probably due in part to the ceiling artifact discussed earlier.

For Mathematics Vocabulary, as with the other two samples, there is only a small sex difference (d = .19), there is somewhat more variability among males (variance ratio = 1.22), and there are more males than females in the top 5% of scores (unadjusted ratio = 2.19) although the adjustment for the mean difference reduces the disproportion quite a bit (mean-adjusted ratio = 1.38).

DISCUSSION

In summary, for all three of the time periods examined in this study, the pattern of mean sex differences revealed in previous Foundation research (SB 1990-2) and outside research (Halpern, 2000) was observed. There were only modest sex differences in variances in scores, with a small trend toward greater variability among males. When the right tails of the score distributions (i.e., the top 5%) were examined, there were greater proportions of males on the scales for which there were mean differences favoring males and greater proportions of females on the scales for which there were mean differences favoring females. When the mean differences were statistically controlled, the proportions of males and females in the right tail tended to be fairly similar. Thus, for the aptitudes and knowledge areas that the Foundation measures, the two sexes appear to be relatively similar in terms of variability, and differences in scores at the high ends of the scales appear to be due to mean differences and not other distributional differences such as variability.

An investigation of the extreme right tail (top 1%) revealed the same pattern as for the right tail, although the Foundation's tests are designed for the full range of aptitudes and knowledge and not specifically for extreme levels.

Regarding the low ends of ability dimensions (the "left tails"), there is considerable evidence in outside studies that there tend to be more males than females in the left tails for general and specific abilities (Halpern, 2000). This issue is difficult to study with Foundation data because the left tails tend not to have much representation in our testing population.

To return to the issue of the proportions of males and females in STEM (Science, Technology, Engineering, and Mathematics) fields, the results of the present study indicate that the greater representation of males in some fields is probably not due to sex differences in variability. This follows from the findings in this study that (a) sex differences in variability are rather modest and (b) more specifically, sex differences in the right tails appear to be due to mean differences and not variability differences. On the other hand, mean sex differences can be expected to lead to greater proportions of males in spatially-related fields, although the female advantage in short-term memory might make the life sciences an appealing outlet for high-memory females.

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Table 1
Cognitive-Ability Scales in the Foundation's Standard Battery

Test	Reliability	Variable measured
Number Checking	.96	"Graphoria" (clerical speed and accuracy); test involves quickly comparing pairs of numbers to see whether they are the same or different.
Ideaphoria	.92	Rate of flow of ideas (ideational fluency).
Foresight	.96	Ability to see possibilities.
Inductive Reasoning	.88	Quickness in seeing relationships among separate facts, ideas, or observations.
Analytical Reasoning	.81	Ability to arrange ideas into a logical sequence.
Number Series	.87	Ability to reason (solve problems) with numbers.
Number Facility	.86	Ability to perform arithmetic operations quickly.
Wiggly Block	.77	Ability to visualize three-dimensional forms. The task is to reconstruct three-dimensional blocks.
Paper Folding	.82	Ability to visualize three-dimensional forms. The task is to mentally rotate two-dimensional surfaces through three-dimensional space.

(*table continues*)

Table 1 (*continued*)

Test	Reliability	Variable measured
Structural Visualization	.87	Ability to visualize three-dimensional forms. Sum of scores on Wiggly Block and Paper Folding.
Memory for Design	.80	Memory for straight-line patterns.
Silograms	.92	Associative memory for verbal material.
Number Memory	.82	Memory for numbers.
Observation	.72	Ability to retain a mental image of various objects in the mind and quickly perceive any changes in the nature or position of an object.
English Vocabulary	.96	Knowledge of the meanings of nontechnical English words.
Mathematics Vocabulary	NA	Knowledge of terms used in mathematics.

Note. Source for reliability coefficients: Statistical Bulletin 2012-8. "NA" means that the reliability for the given scale is not available.

Table 2

Sex Differences in Distributions of Cognitive Abilities, 2008-2010

Scale	Mean difference (*d*)	Variance ratio	Right-tail ratio	Mean-adjusted ratio
Tests				
Number Checking	-.19*	1.15*	0.86*	1.25*
Ideaphoria	-.45*	1.14*	0.49*	1.16*
Foresight	-.23*	0.99	0.68*	0.94
Inductive Reasoning	-.17*	1.09*	0.85*	1.25*
Analytical Reasoning	-.03	1.06	1.08	1.16*
Number Series	.08*	0.96*	1.26*	0.92
Number Facility	.02	1.03	1.01	0.97
Structural Visualization	.37*	1.17*	2.49*	0.99
Wiggly Block	.34*	1.21*	2.49*	1.43*
Paper Folding	.31*	1.25*	2.19*	1.20*
Memory for Design	.12*	1.13*	1.66*	1.25*
Silograms	-.44*	1.03	0.46*	2.50*
Number Memory	-.09*	1.03	0.89	1.09
Observation	-.09*	1.09*	0.93	1.17*
English Vocabulary	.01	1.01	1.07	1.04
Mathematics Vocabulary	.06*	1.25*	1.88*	1.64*

(table continues)

Table 2 (*continued*)

Scale	Mean difference (*d*)	Variance ratio	Right-tail ratio	Mean-adjusted ratio
Factors				
Spatial	.37*	1.25*	2.62*	1.15
Speed of Reasoning	-.11*	1.09*	0.92	1.16*
Numerical	.06*	0.99	1.14	0.94
Memory	-.31*	1.02	0.57*	1.26*
General	.02	1.06*	1.28*	1.22*

Note. *N*s = 12,686 to 15,285 except for Mathematics Vocabulary, for which *N* = 10,203. The mean difference (2nd column) is expressed in terms of Cohen's (1988) *d*, which is the sex difference in standard-deviation units (in the direction of male advantage). The variance ratio (3rd column) is the ratio of the variance for males to the variance for females (with no difference = 1.0). The right-tail ratio is the ratio of the proportion of males in the top 5% of the sample to the proportion of females in the top 5%. Finally, the mean-adjusted ratio is the right-tail ratio between males and females after the mean sex difference has been statistically controlled.

*$p < .05$.

