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Sex differences in general knowledge

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Abstract

A general information or knowledge test, which was shown to measure 19 domains of general knowledge, six first-order factors and one second-order general factor, was constructed. Data obtained from 469 female and 167 male undergraduates were tested for sex differences using Student's *t* and Hotelling's multivariate *t*. It was found that males obtained significantly higher means than females on the second-order general factor and on four of the six first-order factors identified as information about Current Affairs, Physical Health and Recreation, Arts and Science. Females obtained a significantly higher mean than males on the first-order factor identified as Family. There was no sex difference on the remaining first-order factor identified as Fashion. The results confirm the findings in a number of standardisation samples of the Wechsler tests that males obtain higher average scores than females on the Information subtests and that this is not attributable to a bias in favor of males on these tests.

Keywords: General knowledge; Sex differences; Structural equations modeling; Gender; Interests

1. Introduction

General knowledge or information has been a component of a number of intelligence tests for many decades. For instance, the Stanford–Binet test asks 8-year-old children to name the days of the week, which can be considered a test of general knowledge for 8-year-olds (Terman & Merrill, 1960). The Wechsler tests contain information tests which are likewise tests of general knowledge. Factor-analytic hierarchical models of intelligence such as those

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Table 1
Sex differences expressed as *d* scores on verbal IQs and information subtests in six standardization samples

Sample	Verbal IQ	Information	Reference
American WAIS	0.08	0.18	Wechsler, 1958
American WISC-R	0.19	0.37	Jensen & Reynolds, 1983
American WAIS-R	0.14	0.29	Kaufman, McClean, & Reynolds, 1988
Dutch WISC-R	0.11	0.30	Born & Lynn, 1994
Scottish WISC-R	0.22	0.39	Lynn & Mulhern, 1991
Scottish WAIS-R	0.43	0.65	Lynn, 1998

proposed by Carroll (1993) and Horn (1994) include general knowledge as a component of Gc, a general second-order verbal factor.

In this paper, we are concerned with the issue of sex differences in general knowledge. There is a considerable research literature on sex differences in most of the second-order abilities and a wide measure of consensus on the conclusions. This has recently been reviewed by Kimura (1999). She concludes that there are no sex differences in verbal comprehension as measured by vocabulary size, in "visual reasoning" as measured by Raven's Matrices (some prefer to call this abstract or non-verbal reasoning), or in verbal reasoning; that females obtain higher means in perceptual speed and ideational fluency; and that males obtain higher means in spatial ability. This represents the contemporary consensus and is broadly the same as the conclusion reached by Mackintosh (1998).

Although the weight of the evidence indicates that there is a negligible sex difference in vocabulary, as Kimura concludes, there is consistent evidence that males obtain higher average scores than females on the Information subtest of the Wechsler tests. This male advantage is shown in six standardization samples of the Wechsler tests in the US and Europe in Table 1, which gives the sex differences on the verbal IQs and the Information subtests expressed as *d* scores (the difference between the male and females means divided by the standard deviations). Males obtain consistently higher means than females on both the verbal IQs and on the Information subtests, but it will be noted that the male advantage on the Information subtests is consistently larger than on the verbal IQs.

There are two possible explanations for this phenomenon. The first is that the Information subtests of the Wechslers are biased in favor of males in the sense that they are tests of the kinds of information that males tend to possess more than females. This implies that there are other kinds of information, which females tend to possess more than males, but this information is under-represented in the test. The second explanation is that males do have more general information or knowledge than females. Our object in this study is to attempt to discover which of these two explanations is correct. We believe that the resolution of this issue requires an analysis of the major domains of information and of sex differences in these.

