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Sex differences in general knowledge in German high school students

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Abstract

This study examines the hypotheses that (1) 17 domains of general knowledge can be identified; (2) these are positively intercorrelated and form a general factor of general knowledge; (3) there are sex differences in the different domains of general knowledge; and (4) males have more general knowledge in more of these domains than females and in the general factor. The study tests these hypotheses on a sample of 302 German high school students. All the hypotheses were confirmed. All the domains of general knowledge were positively intercorrelated. A general factor was found that explained 31.3% of the variance. Males achieved significantly and substantially higher scores than females in general knowledge of 0.60*d*. The only area in which females scored significantly higher than males was Nutrition for which there was a medium size effect size ($d = 0.50$). The results are highly similar to those among university students in Northern Ireland reported by Lynn, Irwing, and Cammock (2002).

Keywords: General knowledge; Sex differences

1. Introduction

General knowledge can be defined as culturally valued knowledge but non-specialist information generally disseminated by the media. People are exposed to a great deal of this general

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information and much of it is forgotten. People differ in the amount of general knowledge they acquire and retain. It has long been known that general knowledge is a component of intelligence. A number of intelligence tests contain questions on general knowledge. The Wechsler tests all contain an information subtest of general knowledge (Wechsler, 1958) and the Stanford-Binet test asks children to explain the difference between a fly and a butterfly and to name the days of the week, which can be considered a test of general knowledge for 8 year olds (Terman & Merrill, 1960). In hierarchical models of intelligence such as those constructed by Carroll (1993) and Horn (1994), general knowledge is a component of Gc (crystallised ability), a second order verbal factor that also includes vocabulary, reading comprehension, spelling and foreign language proficiency (Carroll, 1993).

We are concerned in this paper with the issues of (1) the factorial structure of general knowledge, i.e. whether the domains of general knowledge such as politics, science, sport, etc. are independent of each other or whether they are all positively intercorrelated and form a general factor; and (2) whether there are sex differences in the domains of general knowledge. Although there is a considerable research literature on sex differences in abilities these questions have been very little investigated. The research literature on sex differences in abilities has recently been reviewed by Kimura (2002). She concludes that there are five abilities in which males are on average better than females (spatial orientation, visualization, line orientation, mathematical reasoning, and throwing accuracy) and five abilities in which females are on average better than males (object location memory, perceptual speed, verbal memory, numerical calculation, and manual dexterity). Neither Kimura, nor the recent textbooks on sex differences in cognitive abilities by Kimura (1999) or Halpern (2000), or the recent textbook on intelligence by Mackintosh (1998), makes any mention of a sex difference in general knowledge.

The existence of a substantial male advantage in general knowledge has recently been claimed by Lynn et al. (2002) and Lynn and Irwing (2002). The first study in this research programme by Irwing, Cammock, and Lynn (2001) was designed to construct a taxonomy of the constituents of general knowledge. This showed the existence of 19 areas or domains of general knowledge (history, science, politics, music, etc.), and a general factor of general knowledge was demonstrated. In the first study of sex differences in a sample of 636 university students it was found that males obtained a higher mean by 0.51*d* (approximately half a standard deviation or 7.5 IQ points) (Lynn et al., 2002). It was also found that sex differences varied in magnitude in different domains of general knowledge. For instance, males had much more knowledge of sport and finance, while females had more knowledge of cookery and medicine. In 15 of the domains of general knowledge males had more general knowledge than females, while in four domains females had more general knowledge than males. In the second study of 1047 university students using a shorter version of the general knowledge test, males obtained a higher mean than females by 0.48*d*, virtually identical to the advantage of 0.51*d* found in the first study. The second study also found the same sex differences in the various domains of general knowledge (Lynn & Irwing, 2002).

These sex differences in general knowledge have been obtained on samples of university students at the University of Ulster in Northern Ireland. It is possible that there is a selective gender bias for students at the University of Ulster, or among students in general, or that for other reasons the finding may not generalise to other populations. We consider that general knowledge is an important ability. It seems rather more important than some of those for which there are sex differences listed by Kimura (2002) such as line orientation (matching the slope of a line) and

throwing accuracy. Hence we believe the finding that males have a considerable advantage in general knowledge is sufficiently interesting to be worth examining in a different population to determine whether it is replicable. The sample we have chosen for this purpose is high school students in Germany.