Table 3
Sex Differences in Distributions of Cognitive Abilities, 1998-2000

Scale	Mean difference (*d*)	Variance ratio	Right-tail ratio	Mean-adjusted ratio
Tests				
Number Checking	-.31*	1.16*	0.69*	1.21*
Ideaphoria	-.45*	1.18*	0.52*	1.39*
Foresight[1]	--	--	--	--
Inductive Reasoning	-.17*	1.09*	0.78*	1.29*
Analytical Reasoning	-.06*	1.06	1.00	1.12
Number Series	.04*	0.99	1.17*	1.15
Number Facility	-.04*	1.09*	1.12	1.21*
Structural Visualization	.42*	1.23*	3.62*	1.19*
Wiggly Block	.42*	1.19*	3.96*	0.98
Paper Folding	.33*	1.27*	2.22*	1.15
Memory for Design	.11*	1.15*	1.58*	1.29*
Silograms	-.49*	1.00	0.46*	2.26*
Number Memory	-.12*	1.03	0.90	1.25*
Observation	-.29*	1.02	0.52*	1.04
English Vocabulary	-.02	1.03	0.99	1.05
Mathematics Vocabulary	.09*	1.27*	1.89*	1.58*

(table continues)

Table 3 (*continued*)

Scale	Mean difference (*d*)	Variance ratio	Right-tail ratio	Mean-adjusted ratio
Factors				
Spatial	.42*	1.27*	3.09*	1.16
Speed of Reasoning	-.14*	1.11*	0.83*	1.15
Numerical	.00	1.05	1.03	1.05
Memory	-.35*	1.02	0.60*	1.52*
General	-.01	1.11*	1.06	1.09

Note. *N*s = 11,455 to 12,105 except for Mathematics Vocabulary, for which *N* = 6,640. The mean difference (2nd column) is expressed in terms of Cohen's (1988) *d*, which is the sex difference in standard-deviation units (in the direction of male advantage). The variance ratio (3rd column) is the ratio of the variance for males to the variance for females (with no difference = 1.0). The right-tail ratio is the ratio of the proportion of males in the top 5% of the sample to the proportion of females in the top 5%. Finally, the mean-adjusted ratio is the right-tail ratio between males and females after the mean sex difference has been statistically controlled.

[1]Foresight was not given in 1998-2000.

*$p < .05$.

Table 4

Sex Differences in Distributions of Cognitive Abilities, 1988-1990

Scale	Mean difference (*d*)	Variance ratio	Right-tail ratio	Mean-adjusted ratio
Tests				
Number Checking	-.36*	1.09*	0.61*	1.10
Ideaphoria	-.36*	1.15*	0.68*	1.37*
Foresight	-.20*	0.88*	0.63*	0.87*
Inductive Reasoning	-.17*	1.10*	0.79*	1.24*
Analytical Reasoning	-.05*	1.02	0.98	1.09
Number Series	.03	0.96	1.06	0.97
Number Facility	-.02	1.06*	1.20*	1.22*
Structural Visualization	.49*	1.26*	3.96*	1.23*
Wiggly Block	.49*	1.20*	3.79*	0.94
Paper Folding	.39*	1.39*	2.83*	1.40*
Memory for Design	.12*	1.10*	1.53*	1.17*
Silograms	-.47*	0.96*	0.41*	1.58*
Number Memory	-.08*	1.01	0.95	1.21*
Observation	-.28*	1.00	0.48*	1.00
English Vocabulary	-.01	1.00	1.03	1.04
Mathematics Vocabulary	.19*	1.22*	2.19*	1.38*

(table continues)

Table 4 (*continued*)

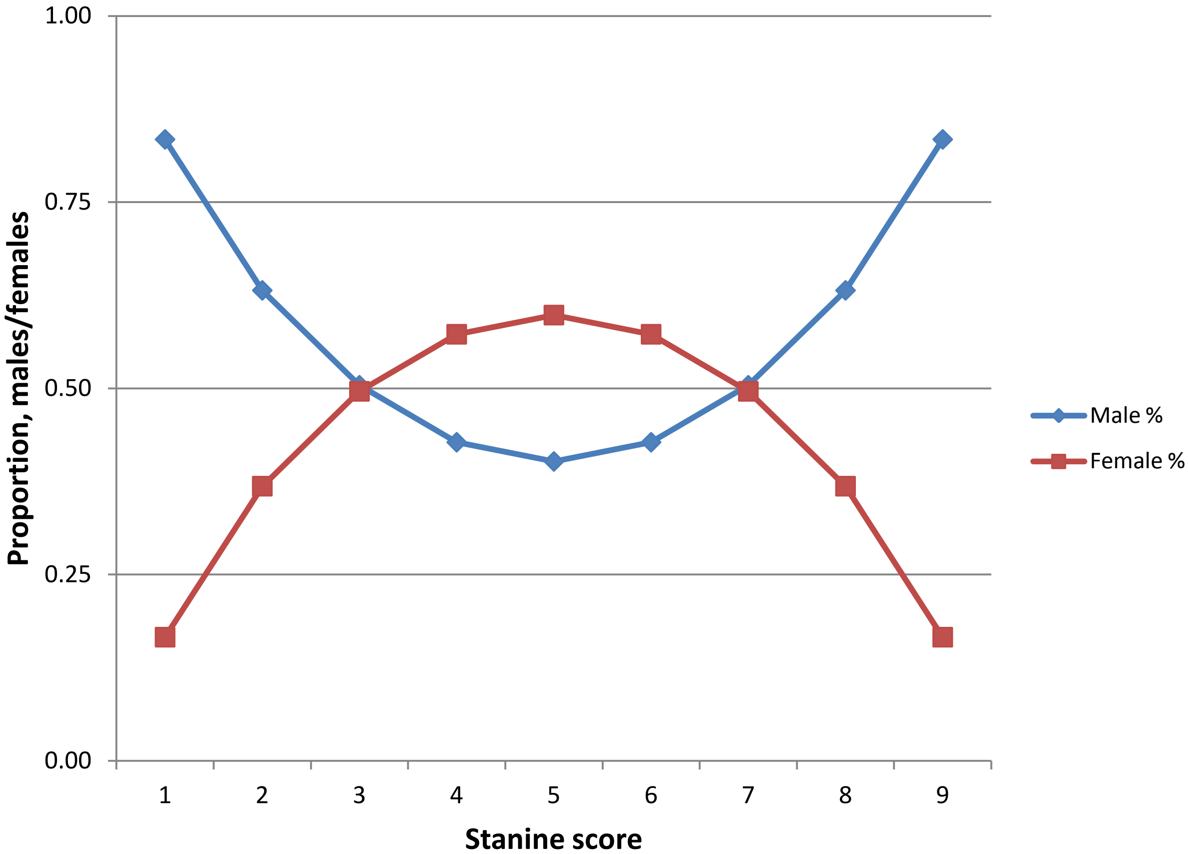
Scale	Mean difference (*d*)	Variance ratio	Right-tail ratio	Mean-adjusted ratio
Factors				
Spatial	.50*	1.31*	3.92*	1.27*
Speed of Reasoning	-.13*	1.06*	0.77*	1.06
Numerical	.00	1.05	1.26*	1.23*
Memory	-.32*	0.99	0.60*	1.17*
General	.02	1.10*	1.25*	1.16

