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Sex Differences in General Knowledge Domains

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A B S T R A C T

The aim of this study was to investigate some cognitive differences in highly comparable (according to age, education and motivation) samples of female and male university graduates in Croatia. Female (N=280; age X=26.59; SD=2.84) and male participants (N=96; age X=26.99; SD=2.99) were university graduates in economics, law humanities and social sciences applying for positions in public service. As part of the selection procedure, they were given a number of cognitive tests. The results were that men obtained higher average scores on the g-factor intelligence test, on the general knowledge tests of natural and social sciences, world religion and customs, and knowledge of current affairs. There were no significant sex differences on vocabulary, foreign language ability and general knowledge of culture. An analysis of covariance, with intelligence test as a covariate, showed that sex differences in general knowledge were present when intelligence was controlled.

Key words: *sex differences, general knowledge domains, university graduates*

Introduction

General knowledge is an important construct in the Cattell-Horn, Carroll's and McGrew theories of the structure of intelligence[1–3]. It is primarily a measure of knowledge, although it can be treated as a measure of cognitive aptitude. Therefore, gender differences can have different causes and mediators, that are probably inter-related. Because in Croatia general knowledge tests are increasingly used for different purposes, i.e. university entrance exams, professional selection, the question of gender differences in general knowledge have a theoretical, as well as socio-political and ethical importance. Wittmann points out (p. 223): »Group differences are the most controversial topic in psychology and social sciences, in which a researcher can easily fall into booby traps, ruin or endanger his or her academic career, or at least get a finger burned« [4].

Ackerman and Beier have described the debate between Terman and Yerkes in the early decades of the twentieth century that is still running: do males and females have the same overall IQ, should abilities and knowledge tests yield equal means for boys and girls, or should they have separate norms?[5]. In overall IQ most studies show very small and inconsistent sex differences[6]. More recently, Johnson and Bouchard write (p. 24): »Taken together, these data suggest that men and women achieve similar levels of overall intellectual processing power using different neuroanatomic and brain structural pathways, which in turn contribute to differences in more specialized abilities[7]. Also Spelke (discussing sex differences in math and science) points out that boys and girl show somewhat different cognitive profiles[8]. These differences are complex, subtle, tend to be small and they stem primarily from differing strategy choices. The contemporary consensus favours what Hyde calls the gender similarities hypothesis[9]. Namely, meta-analysis show there are many more similarities than differences in cognitive abilities of men and women.

However, there is widespread consensus that males and females have different cognitive profiles[10]. In addition, it has frequently been reported that there is greater male variability in cognitive measures and that males are over-represented at both extremes[11–12].

Cognitive sex differences have been reviewed in several books[13–19]. There is a general consensus that on average males obtain higher means than females on spatial orientation, visualization, line orientation, mathematical and mechanical reasoning while females on average obtain higher means than males on object location memory, perceptual speed, verbal memory, numerical calculation

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and word fluency. But none of these books on cognitive sex differences makes any mention of sex differences in general knowledge. It is only recently that there has been interest in this subject. Recent studies have reported than men on average obtain higher scores than women on tests of general knowledge. This has been found in school and college student samples in the United States by Ackerman, Bowen, Beier, and Kanfer, Rolfhus and Ackerman, in Northern Ireland by Lynn, Irwing and Cammock and Lynn and Irwing, in Estonia by Allik, Must and Lynn, and in Germany by Lynn, Wilberg and Margaf-Stiksrud[20–25]. The sex difference in these studies has been approximately 0.5d (half a standard deviation) and is one of the higher of the sex differences in abilities. Recently Zarevski, Ivanec, Zarevski and Lynn[26] have reported sex differences in general knowledge for four studies of school students aged 15 and 18 years in Croatia (total n=4430), and the results were compared with those obtained on college students in the United States[20] and the study of Northern Ireland college students[22]. The results are generally consistent across the three countries in finding that males had more knowledge of the domains of discovery and exploration, finance, geography, history, politics, science and sport. Females had more knowledge in the domains of cookery and medicine. But in the total sample of Croatian participants average of d value of different general knowledge domains was zero.

Research applying a hierarchical factor model to general knowledge has identified some twenty domains[21,22]. These have been condensed into six higher order factors identified as Current Affairs, Family, Physical Health and Recreation, Fashion, Arts and Sciences[22].