2. Method

The first stage of the study was to translate the General Knowledge Test (GKT) constructed by Irwing et al. (2001) into German and to demonstrate its applicability for a German group of young adults. The 216 items were translated and administered to a group of 35 men and 40 women, mostly students (93%). The age range was 16–69 years, median 24 years. The administration took about 60 min. Items of extremely low (<20) and extremely high (>80) difficulty and of low discriminatory power, i.e. items which were only slightly related to the total score (<0.30), were eliminated. This left 95 items for 17 domains of general knowledge. The domains of popular music and jazz in the Lynn et al. (2002) study were combined, and general science and history of science were also combined. The test is designated the GKT-G test (General Knowledge Test-German).

For the main study the participants were school students in grade 12 attending 5 schools in the cities of Marburg and Giessen in the central German county of Hesja. Permission to carry out the study was obtained from the government ministry, head teachers and parents. Participation by the students was anonymous and voluntary. The mean age was 17.6 years (SD = 0.94, median 18 years). The number tested was 302, consisting of 153 females and 149 males. The sample is believed to be representative of German 17 year olds at school. School is voluntary for 17 year olds in Germany so these students who have chosen to remain in school probably have somewhat above average IQs. The approximately equal numbers of boys and girls in the sample suggest that the sample is equally representative of the two sexes. The participants took the tests at school in the break time between the classes in groups of 5–50. The tests were administered by two students of psychology.

3. Results

Reliability of the total score and the scores on the subtests was calculated by Cronbach's Alpha. The coefficients of internal consistency were 0.90 for the complete test of 95 items. The coefficient was 0.91 for the males and 0.87 for the females. The number of items in the subtests and reliability coefficients for the subtests are given in Table 1.

The GKT-G data were tested for normal distribution by the Kolmogorov–Smirnov test. The values were normally distributed in an adequate manner. The means and standard deviations of the males and females on the 17 domains of general knowledge and on the total score are shown in the first five columns of Table 2. Column 6 gives the results of univariate F-tests as measures of the statistical significance of the sex differences on the 17 subtests. The multivariate t-test is statistically significant ($F_{17,278} = 14.25$, $p < 0.001$). This result shows a highly significant effect of sex in regard to the scores on the 17 GKT-G subtests. The last row gives the means and standard

Table 1
Cronbach's Alpha reliability coefficients for the subtests

Subtest	Alpha	Number of items
Popular Music	0.56	6
Discovery & Exploration	0.64	11
Sport	0.65	5
Politics	0.67	5
History	0.64	6
Classical Music	0.49	5
Art	0.40	4
Literature	0.47	5
Physics/Chemistry	0.52	5
Geography	0.57	5
Nutrition	0.63	5
Medicine	0.42	6
Games	0.47	6
Biology	0.37	4
Finance	0.53	5
Fashion	0.55	6
Film	0.61	7
GKT-G total	0.90	95

deviations of the total scores and shows that males obtained a higher mean score than females. The difference is statistically significant, tested by t-test for independent groups ($t = 5.2$, df $= 280$, $p < 0.001$).

Columns 7 and 8 give the effect size d for the present German sample and for the Northern Irish sample reported by Lynn et al. (2002). The effect size for the present German sample is $d = 0.60$. This is the equivalent of more than half a standard deviation and is normally considered as a medium size effect. In the Northern Irish samples reported by Lynn et al. (2002) and Lynn and Irwing (2002), males obtained a higher mean on the total test of the same effect size ($0.51d$ and $0.48d$). Thus the male advantage in total general knowledge is closely similar in the German and Irish samples.