Note. *N*s = 20,932 to 21,378 except for Mathematics Vocabulary, for which *N* = 10,959, and Number Facility, the Numerical factor, and the General factor, for which the *N*s = 11,885, 11,854, and 11,453, respectively. The mean difference (2nd column) is expressed in terms of Cohen's (1988) *d*, which is the sex difference in standard-deviation units (in the direction of male advantage). The variance ratio (3rd column) is the ratio of the variance for males to the variance for females (with no difference = 1.0). The right-tail ratio is the ratio of the proportion of males in the top 5% of the sample to the proportion of females in the top 5%. Finally, the mean-adjusted ratio is the right-tail ratio between males and females after the mean sex difference has been statistically controlled.

*$p < .05$.

Figure 1

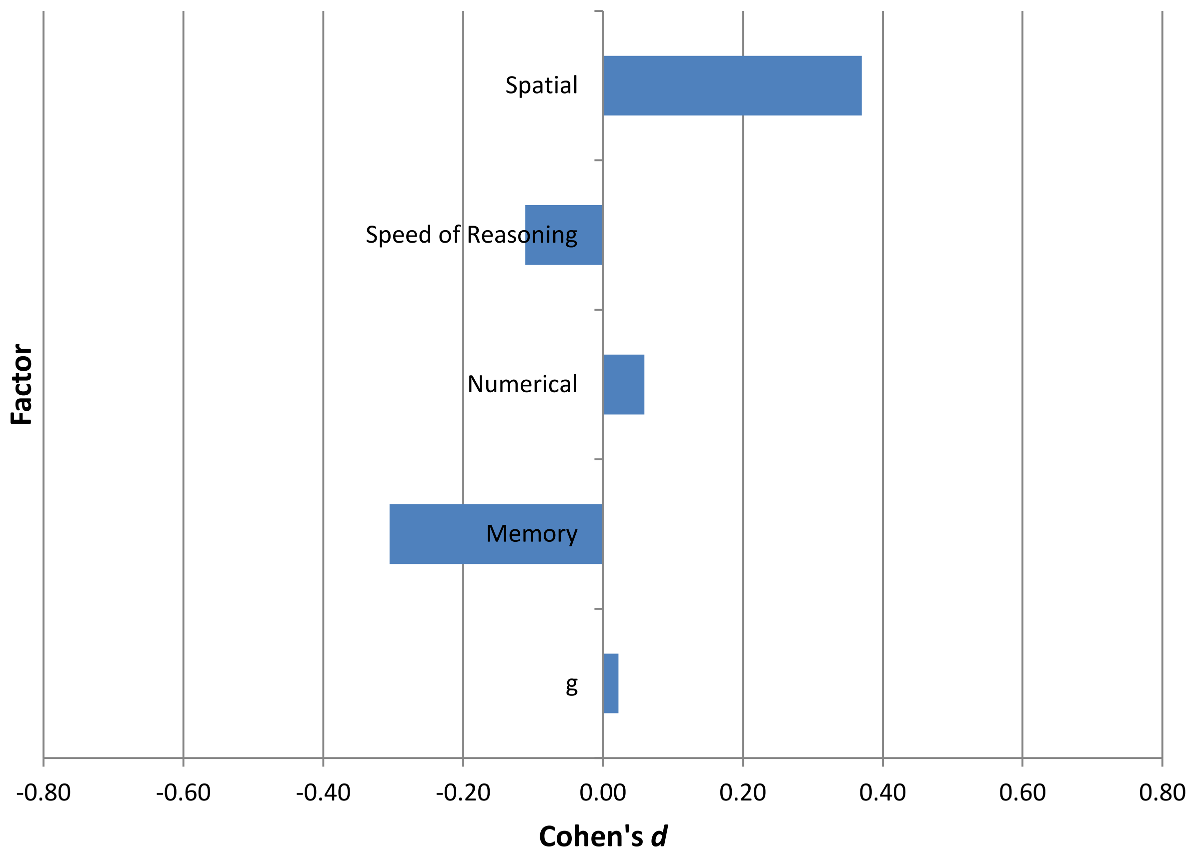
Hypothetical Stanine Distribution



Note. In this example, the mean sex difference is set to be zero, and the male standard deviation is set to be 1.5 times the female standard deviation.