The objectives of the present paper were (1) to report the results on sex differences in some domains of general knowledge found in a sample of university graduates in Croatia (samples were balanced in terms of their age, education and motivation). Work selection represents a good situation to control for non-cognitive factors such as persistence, seriousness and motivation; factors which can influence the results of studies on sex differences in cognition; (2) to investigate how sex differences in general knowledge are related to differences in general intelligence, vocabulary and foreign language knowledge.

Materials and Methods

Measures

General knowledge tests were constructed for selection of candidates applying for positions in public services and were intended to measure three broad domains: General Culture, Natural and Social Sciences, and Current affairs (note: our aim was not to investigate the latent structure of the whole general knowledge space).

1. Intelligence test, measuring reasoning with verbal, nonverbal and numerical stimuli. It is a standardized intelligence test often used for the selection purposes of highly educated individuals. Its convergent validity to other intelligence tests has been confirmed, and the correlations between the test used for these selective purposes and the RPM is high (r=0.77)[27].

Three tests for measuring the general knowledge of three wide domains:

2. General Culture: National and World History, and Arts (item example: *Koechel numbers signify the work of*: a) J. S. Bach; b) L. van Beethoven; c) L. da Vinci; d) J. W. Goethe; e) W. A. Mozart).

3. Natural and Social Sciences: Natural and Social Sciences, Medicine, and World's Religions and customs (item example: *Used in plastic surgery for the purpose of face-lifting is*: a) botox; b) lumex; c) lanolin acid; d) aloe vera; e) bitumen).

4. Current affairs: Politics, Business, Technology, Sports and Entertainment (item example: *The name of the two stock market indices in Croatia are*: a) CROBEX and VIN; b) CRSI and VSI; c) BIZ and VBI; d) CROSI and VX; e) SIC and VINDSI).

5. Vocabulary (participants had to find Croatian synonyms for international words)

6. English language test

Tests 2 through 5 offered consisted of multiple-choice items, which presented a correct answer and four distracters. These tests consisted of the same number of items (50). All six tests are power tests, i.e. enough time was provided for all participants to answer all items. Applicants were told that there are no negative scores (incorrect answers were not subtracted from correct ones). All the tests have a satisfactory internal consistency (Cronbach's alfa:.80 and more).

Subjects

The participants were 96 men and 280 women who applied for positions in the public service in one ministry. Women's average age was 26.59 (SD=2.84) and men's average age was 26.99 (SD=2.99). This difference is not statistically significant ($t_{df=374}=1.15$; p=0.40). As part of the selection procedure, they were given a number of tests constructed for selection purposes (note: therefore names of the test authors can not be stated, only the object of test measurements). All the participants were economics, law, humanities and social sciences university graduates. Hence, there is a higher number of female participants. However, this ratio represents the population of graduates of such vocational profiles quite well. This, of course, also signifies the possibility of generalizing these data only on a subpopulation like the one in question. On the other hand, these samples, balanced in terms of their age and education, allowed for the investigation of sex differences in cognition in this specific subpopulation.

Statistics

Several statistical analyses were performed. In correlation analysis Pearson coefficient correlation (r) were used. Because of slight asymmetry, the distributions were

for the purposes of correlation analysis normalized for two tests, General Culture and Current Affairs. Distributions of other tests did not differ from normal distribution (tested by Kolmogorov-Smirnov one-sample test). In order to explore the factor structure of the selection battery tests, a principal components analysis was calculated for both sexes. To determine statistical significance of sex differences on dependent variables, t-test and analysis of covariance were used. Effect size was expressed as Cohen's d (in the case of t-test), and partial eta squared (η^2 – in the case of analysis of covariance). The SPSS version 16.0 was used for statistical data analysis.

Results

The Pearson correlation coefficients between the six variables are shown in Table 1. It will be seen that all the variables are positively inter-correlated, indicating the existence of a general factor[28]. All the correlations are statistically significant at $p<0.01$.

Principal component analysis revealed that in the male sample only the first component had an eigenvalue higher than 1 (3.20) and it explained 53.3% of the variance in the correlation matrix. In female sample the first eigenvalue (3.08) explained a very similar amount of matrix variance (51.4%), but there is also a second eigenvalue greater than 1 (1.04) which explained 17.3% of variance. The loadings of the tests on the first principal component are shown in Table 2. All the tests had high and very similar loadings on the first principal component in male and female samples. Since Kaiser-Guttman criteria for keeping the eigenvalues has a tendency of hyperfactorization, and the second eigenvalue is higher than one only at the second decimal place, we have decided to base our interpretation of the psychological contents of the selected test battery on the similarity of the first latent variables of this space[29]. This is also confirmed by the very high congruence coefficient (.973). Therefore, we can assume that our tests measure the same constructs in females and males. Also, the component analysis of correlation matrix of these test on the total sample resulted in one latent dimension accounting for 52.32% of the variance.