2. Method

We have tackled this project in two stages. The first was designed to establish the domains and factor structure of general knowledge and the second to investigate sex differences in

Table 2
Socioeconomic status as indicated by father's education and occupation for men and women

	Sex	
Indicator of SES	Men (%)	Women (%)
Father's occupation		
(1) Professional/managerial	12.7	12.3
(2) Minor professional/junior managerial	27.9	36.7
(3) White collar/service	19.4	12.5
(4) Skilled	7.9	10.8
(5) Semi-skilled	32.1	27.7
Father's education		
(1) Secondary school to age 16	64.0	62.3
(2) Secondary school to age 18	15.9	13.7
(3) Non-university higher education	6.1	7.0
(4) University	14.0	17.0

these. The first stage of the project has been reported in Irwing, Cammock and Lynn (2001) and is summarized here.

2.1. Participants

The sample was comprised of 636 undergraduate students from the Faculty[1] of Health, Social Sciences and Education at the University of Ulster (469 women and 167 men) ranging in age from 11 to 48 years (mean = 20.4, S.D. = 3.6). The sex composition of the sample was representative of the student body within the Faculty. Men and women did not differ significantly with respect to age (female mean = 20.4, male mean = 20.2, $t(631) = -0.75$, $P > .05$), total "A" level points (female mean = 14.7, male mean = 16.7, $t(472) = 1.54$, $P > .05$), or socioeconomic status as indicated by father's education ($\chi^2(3) = 1.2$, $P > .05$) and occupation ($\chi^2(4) = 8.6$, $P > .05$: see Table 2).

2.2. Measures

A general information or general knowledge test consisting of 182 free response items was developed by the authors, in collaboration with one subject matter expert (Irwing et al., 2001). General knowledge was defined as culturally valued knowledge, communicated by a range of non-specialist media. Ephemera or knowledge confined solely to one medium, such as "television soaps," was explicitly excluded by this definition, as was information so specialist as to require extensive training for it to be acquired. Eighteen domains of general

[1] In the UK, a Faculty is an administrative unit which comprises a number of closely related schools. Typical examples would be Faculties of Arts, Science, or Business. The members of a UK Faculty include academic staff, students, and administrators, i.e., the term Faculty does not conform to US usage, in which (uncapitalized) it denotes academic staff, alone.

Table 3
Example items for each domain of general knowledge

History of Science
(1) Who discovered the double helix structure of DNA?
(8) Which British chemist was the originator of the modern atomic theory of matter?

Politics
(18) Who was leader of the Khmer Rouge and became premier of Cambodia in 1975?
(24) Who has ruled Cuba since 1959?

Sport
(28) Where were the 1996 Olympic games held?
(35) What in golf describes a score of one under par on a particular hole?

History
(43) Which king of England was executed in 1649?
(46) Which Italian wrote an account of his visit to China about 1275?

Classical Music
(51) Who composed The Ring?
(58) Who composed II Barbiere di Seviglia?

Art
(61) Who painted the ceiling of the Sistine chapel?
(67) Who painted the Laughing Cavalier?

Literature
(82) Who wrote "Utopia?"
(83) Who wrote "Don Quixote?"

General Science
(90) What are the chemical constituents of steel?
(92) Who formulated the law that the energy of a quantity of matter is equal to the product of the mass times the square of the velocity of light?

Geography
(97) Which country lies west of the Bering Strait?
(l00) Which is the longest river in Asia?

Cookery
(110) What is parmesan?
(111) What are croutons made of?

Medicine
(123) What disease is caused by insufficient production of insulin?
(130) What is the commonest cause of cirrhosis of the liver?

Games
(134) In what game can a piece be crowned?
(142) What card game has only one player?

Table 3 *(continued)*
Example items for each domain of general knowledge

Discovery and Exploration
(147) Who was the first to reach the South pole?
(148) Who was the first to fly the Atlantic?
Biology
(157) What lizard changes colour to match its surroundings?
(165) What is the largest sea bird?
Film
(171) Who played Dr. Zhivago in "Dr. Zhivago?"
(174) Who played the Godfather in "The Godfather?"
Fashion
(181) Which Italian designer was shot in Miami in 1997?
(186) Which British model started the "superwaif" trend?
Finance
(195) Who is the president of Microsoft?
(202) What is the currency of Russia?
Popular Music
(210) Who wrote and sang "Thriller?"
(211) Which American had a big hit with "Like a Virgin?"