The factorial structure of the test was examined. The sample size relative to the number of dichotomous items is too small to factor analyse the items, and so a factor analysis on the 17 subtests was calculated to determine the factorial structure of the test (see Nunnally, 1978, for an explanation of this procedure). The correlation matrix of the GKT-G subtests is shown in Table 3. This was factor analysed by principal components followed by varimax-rotation. The eigenvalues of the first six factors were 5.32, 1.70, 1.41, 1.11, 0.86, and 0.83. The existence of four factors with eigenvalues above 1.0 suggests the presence of four significant factors. The total variance explained by the first four factors is 56.1%. The first principal component accounts for 31.3% of the variance indicating a fairly strong general factor. The second, third and fourth factors explain 10.0%, 8.3%, and 6.5% of the variance, respectively. Loadings of the 17 domains of general knowledge on the first principal component and the first four varimax-rotated factors are shown in Table 4. Column 2 gives the loadings on the first principal component identified as the g of general knowledge (gGK). It will be seen that all the knowledge domains

Table 2
Sex differences in the GKT-G subtests by sex; effect sizes for the mean differences in the German sample and in the Irish sample of Lynn et al. (2002)

Subtest	Male ($n = 149$)		Female ($n = 153$)		F	Effect sizes	
	Mean	SD	Mean	SD		German d	Irish d
Popular Music	3.6	1.4	3.5	1.3	0.7	0.04	−0.15
Discovery & Exploration	2.8	2.1	1.8	1.4	21.6***	0.56	0.69
Sport	3.3	1.4	1.8	1.3	92.6***	1.12	0.84
Politics	1.2	1.3	0.8	1.1	8.0**	0.33	0.69
History	2.1	1.5	1.2	1.2	28.7***	0.62	0.72
Classical Music	0.5	0.9	0.5	0.8	0.1	−0.03	0.08
Art	0.7	0.8	0.9	0.9	2.0	−0.16	0.07
Literature	0.5	0.8	0.6	0.9	0.6	−0.09	0.49
Physics/Chemistry	2.2	1.3	1.5	1.2	22.3***	0.55	0.63
Geography	2.1	1.3	1.3	1.1	32.9***	0.67	0.41
Nutrition (Cookery)	2.3	1.5	3.0	1.3	18.7***	−0.50	−0.48
Medicine	3.8	1.4	4.1	1.2	3.1	−0.20	−0.32
Games	3.5	1.4	2.4	1.2	48.4***	0.82	0.54
Biology	2.1	1.2	1.6	1.0	17.9***	0.49	0.42
Finance	4.0	0.9	3.1	1.2	54.4***	0.85	0.69
Fashion	3.1	1.3	3.1	1.5	0.1	0.03	−0.05
Film	2.5	1.3	2.4	1.3	0.3	0.06	0.13
Total score	40.3	11.8	33.6	10.0	5.2***	0.60	0.51

*$p < 0.05$.
**$p < 0.01$
***$p < 0.001$.

have positive loadings on the first principal component showing the existence of a general factor of general knowledge.

Columns 3, 4, 5 and 6 give loadings on the four varimax factors. The factors are not particularly easy to interpret. The first factor looks like a cultural interests factor with appreciable loadings on all the domains except sport, games, popular music, fashion, physics/chemistry, biology and medicine, Factor 2 is predominantly a sport and games factor (the two highest loaders), but has appreciable loadings on history and finance. Possibly this is a competetiveness factor, since history and finance are both concerned with competition. Factor 3 with the highest loadings on popular music, nutrition and fashion seems uninterpretable. The fourth factor with the highest loadings of physics/chemistry, biology and medicine is a science factor.

4. Discussion

This study of sex differences in general knowledge among German high school students compared with university students in Northern Ireland provides two points of interest. First, factor analysis of the factorial structure of general knowledge in the two samples shows the presence of a general factor that explains 31.3% of the variance in the German sample and 28% of the variance