Figure 2

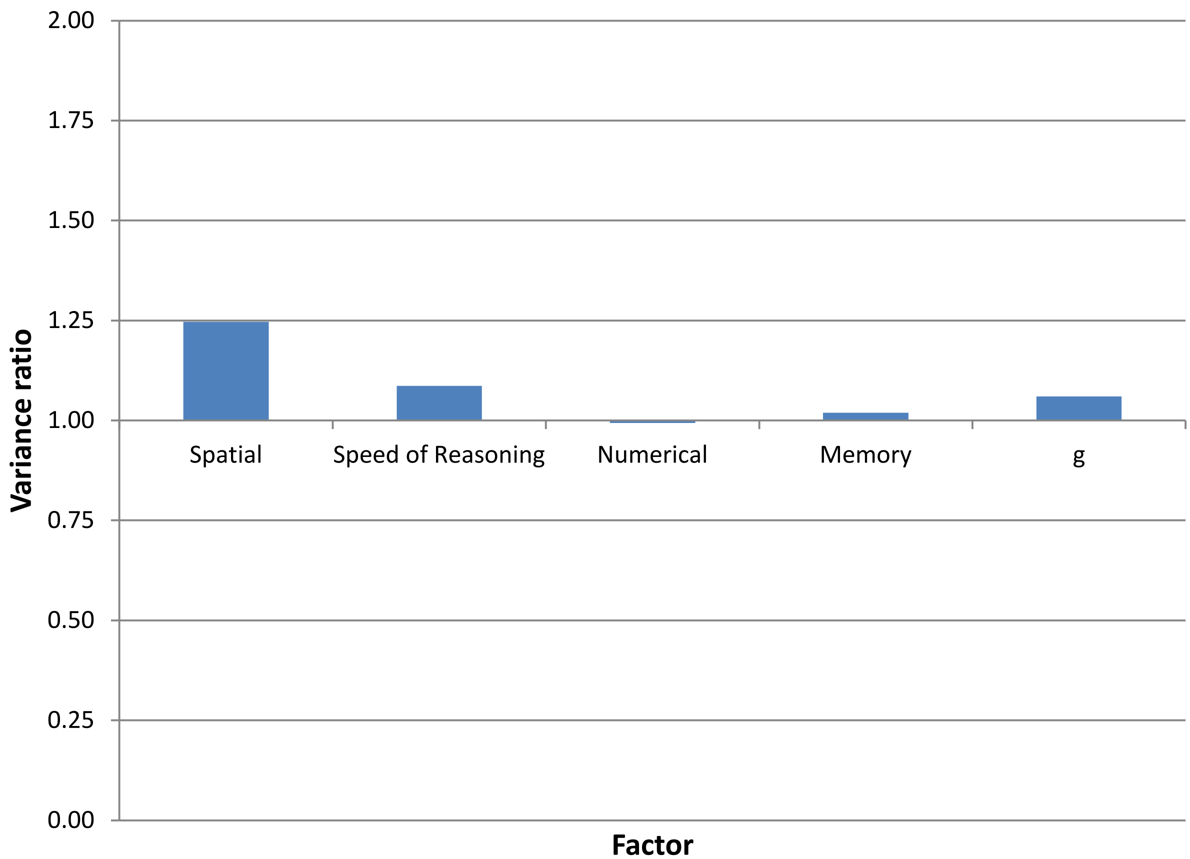
Mean Sex Differences for Five Factors for 2008-2010 Sample



Note. Cohen's *d* represents the mean sex difference in standard-deviation units, with positive values indicating higher values for males and negative values indicating higher values for females (Cohen, 1988).

Figure 3

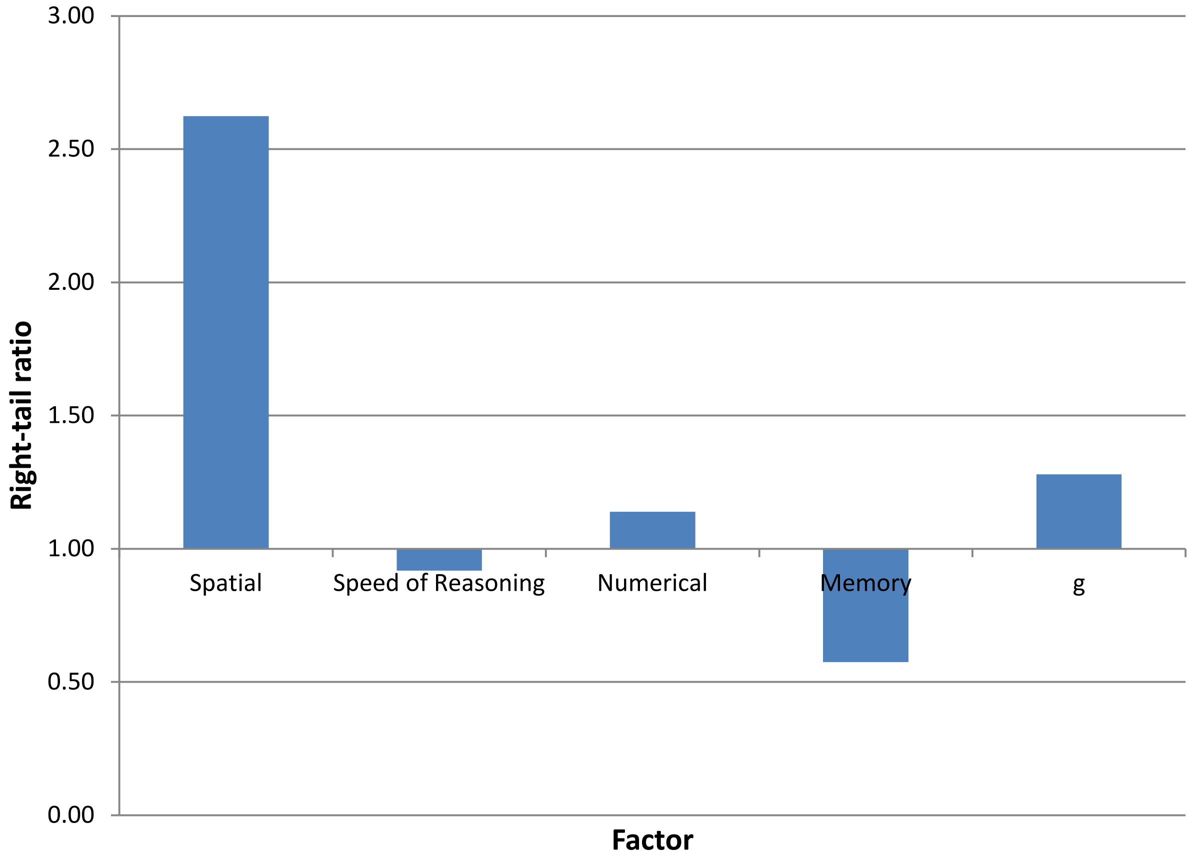
Male-Female Variance Ratios for Five Factors for 2008-2010 Sample



Note. The variance ratio is the male variance divided by the female variance.