TABLE 2
PROJECTIONS OF THE TESTS ON THE FIRST PRINCIPAL COMPONENT IN THE MALE (N=98) AND FEMALE (N=280) SAMPLES, PERCENTAGES OF THE VARIANCE EXPLAINED WITH THE FIRST PRINCIPAL COMPONENT

Test	Males	Females
Vocabulary	0.81	0.79
General culture	0.75	0.80
Natural & social science	0.79	0.81
Current affairs	0.68	0.66
Intelligence	0.62	0.55
English language test	0.71	0.66
Percentage of variance	53.3	51.4

Table 3 gives the sex differences on the six tests. Men obtained higher average scores than women on all the tests, but the differences were statistically significant (tested by t-tests) only for Natural and Social Sciences, Current Affairs and Intelligence.

To determine whether there were sex differences in vocabulary, general knowledge and English when intelligence was controlled, a covariance analysis was carried out for the five abilities using the sex as an independent variable and intelligence as a covariate. The results are

TABLE 3
t -TEST VALUES AND RESPECTIVE SIGNIFICANCE LEVELS (p) IN TESTING DIFFERENCES ON ALL MEASURES BETWEEN MEN AND WOMEN. THE EFFECT SIZES RELATED TO THE STATISTICALLY SIGNIFICANT DIFFERENCES (COHEN d) ARE IN LAST COLUMN (NOTE: ALL MEAN VALUES ARE HIGHER IN MEN'S SAMPLE)

Variable	t	df	p	d
Vocabulary	1.59	374	ns	0.19
General culture	1.54	374	ns	0.18
Natural & social science	4.60	374	p<0.0001	0.54
Current affairs	8.87	374	p<0.0001	1.05
Intelligence	2.54	374	p<0.05	0.30
English language test	1.89	371	p=0.059	0.22

ns – non significant

TABLE 1
PEARSON'S CORRELATION COEFFICIENTS BETWEEN SIX VARIABLES. VALUES ABOVE DIAGONAL REFER TO MEN AND VALUES BELOW REFER TO WOMEN

Test	Vocabulary	General culture	Natural & social sciences	Current affairs	Intelligence	English language test
Vocabulary		0.65**	0.44**	0.42**	0.47**	0.52**
General culture	0.62**		0.54**	0.38**	0.32**	0.34**
Nat. & soc. sciences	0.50**	0.61**		0.58**	0.39**	0.46**
Current affairs	0.37**	0.45**	0.59**		0.23**	0.40**
Intelligence	0.37**	0.29**	0.20**	0.15*		0.40**
English language test	0.47**	0.33**	0.39**	0.29**	0.45**	

* p <.05; ** p < .01

TABLE 4
RESULTS OF COVARIANCE ANALYSIS IN TESTING DIFFERENCES BETWEEN MEN AND WOMEN, WITH INTELLIGENCE AS A COVARIATE

Variable	F	df	p	η^2
Vocabulary	0.41	1/373	ns	–
General culture	0.66	1/373	ns	–
Natural & social science	15.17	1/373	p<0.001	0.04
Current affairs	71.86	1/373	p<0.001	0.162
English language test	0.75	1/370	ns	–

ns – non significant

given in Table 4. These results show that by controlling for men's better results on the intelligence test, the statistical marginal higher mean (p=.059) obtained by men in English language test becomes non-significant. But the sex differences in Natural and Social Science and in Current Affairs still remain statistically significant in favour of men.

Discussion

Table 1 show that the six tests are all positively inter-correlated and that a substantial general factor is present that accounts over 50 percent of the variance in both samples. This factor can be recognised as Cattell's crystallised intelligence (G_c), consisting of the verbal abilities and the ability to acquire and effectively use information[1]. Carroll in his synthesis of factor analytic studies on intelligence described the factor as consisting of verbal ability, reading comprehension, general information (general knowledge), spelling, numerical ability, and foreign language proficiency. Studies showing that foreign language proficiency is a component of this factor, are quite sparse and the present result supports this.