Numbers denote the item order in the general knowledge test.

knowledge were initially identified as conforming with this definition, viz., History of Science, Politics, Sport, History, Classical Music, Art, Literature, General Science, Geography, Cookery, Medicine, Games, Discovery and Exploration, Biology, Film, Fashion, Finance, and Popular Music. Example items are shown in Table 3.

Principal components analysis showed that the test comprised 19 domains of general knowledge rather than 18 domains as initially envisaged. The only substantive revision was that Popular Music was comprised of two components, one which retained the label "Popular Music" and the second which was denoted "Jazz and Blues." Ten items had satisfactory factor loadings for each of the first 17 domains, while six items loaded on Popular Music, and Jazz and Blues, respectively. Items required a one- or two-word answer, which was unambiguous. Each correct answer was awarded a score of one. In nine cases, there were two answers deemed to be equally acceptable, e.g., Newton or Leibniz as the inventor of calculus. For a further five items (17, 38, 40, 47, and 88), half marks were awarded for a partial answer, e.g., either hydrogen or oxygen in response to the question "What are the chemical constituents of water?" Unless otherwise indicated, all subsequent analyses reported in this paper were based on unit weighted composites scores for each domain of general knowledge.

A confirmatory factor analysis showed that the best factorial solution consisted of six first-order factors and one second-order factor. The six first-order factors were identified as Current Affairs, Fashion, Family, Arts, Science, and Physical Health and Recreation, with internal consistencies of 0.84, 0.69, 0.71, 0.64, 0.68, and 0.70, respectively (Werts, Rock,

Table 4
Mean differences in men's and women's scores on general knowledge with total effects of sex

Factors and domains of general knowledge	*M* Men, $n=166$	Women, $n=469$	SD	*F*	d	Sex
Current Affairs	13.28	7.58	6.94	95.83***	0.82	− 0.38
Politics	3.32	1.88	2.08	64.95***	0.69	− 0.28
Finance	4.67	3.08	2.31	63.28***	0.69	− 0.29
History	2.45	1.21	1.72	70.23***	0.72	− 0.26
Discovery and Exploration	1.71	0.79	1.34	63.95***	0.69	− 0.26
Geography	1.17	0.61	1.35	21.58***	0.41	− 0.22
Fashion	13.50	13.55	4.46	0.02	− 0.01	0.05
Fashion	5.96	6.07	2.20	0.65	− 0.05	0.05
Popular Music	4.64	4.83	1.25	2.70	− 0.15	0.02
Film	2.90	2.61	2.17	2.21	0.13	− 0.11
Family	10.83	12.59	3.81	27.59***	− 0.46	0.23
Medicine	6.01	6.74	2.25	12.73***	− 0.32	0.17
Cookery	4.85	5.86	2.09	29.86***	− 0.48	0.17
Physical Health and Recreation	18.98	15.34	4.83	78.02***	0.75	− 0.38
Biology	6.05	5.13	2.18	22.69***	0.42	− 0.19
Games	6.54	5.52	1.90	37.43***	0.54	− 0.25
Sport	6.40	4.69	2.03	100.87***	0.84	− 0.37
Arts	6.18	5.01	3.83	11.81***	0.31	− 0.36
Literature	1.34	0.94	0.82	30.77***	0.49	− 0.22
Art	1.06	0.98	1.11	0.80	0.07	− 0.05
Classical Music	0.36	0.29	0.87	0.88	0.08	− 0.04
Jazz and Blues	0.52	0.20	0.69	28.51***	0.46	− 0.21
Science	6.99	5.18	3.10	44.71***	0.58	− 0.38
General Science	5.05	3.69	2.15	52.97***	0.63	− 0.28
History of Science	1.95	1.49	1.39	13.71***	0.33	− 0.13
Total — General Knowledge	69.75	59.26	20.51	5.47***,[a]	0.51	− 0.42

[a] *t* test.