Figure 4

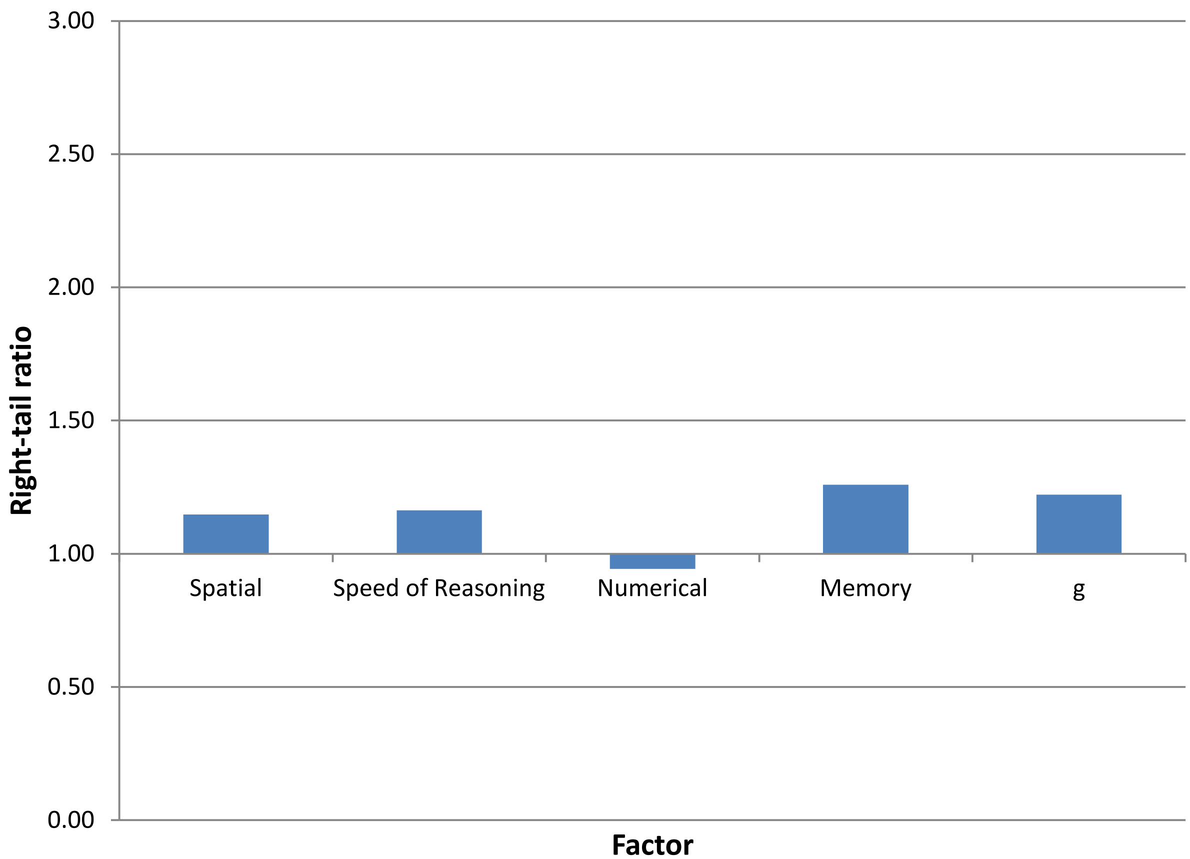
Male-Female Right-Tail Ratios for Five Factors for 2008-2010 Sample



Note. In this analysis, the right tail of each distribution is the top 5% of scores. The right-tail ratio is the ratio of the proportion of males scoring in the top 5% to the proportion of females scoring in the top 5%.

Figure 5

Male-Female Right-Tail Ratios for Mean-Adjusted Factors for 2008-2010 Sample



Note. For the analysis shown in this figure, the mean sex difference for each factor is statistically controlled. The values shown are the right-tail ratios for the mean-adjusted scores.

Figure 6

Proportions of Males and Females for Stanine Scores for Spatial Ability Factor for 2008-2010 Sample