The sex differences on the six tests are given in Table 3. The sex difference in the vocabulary test (d=0.19) is not statistically significant. This supports the results of a number of U.S. studies summarized in Hyde and Linn's meta-analysis[30]. On the three tests of general knowledge, the sex difference for General Culture (d=0.18) is not statistically significant; for Natural and Social Sciences, men obtained a significantly higher mean (d=0.54) than women; and for Current Affairs, men also obtained a significantly higher mean (d=1.05) than women. The average of the three general knowledge tests was d=0.59 and was similar to the sex differences in general knowledge considered as a unitary construct[21–23].

The results of this study support the studies mentioned in the introduction that have found that there are considerable variations in the sex differences in different domains of general knowledge. It has typically been found that there is little difference in knowledge of culture and the arts, while men have on average considerably more knowledge than women of politics, sports, technology, and business. These differences may reflect the respective interests of men and women in these different domains of knowledge, in which men and women typically have different levels of interests. Lubinski and Humphreys reported a study in which men had more interest in science (d=1.05), sports (d=0.70) and finance (d=0.46), while women had more interest in literature (d=0.61), music (d=0.38) and art (d=0.40)[31]. These different interests may explain the differences in knowledge because people acquire knowledge of the domains they are interested in. The sex difference in interests finds further expression in the kinds of occupations typically chosen by men and women. Lippa proposed a »people-things dimension« of interests such that women are typically more interested in people, and hence in literature and culture, while men are typically more interested in things, and hence in science and technology[32]. In a review of the evidence, he concluded that »women are more interested in social and artistic occupations« and men are »more interested than women in investigative occupations« (p. 24)[18].

The higher mean obtained by men on the test of intelligence (d=0.30) may be surprising in view of the frequent assertions made over the last half century that there is no sex difference in intelligence, e.g., Cattell stated that: »it is now demonstrated by countless and large samples that on the two main general cognitive abilities – fluid and crystallized intelligence – men and women, boys and girls, show no significant differences«[1]; Brody[33] said that »gender differences in general intelligence are small and virtually nonexistent«; Mackintosh argued that »there is no sex difference in general intelligence worth speaking of«[34]. Further, Lubinski[35] stated that »most investigators concur on the conclusion that the sexes manifest comparable means on general intelligence«; and Halpern[16] concluded that »sex differences have not been found in general intelligence«.

This consensus was questioned by Lynn who contended that the sex difference in general intelligence is minimal up to the age of 15 years but from the age of 16 onwards men begin to obtain higher means than women until the male advantage reaches about 4–5 IQ points among adults[36]. Subsequent studies have shown that this is approximately correct. For instance, a meta-analysis of 57 studies of sex differences in general population samples on the Standard and Advanced Progressive Matrices, adopted as one of the best measures of general intelligence, showed that in adults there is a male advantage of 0.33 d, equivalent to 5 IQ points[37]. Several other studies reached the same conclusion. In Spain, Colom, Garcia, Juan-Espinoza and Abad[38] analysing the Spanish standardization sample of adults on the WAIS-III found a male advantage of 3.6 IQ points, while Colom and Lynn[39] in an analysis of the Spanish standardization sample of the DAT found a male advantage among 18 year olds of 4.3 IQ points. In Denmark, Nyborg found a male advantage among adults of 5.55 IQ points[40]. In the present study result of men obtaining a higher mean on the intelligence test of 0.3 d (4.5 IQ points) is a further confirmation for the accumulating evidence that, in adults, men have an IQ advantage of around 4–5 IQ points.

On the English language test, men achieved a higher average score (d=0.22) but this difference was not statistically significant. There have not been many studies of sex differences in foreign language ability. There are a few studies reporting that 10–12 year-old girls had higher means on foreign languages than boys, e.g. of 0.27 d in Sweden, 0.38 d in Ireland, and 0.13 d in Mauritius[41–43]. The only report of foreign language ability in adults of which we are aware is Zeidner's study in Israel reporting a negligible female advantage of 0.05 d among 24-year-old applicants for the university[44]. This is consistent with the non-significant difference in the present study.