*** Significance level cannot be evaluated, but would reach $P<.001$ in univariate context.

Linn, & Jöreskog, 1978). The first-order factors positively intercorrelated, and were explicable in terms of a second-order general knowledge factor, with an internal consistency of 0.91. The factor structure is shown in Fig. 1, to which the general knowledge test provides a good fit (NNFI = 0.90, SRMR = 0.047).[2] The second-order factor had an average extracted

[2] Some parameter estimates of the second-order factor model of general knowledge, reported here, differ from that presented in Irwing et al. (2001) due to the difference in sample characteristics. The current sample was confined to students, whereas Irwing et al. included an additional 82 subjects, comprising 41 full-time employees, 33 secondary school pupils, 2 unemployed persons, and 4 persons for whom data were missing.

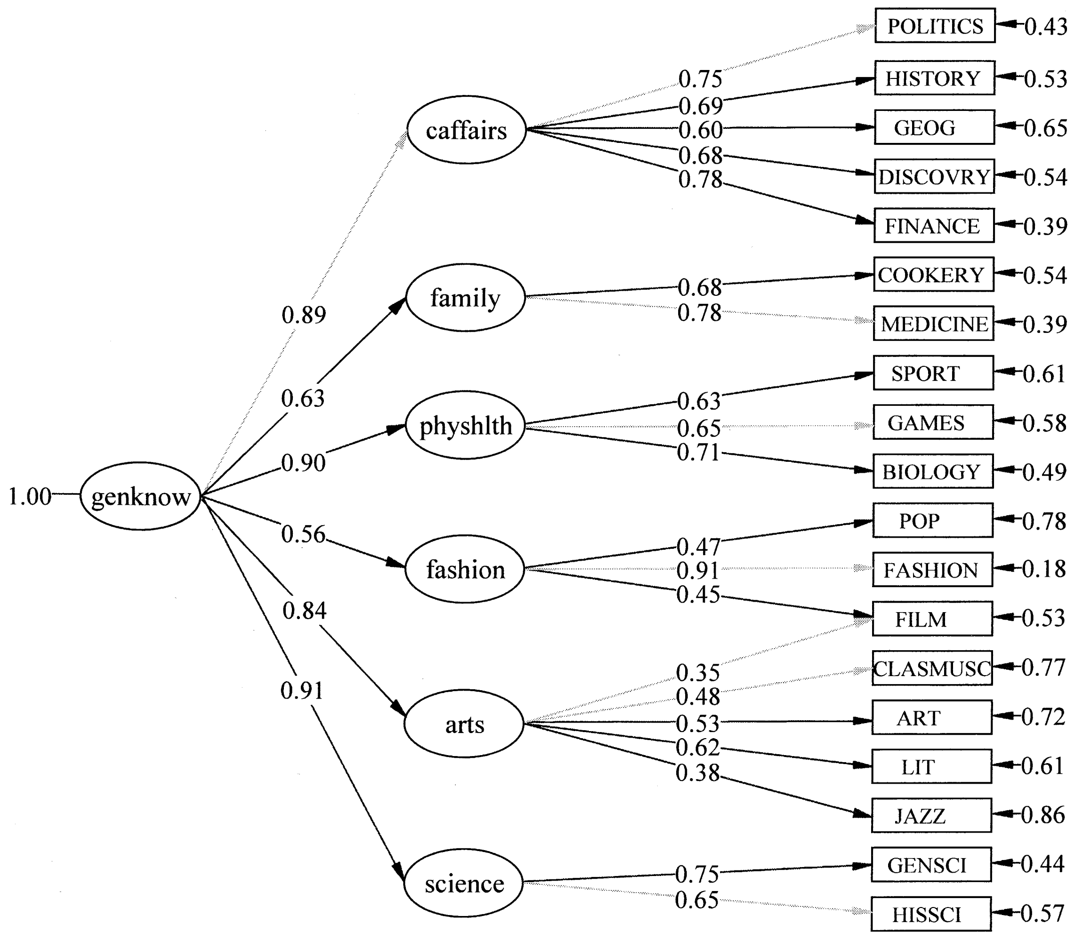
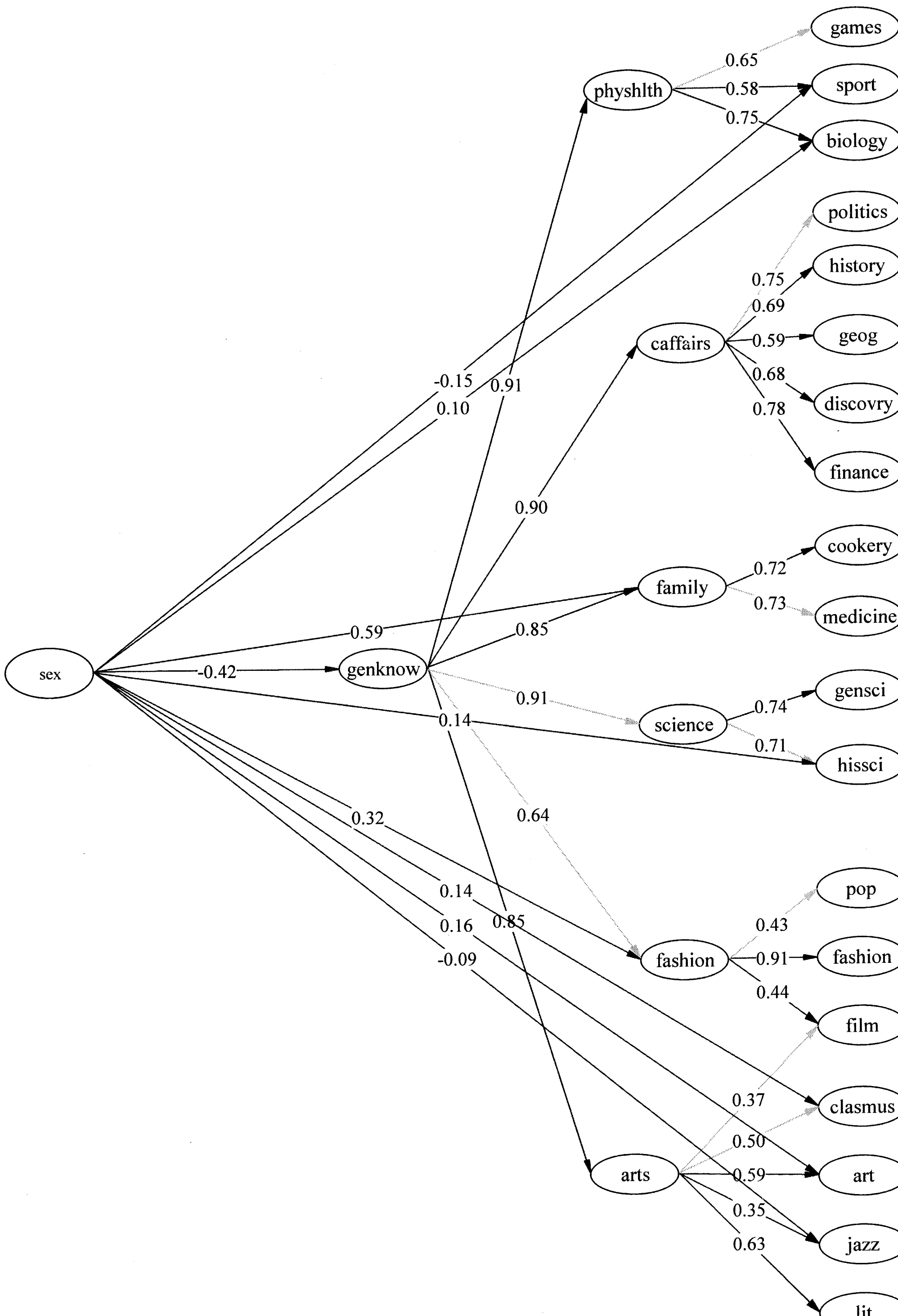


Fig. 1. Second-order confirmatory factor model of general knowledge test. (Ellipses enclose factors; boxes enclose indicators; long unidirectional arrows represent factor loadings; short arrows unexplained variance; grey and black signify free and fixed parameters, respectively. discovry = discovery and exploration; geog = geography; clasmusc = classical music; lit = literature; gensci = general science; hissci = history of science; caffairs = current affairs; physhlth = physical health and recreation; genknow = general knowledge.)

variance of 0.64 in the first-order factors (for further details of the General Knowledge Test, see Irwing et al., 2001).