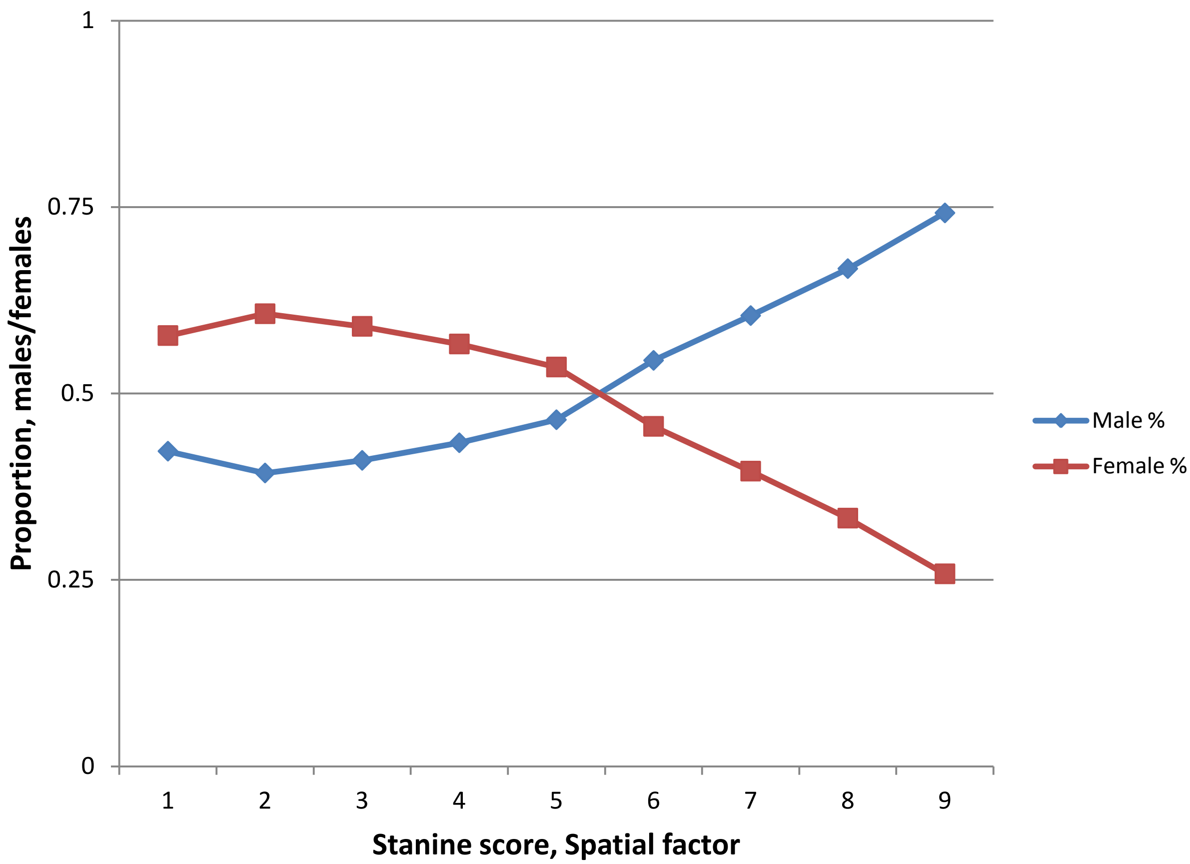


Figure 7

Proportions of Males and Females for Mean-Adjusted Stanine Scores for Spatial Ability Factor for 2008-2010 Sample

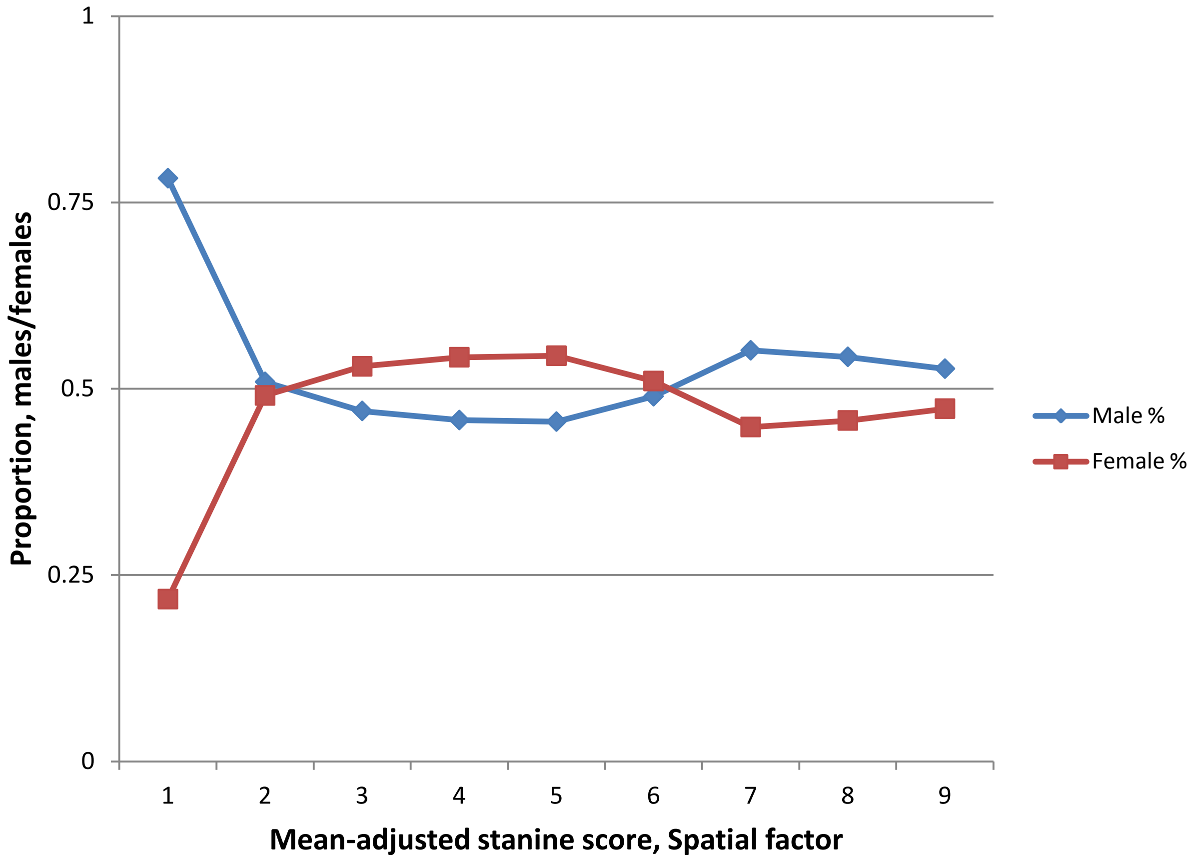


Figure 8

Proportions of Males and Females for Stanine Scores for Memory Factor for 2008-2010 Sample