Table 4 shows that when intelligence is controlled, there are no sex differences in Vocabulary, General Culture and in English language test. However, men still obtain significantly higher means in Natural and Social Science and in Current Affairs. We can conclude that a part of the variance of the higher results of male university graduates in the measures predominantly related to G_c (vocabulary, general culture and foreign language) stems from the difference in measures of the general intelligence factor. It is not certain whether this is due to the more efficient excluding of distractors and/or a more pronounced risk-taking tendency to guess when male participants do not know the correct answer. This is something that would certainly need to be investigated in future research. When it comes to general knowledge about Natural and Social Science, and especially of Current Affairs, the male advantage is not *g*-related. Since the general knowledge test was dominated by the Current Affairs questions on politics, business, technology and sports, and only a smaller part dealt with entertainment (a domain in which women traditionally excel), this finding is not surprising. Also, knowledge of politics, business and sports are associated with a higher competitiveness of males[45].

Finally, we consider some possible explanations for the sex differences in the different domains of general knowledge and what are possible consequences of them. Part of the explanation of these lies in the typically different interests of males and females. Males are typically more interested in domains largely concerned with competition between males, such as sport, current affairs, business, politics, and history. Females are typically more interested in domains largely concerned with nurturing and home making, such as cookery and medicine[46]. It has been shown that interests in different domains are positively correlated with knowledge of the same domains[47]. This sex difference in interest is maybe the most important reason for our results.

These different interests may arise from differential socialisation in childhood[48]. Alternatively, they may be explained in terms of evolutionary psychology, according to which males have an evolved propensity for competition with other males as individuals and between groups. Females have an evolved propensity for nurturance[45]. Wittmann points out that diversity within and between groups helps populations to survive[4]. But Ackerman raises the problem of when to accept group differences and when society should make efforts to close them[49].

Spelke (p. 956) concludes that: »Studies of cognitive sex differences suggest that today's gender disparities have causes similar to those of past disparities. If this is the case, then studies of cognitive development and of its biological basis will not explain the preponderance of men on academic faculties of mathematics and science. We must look beyond cognitive ability to other aspects of human biology and society for insights into this phenomenon«[8]. It can be hypothesized that differences found in some areas of general knowledge in Croatian adolescents are more related with gender roles than with biologically determined sex. Also, it is probable that the source of observed gender differences in some domains of general knowledge could be located in attitudinal variables, rather than in cognitive variables. As Voyer, Voyer and Bryden have pointed out (p. 265): »the decrease in magnitude of sex differences in recent years argues for the fact that attitudes concerning sex-related cognitive differences have changed. This attitude change is likely to have affected the way children are raised and the way women and men approach different task«[50].

While sex differences in general knowledge most likely have environmental determinants arising from socialization and societal norms, it is also likely that they have some genetic determination as well. Sex differences in general knowledge appear to be partly determined by differences in interests. Lykken, Bouchard, McGue and Tellegren have shown that interests have a heritability of about 50%[51]. Plomin has also concluded that there are genetic dispositions that make individuals more or less prone to knowledge acquisition[52]. It seems likely that cognitive sex/gender differences in general knowledge are a result of interaction between abilities, personality, interests motivation, that they are influenced by social norms and different socialization processes, and by some genetic predisposition.

What is the relevance of these sex differences in a real-life situation of personnel selection? It seems that typical selectional procedures favor masculine gender roles. Is a fair solution to this problem a quota for the employment of women and men in public services? The answer to this question should be decided after a debate on the psychological, sociological, societal, economic and political aspects of this bias.

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SPOLNE RAZLIKE U DOMENAMA OPĆEG ZNANJA

SAŽETAK

Cilj itraživanja bio je ispitati razlike u domenama općeg znanja između žena i muškaraca koji su bili izjednačeni prema dobi, razini obrazovanja i motivaciji. Žene (N=280, dobi X=26,59; SD=2,84) i muškarci (N=96; dobi X=26,99; SD=2,99) bili su završeni studenti ekonomije, prava i humanističkih i društvenih znanosti. Svi su oni aplcirali za radno mjesto u javnoj upravi. Kao dio selekcijskog postupka rješavali su nekoliko testova općeg znanja i kognitivnih sposobnosti. Rezultati su pokazali da mušakrci postižu u prosjeku veće rezultate na g-faktoru inteligencije, u testu općeg znanja o prirodnim i socijalnim znanostima, svjetskoj religiji i običajima te na testu informiranosti o aktualnim zbivanjima. Nije bilo značajne razlike među spolovima u testu rječnika, testu stranog jezika te u testu općeg znanja iz kulture. Analiza kovarijance, gdje je uradak na testu inteligencije uzet kao kovarijata, pokazala je da dobivene spolne razlike i dalje postoje.