3. Results

Table 4 shows the means obtained by males and females on the second-order information factor, on the six first-order factors, and on the domains of which the first-order factors are composed. Also shown are the standard deviations of the combined male and female samples, the F values to show the statistical significance of the male–female differences, the d effect


games
sport
biology
physhlth
0.65
0.58
0.75
politics
history
geog
discovry
finance
caffairs
0.75
0.69
0.59
0.68
0.78
-0.15
0.91
0.10
0.90
cookery
medicine
family
0.72
0.73
0.59
0.85
sex
-0.42
genknow
0.91
science
gensci
hissci
0.74
0.71
0.14
0.32
0.64
pop
fashion
film
0.43
0.91
0.44
0.14
0.16
-0.09
0.85
clasmus
art
jazz
lit
arts
0.37
0.50
0.59
0.35
0.63

sizes (the difference between the male and female means divided by the pooled standard deviation), and total effects derived from MIMIC model 3 (see below).

The statistical significance of the male–female differences was first tested for each of the 19 domains of general knowledge using a multivariate *t* test. Hotelling's *t* indicated that there was an effect of sex on the combined general knowledge scores ($F(19) = 21.53$, $P < .001$). The results showed a strong association between sex and the combined dependent variables with $\eta^2 = 0.40$, showing that 40% of the total variance in general knowledge scores was explicable in terms of sex. A second multivariate *t* test was applied to determine whether there was a difference between men and women on the combined first-order general knowledge factors. Again, Hotelling's *t* indicated a significant difference in general knowledge scores between the sexes on first-order factors ($F(6) = 57.76$, $P < .001$). Finally, Student's *t* indicated a sex difference in total general knowledge scores significant at the .001 level ($t = 5.47$, $P < .001$).

We carried out univariate *F* tests to examine for mean sex differences in general knowledge scores at the second-order and first-order factor levels. The results are shown in Table 4. Overall, there is a substantial sex difference in general knowledge, with men ($M = 69.75$) scoring higher than women ($M = 59.26$). Using Cohen's measure of effect size, the overall difference in general knowledge scores between men and women is approximately half a standard deviation ($d = 0.51$). For the six first-order factors, it will be noted that men obtain significantly higher means than women on Current Affairs, Physical Health and Recreation, Arts, and Science; women obtain a significantly higher mean on Family, and there is no sex difference on Fashion.

3.1. Mimic model

While the above analysis provides useful information with regard to mean differences in general knowledge scores between men and women, it takes no account of the pattern of covariation in general knowledge scores. In principle, the complex pattern of sex differences with respect to different domains of general knowledge may be explicable in terms of a limited number of unique effects. Irwing et al. (2001) showed, using structural equations modeling, that the general knowledge test used here conforms to the second-order factor model shown in Fig. 1. We can combine this second-order factor model with sex to form a MIMIC model. "The term MIMIC stands for multiple indicators and multiple causes" (Jöreskog & Sörbom, 1993, p. 172). In this case, sex is the single predictor variable, while the second-order general knowledge factor is a latent variable with multiple indicators at the first-order factor and domain levels of general knowledge. The model is shown in Fig. 2.

The MIMIC models were tested with LISREL 8.30 using maximum likelihood estimation. The 19 general knowledge composites were normalized, prior to maximum likelihood analysis, in order to produce correct parameter estimates and chi-squares (Jöreskog, Sörbom, du Toit, & du Toit, 1999).

Fig. 2. MIMIC model 3 for the effect of sex on general knowledge. (Conventions as for Fig. 1. Observed variables were omitted for clarity.)