Table 3
Correlation matrix of the GKT-G subtests

	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q
a	0.31	0.21	0.26	0.14	0.13	0.22	0.19	0.10	0.15	0.31	0.30	0.25	0.11	0.23	0.36	0.35
b		0.31	0.56	0.53	0.40	0.37	0.31	0.35	0.50	0.10	0.34	0.36	0.36	0.41	0.32	0.45
c			0.28	0.32	0.07	0.01	0.00	0.18	0.39	0.04	0.01	0.43	0.17	0.38	0.26	0.29
d				0.58	0.46	0.45	0.40	0.22	0.49	0.23	0.23	0.30	0.24	0.38	0.21	0.43
e					0.37	0.28	0.29	0.34	0.49	0.08	0.15	0.33	0.29	0.36	0.16	0.38
f						0.33	0.38	0.19	0.35	0.24	0.25	0.19	0.18	0.19	0.16	0.24
g							0.40	0.11	0.19	0.33	0.29	0.19	0.16	0.22	0.19	0.29
h								0.10	0.20	0.16	0.23	0.09	0.15	0.20	0.11	0.30
i									0.29	0.09	0.24	0.28	0.22	0.36	0.14	0.06
j										0.14	0.13	0.33	0.29	0.35	0.24	0.34
k											0.25	0.14	0.03	0.11	0.28	0.20
l												0.06	0.24	0.15	0.19	0.19
m													0.35	0.42	0.27	0.27
n														0.29	0.16	0.13
o															0.35	0.32
p																0.40

a—Popular Music, b—Discovery & Exploration, c—Sport, d—Politics, e—History, f—Classical Music, g—Art, h—Literature, i—Physics/Chemistry, j—Geography, k—Nutrition, l—Medicine, m—Games, n—Biology, o—Finance, p—Fashion, q—Film.

Table 4
Loadings of the domains of knowledge on the first principal component and the four varimax rotated factors (decimal points omitted)

Domain	*g*GK	1	2	3	4
Politics	776	718	393	108	088
Literature	748	701	−043	147	028
Classical Music	686	689	055	068	177
Art	651	622	−051	358	101
History	618	570	503	−123	223
Discovery & Exploration	617	522	443	158	361
Sport	562	−050	783	081	039
Games	553	039	610	168	326
Geography	526	420	570	−042	196
Finance	476	142	561	185	360
Film	468	408	485	396	−163
Popular Music	347	083	229	713	052
Nutrition	492	219	−068	658	028
Fashion	464	008	413	623	053
Physics/Chemistry	419	093	216	−008	703
Biology	446	131	223	005	641
Medicine	455	258	−206	471	547

in the Northern Irish sample. Second, the direction and magnitude of the sex differences in general knowledge is similar in both samples. The results set out in column 7 of Table 2 show that in the present German sample males achieved significantly and substantially higher scores than females in general knowledge of 0.60*d*. In the domains of general knowledge males achieved significantly and substantially higher scores than females in the general knowledge areas of Sport ($d = 1.12$), Finance ($d = 0.85$), Games ($d = 0.82$), Geography ($d = 0.67$) and History ($d = 0.62$). Males had a smaller advantage in the knowledge areas of Physics/Chemistry ($d = 0.55$), Discovery & Exploration ($d = 0.56$), Biology ($d = 0.49$), and Politics ($d = 0.33$). There were no sex differences in the knowledge areas of Popular Music, Classical Music, Literature, Film and Fashion. Females scored slightly higher in Art and Medicine but their advantage in these areas is not statistically significant. The only area in which females scored significantly higher than males is Nutrition for which there is a medium size effect size ($d = 0.50$). Comparison with the results set out in column 8 of Table 2 giving the corresponding sex differences in the Northern Irish sample show that the sex differences in the German and Irish samples are closely similar. The product–moment correlation of the d values in the two samples is 0.85, and Spearman's rank correlation is 0.81 (for both correlations $p < 0.01$). It is concluded that the sex differences in general knowledge among high school students in Germany are highly similar to those among university students in Northern Ireland.

We discuss some possible shortcomings of the study. First, it is difficult to establish that the 17 domains of general knowledge measured represent the totality of general knowledge. It may be that there are other domains of general knowledge and that there are different sex differences in these. We believe that the 17 domains represent general knowledge as generally understood but further research could prove otherwise. Second, it has often been suggested that there is greater variance of intelligence in males than in females. If this is so, in this sample and in the Irish student

samples with mean IQs probably somewhat above the mean, males would have greater general knowledge. However, we agree with Mackintosh (1998) who has reviewed the evidence for sex differences in variance and concluded that it is confined to visualisation abilities, so do not think this possibility is likely.

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