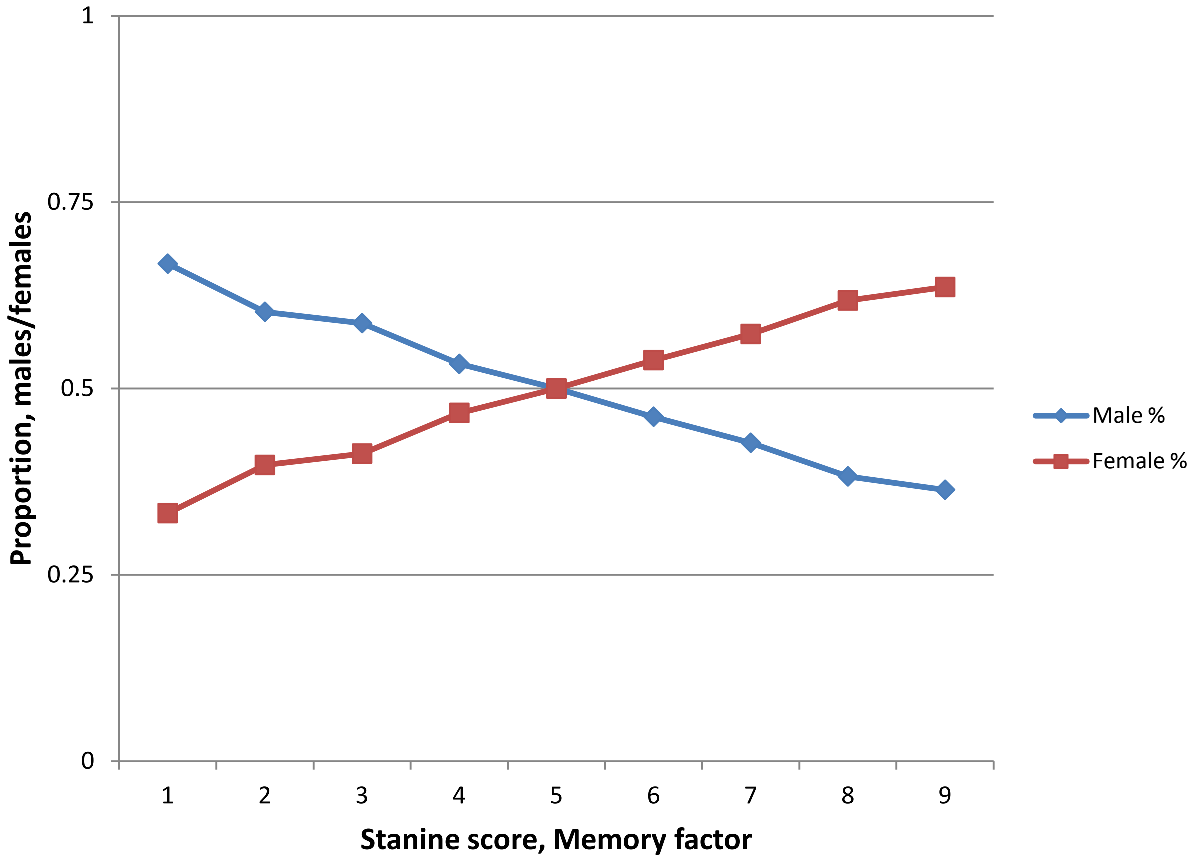


Figure 9

Proportions of Males and Females for Mean-Adjusted Stanine Scores for Memory Factor for 2008-2010 Sample

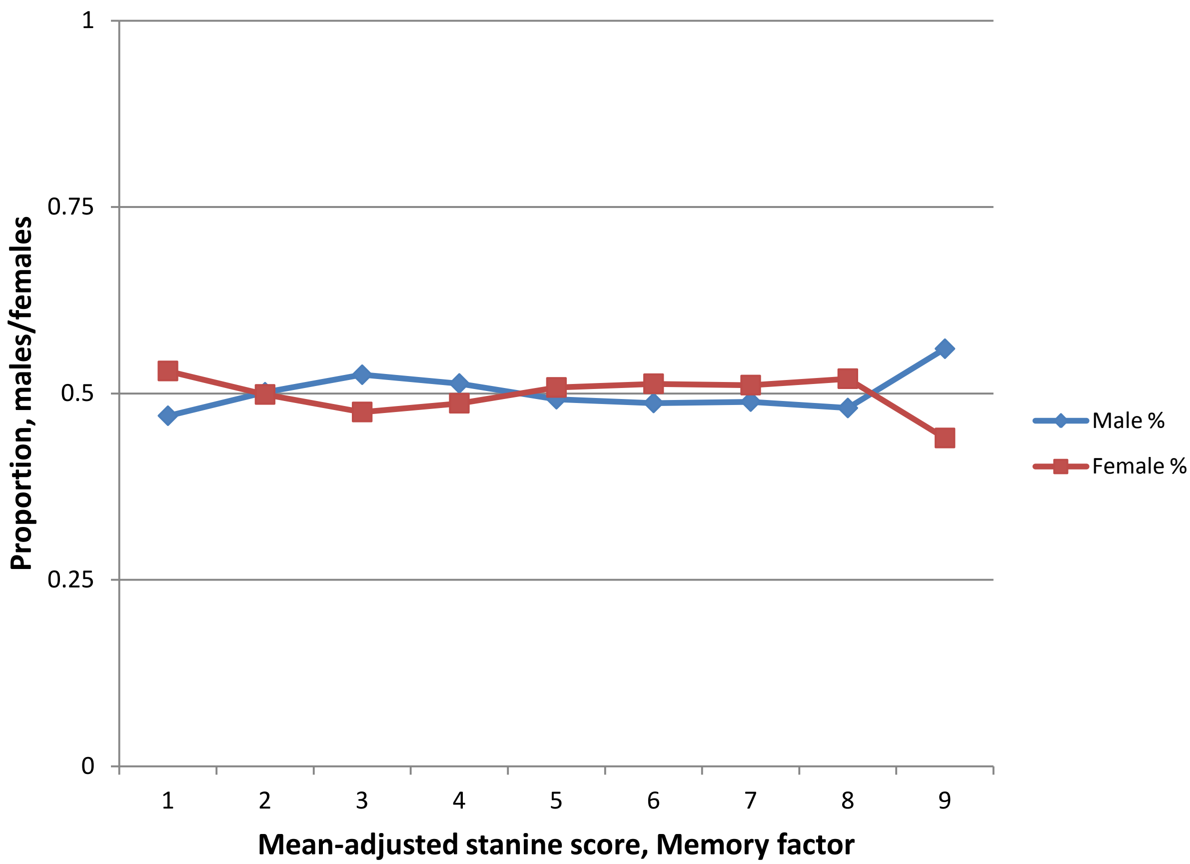
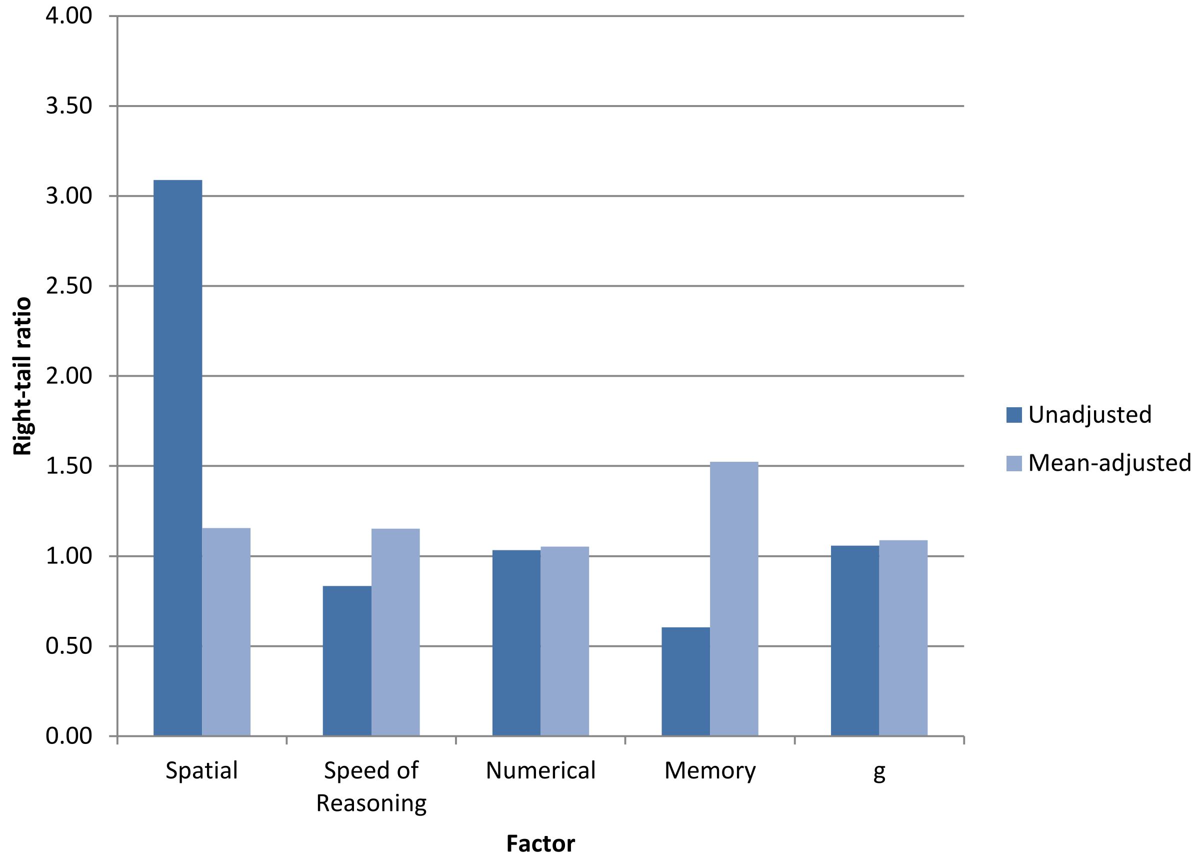