Table 5
Fit indices for higher-order confirmatory factor analysis of general knowledge and MIMIC models of the relationship between sex and general knowledge

Factor models	χ^2	*df*	χ^2 difference	SRMR	NNFI
(1) Higher-order factor model	477.4	145		0.047	0.90
(2) MIMIC model 1	749.9	165		0.062	0.84
(3) MIMIC model 2	552.8	163	197.1 (2)***	0.051	0.89
(4) MIMIC model 3	476.0	157	76.8 (6)***	0.043	0.91

SRMR = Standardized Root Mean Square Residual; NNFI = Non-Normed Fit Index.
*** $P < .001$.

Following the current consensus, multiple indices were used to evaluate model fit (Bollen, 1989; Marsh, Balla, & Hau, 1996). Specifically, in conformity with recent advice (Hu & Bentler, 1998; Marsh et al., 1996), we examined the Standardized Root Mean Square Residual (SRMR; Bentler, 1995; Jöreskog & Sörbom, 1981), and the Non-Normed Fit Index (NNFI; Bentler & Bonett, 1980). According to standard guidelines, an NNFI $\geq$ 0.90 (Marsh et al., 1996) is considered to be indicative of adequate fit. For the SRMR, we adopted a cutoff of 0.05 suggested by Spence (1997). When comparing models, we adopted Jöreskog's (1993) recommended procedures for selecting the best of two or more alternative models. In the case of nested models, Jöreskog recommended that if there is a significant difference in the likelihood ratio test between the two models, then the less restrictive model should be selected.

Three substantively different MIMIC models were estimated. In MIMIC model 1, the sole parameter estimated, relating to sex, was for the effect of sex on the second-order factor of general knowledge. For MIMIC model 2, two additional parameters were estimated, allowing an effect of sex on the first-order Family and Fashion factors. Finally, for MIMIC model 3, six effects of sex on the general knowledge domains of Sport, Biology, Classical Music, Art, Jazz, and the History of Science were added (see Fig. 2). For MIMIC models 2 and 3, additional parameters were selected empirically using LISREL'S modification indices. Since this procedure may capitalize on chance, there is a risk that models generated in this way may not generalize to other samples. However, to the extent that freeing a parameter leads to a substantial increment in fit, the probability that the effect is due to chance becomes progressively less.

Table 5 shows that MIMIC model 1 provides an inadequate fit to the data, with neither the NNFI or SRMR approaching the specified fit criteria. MIMIC model 2 showed a substantial increment in fit ($\Delta\chi^2(2) = 197.1$) and came close to satisfying the absolute fit criteria for both indicators. However, MIMIC model 3 (see Fig. 2) met both pre-specified criteria of fit and showed a significant improvement, as evidenced by a decrement in the likelihood ratio test ($\Delta\chi^2(6) = 76.8$), as compared with MIMIC model 2. Therefore, in accordance with Jöreskog's (1993) recommendations for comparing nested models, MIMIC model 3 was accepted.

In interpreting the pattern of coefficients shown in Fig. 2, it should be noted that sex was coded male = 1, female = 2. In total, nine coefficients from a possible 26 were required to explain the association of sex with general knowledge. The most important parameter is the coefficient of $-.42$ for the effect of sex on the overall general knowledge factor. This represents a substantial tendency for higher scores on general knowledge to be associated with men rather than women. Counter to this overall trend, positive effects on the Family (0.59) and Fashion (0.32) factors reflect better than average performance by women on these factors. However, in terms of total effects (see Table 4, last column), only higher scores on the Family factor are associated with women rather than men (total effect = 0.23). The remaining effects are comparatively small. In two cases, Sport (− 0.15) and Jazz (− 0.09), there is a tendency for men to exceed their overall level of performance. Conversely, there is a tendency for women to show better-than-expected performance on Art (0.16), Classical Music (0.14), Biology (0.10), and History of Science (0.14). Considering the total effects (Table 4) of sex on the 19 domains of general knowledge, only with Cookery and Medicine is there an association such that women tend to score significantly higher than men. For scores on Popular Music, Film, and Fashion, there is no association with sex, while for the remaining 14 domains of general knowledge, there is a tendency for men to score higher than women.

4. Discussion

The study has four principal points of interest. First, it confirms the results obtained in the Wechsler standardisation samples shown in Table 1 that males tend to have more general knowledge than females. The magnitude of the male advantage as expressed in the sex difference on the general factor amounts to 0.51*d* or approximately half a standard deviation. This is a rather considerable advantage. It is greater than that present in five of the six studies of the Wechsler Information subtest shown in Table 1 although it is not so great as the 0.65*d* advantage obtained by males on the Information subtest in the Scottish WAIS-R standardisation sample. Taken as a whole, the results of the present study indicate that the higher average scores obtained by males on the Information subtest in the Wechsler standardisation samples are not due to bias in the questions, but reflect a genuine phenomenon of a tendency of males to possess more general knowledge than females. Two aspects of the data run counter to the possibility that the observed difference is due to test bias. Firstly, in comparison with the Wechsler Information subtest, the measure of general knowledge incorporated in the current study is more systematic and comprehensive (Irwing et al., 2001). Secondly, of those domains, which may be considered stereotypically female (Fashion, Medicine, Cookery, Literature, and Art), in only two (Medicine and Cookery) did females outperform males; otherwise, the differences were non-significant (Fashion and Art) or males showed an advantage (Literature). This conclusion is further confirmed by other studies. For instance, a study of the Estonian high school students found that males obtained a higher average score on a general knowledge test by 0.65*d* (Allik, Must, & Lynn, 1999) and a 0.28*d* advantage was obtained by 15-year-old boys in a 26-nation study of historical general knowledge obtained by Wilberg and Lynn (1999). A small male advantage in general knowledge has also been reported by Rolfhus and Ackerman (1999).

Second, the fact that males obtain higher scores on information as compared with their scores on verbal ability as a whole, as shown in Table 1, suggests that some factor other than verbal ability must contribute to the male advantage in general knowledge. This inference confirms the conclusion reached by Ackerman and Rolfhus (1999) who demonstrated that general knowledge is not sufficiently highly correlated with either *g* or verbal ability to be explained in terms of these. They conclude that "knowledge is something more than *g* and/or verbal abilities or Gc as traditionally measured" (p. 327). Probably, this "something more" consists of interests rather than an advantage in general memory capacity because studies of this reviewed by Kimura (1999) do not suggest that males have an advantage.

Third, the results of the sex differences on the six domains of general knowledge confirm the view that the differences between males and females in information are substantially determined by their different interests. Males have greater knowledge than females in Current Affairs (0.82*d*), Physical Health and Recreation (0.75*d*), Science (0.58*d*), and Arts (0.31*d*), but females have substantially greater knowledge than males in Family (− 0.46*d*), while there is no sex difference in Fashion (− 0.01*d*). These variations should probably be regarded as functions of different interests typically possessed by males and females. Considered in terms of the evolutionary psychology theory of sex differences presented by Geary (1998), these sex differences in interests are likely to be biologically programmed. Males are more concerned with competition with other males for status and power, which are central concerns of our Current Affairs factor and of the games and sport components of our Physical Health and Recreation factor. Females are more concerned with nurturance in the family, which are central concerns of our Family factor. Alternatively, these sex differences in interests may be solely culturally determined.

Fourth, while the cumulative evidence that males tend to have more general knowledge than females must be regarded as quite strong, it should be noted that there is also a certain amount of evidence that females tend to be stronger than males on what has sometimes been called "autobiographical" knowledge by researchers on memory. This distinction was made by Tulving (1972) who posited the existence of two memory systems which he designated "semantic memory" and "episodic memory."

Semantic memory consists of general knowledge while episodic memory consists of memory of personal experiences. Ross and Holmberg (1992), Sehulster (1995), and Herlitz, Nilsson, and Backman (1997) have found that females tend to have stronger episodic memory than males. This kind of memory is not, however, tested in intelligence tests.

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