Figure 10

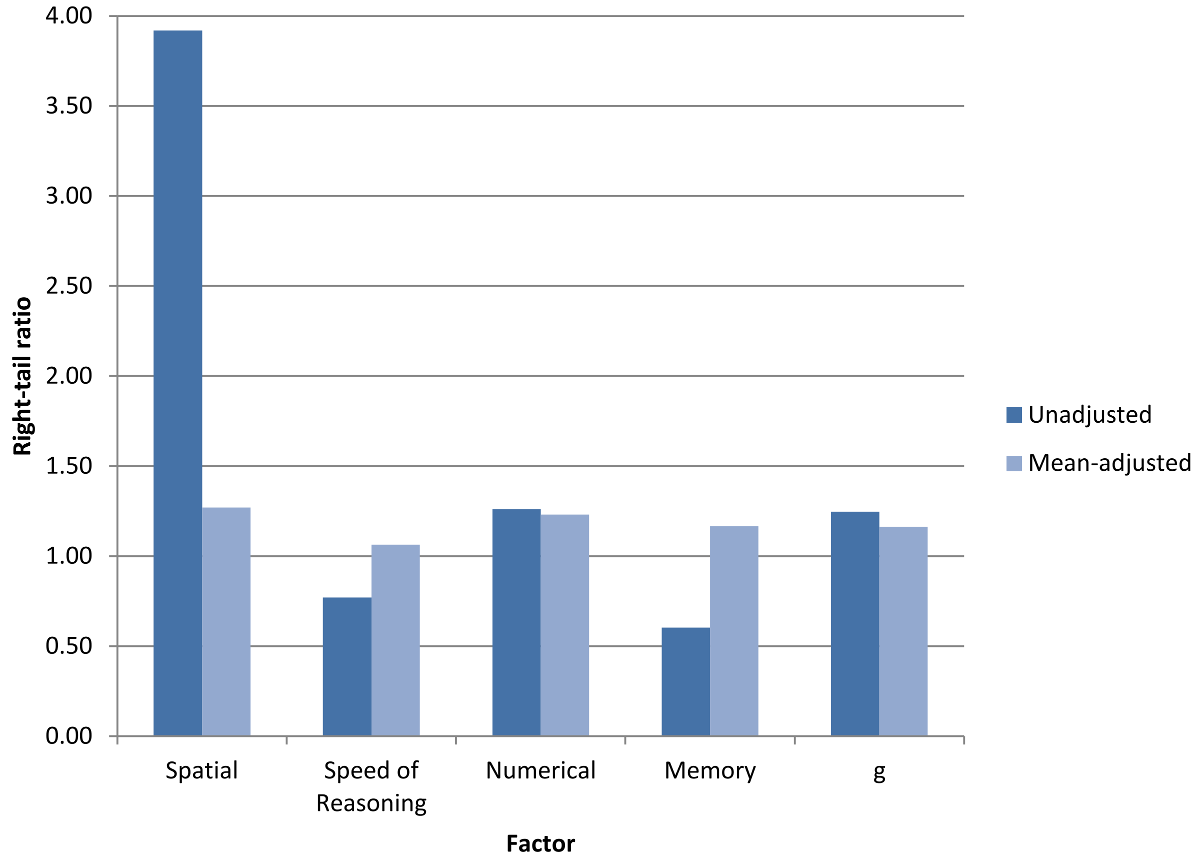
Male-Female Right-Tail Ratios for Five Factors for 1998-2000 Sample



Note. For this analysis, the right tail of each distribution is the top 5% of scores. For the mean-adjusted values, the mean sex difference is statistically controlled.

Figure 11

Male-Female Right-Tail Ratios for Five Factors for 1988-1990 Sample



Note. For this analysis, the right tail of each distribution is the top 5% of scores. For the mean-adjusted values, the mean sex difference is statistically controlled.