

## SEX DIFFERENCES IN READING ACHIEVEMENT

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**Abstract.** In the last century many studies have revealed the advantages of girls in reading and superiority of boys in science. However, the international tests detected no difference in science test results in the 21st century. The aim of the study was to find the sex effect size and variances in reading achievement in recent international studies. The analysis of PISA 2000, 2003, and 2006 data and the PIRLS 2001 and 2006 data revealed that the advantages in reading achievement of ten-year old girls was  $0.23d$  and that of 15-year old girls was  $0.42d$ . One explanation of girls' higher achievement in reading is in their deeper engagement in language related activities. Comparisons with other studies and possible implications are shown.

**DOI:** 10.3176/tr.2009.1.01

**Keywords:** reading achievement, sex effect, meta-analysis, effect size, abilities

### 1. Introduction

It has frequently been asserted that women have higher average verbal abilities than men. For instance, “boys, from various cultures, are superior to girls on spatial problems; girls are superior to boys on verbal tasks” (Kagan 1971:182); “females are consistently superior to males in a wide range of verbal tasks” (Galsworthy et al. 2000:206); “the well attested fact that women are stronger on verbal items” (Bartholomew 2004:106); “it is well known that females have about a one-third of a standard deviation (5 IQ points) advantage over males” (Anderson 2004:828).

However, these assertions have not been universally accepted. In the meta-analysis of sex differences in verbal abilities in the United States by Hyde and Linn (1988) it was calculated that in pre-1973 studies girls had an advantage of  $0.23d$ , while in post-1973 studies it had dropped to  $0.10d$ . But the girls' advantage of  $0.10d$  was only obtained by omitting the boys' advantage of  $0.11d$  of 18 year olds on the verbal SAT (Scholastic Assessment) in 1985 ( $n = 977,361$ ). Hyde and

Linn (1988) also showed that the girls' advantage on verbal abilities varied according to age and the type of ability. In reading comprehension, girls below the age 6 performed better than boys (0.31*d*), but among older children the sex difference was negligible. In vocabulary, girls aged 6–10 years performed better than boys (0.26*d*), but among 11–18 year olds there was no difference, while among 19–25 year olds men performed better than women (0.23*d*). Analysis of sex differences by type of ability showed that women have higher average abilities in speech production (word fluency) (0.33*d*) and anagrams (0.22*d*), men have higher average abilities than women in analogies (0.16*d*), and there were negligible differences in reading comprehension, essay writing, and vocabulary.

Hyde and Linn's (1988) meta-analysis of sex differences in verbal abilities was a valuable contribution to this question. However, it was not complete. It omitted some data, such as all the Wechsler verbal intelligence studies and the study by Hogrebe, Nist, and Isadore (1985) who found no sex difference in reading achievement of 23,362 in-school seniors and 24,678 in-school sophomores in the results of High School and Beyond (HSB) national survey in 1980.

There have been some subsequent studies of sex differences in verbal abilities in the United States. Mau and Lynn (2000) analysed the tenth and twelfth graders' (16–18 year olds) test results in the American National Educational Longitudinal Study. They found that "females obtained significantly higher mean scores in reading." Klecker (2006:50) has made "a secondary analysis of the National Assessment of Educational Progress (NAEP) dataset ... for the fourth, eighth, and twelfth grade reading scores by students' sex across the years 1992, 1994, 1998, 2000, 2002, and 2003. The statistically significant ( $p < .01$  with effect size measured by Cohen's *d*) differences in reading scores by sex were consistent across grade level and years with females scoring higher than males." Effect sizes (0.13 to 0.44) were smaller for the younger students. However, Jackson and Rushton (2006) reported a boys' advantage of 17/18 year olds of 0.10*d* on the 1991 SAT ( $n = 102,516$ ). This replicated the result reported by Hyde and Linn's (1988). It is apparent, therefore, that the question of whether there are sex differences in verbal abilities is considerably more complex than the assertions quoted in the first paragraph of this paper suggest.

The studies reviewed above are all from the United States. It is important to investigate what the sex differences are internationally. A valuable contribution to this has been made recently by Lietz (2006). In a meta-analysis of sex differences in reading achievement in a number of countries she found that girls in secondary school performed 0.19 standard deviation units above boys.

The objective of the present paper is to make a further contribution to international sex differences in reading ability by examining sex differences in means and variances in the three PISA (Program for International Student Assessment carried out in 2000, 2003 and 2006) and two PIRLS studies, which provide extensive data on this question. The issue of sex differences in variances in reading ability has not been examined hitherto and is a further interesting component of this topic.

## 2. Data

### 2.1. The PISA 2000 study

PISA tests measure reading, mathematical and scientific literacy level of students near the end of compulsory education. In 2000, the tests were carried out with 15-year-olds in 27 countries. The total sample size was approximately 180,000 and includes around 5,000 students in each country. The results on reading comprehension consist of the scores on the test but in addition Wittmann (2005) has calculated latent factor scores by factor analysing the items. Both sets of scores are shown in Table 1. The scores are presented as *ds* (the difference between the means of boys and girls divided by the standard deviation), with positive *ds* denoting higher mean scores obtained by girls. The raw scores show that girls scored higher than boys in all countries. The latent factor scores also show that girls obtained higher average scores than boys in all countries and magnify the girls' advantage.

**Table 1. Sex differences in reading comprehension in the PISA 2000 study (*ds*)**

Country	Raw score	Latent factor score	Country	Raw score	Latent factor score
Australia	0.33	0.69	Japan	0.59	0.45
Austria	0.28	0.81	Rep. of Korea	0.56	0.41
Belgium	0.31	0.65	Luxembourg	0.65	0.52
Canada	0.35	0.65	Mexico	0.45	0.48
Czech Rep.	0.40	0.76	New Zealand	0.79	0.26
Denmark	0.26	0.63	Norway	0.93	0.49
Finland	0.60	0.91	Poland	0.72	0.38
France	0.32	0.74	Portugal	0.49	0.54
Germany	0.32	0.64	Spain	0.67	0.57
Greece	0.39	0.72	Sweden	0.66	0.27
Hungary	0.34	0.71	Switzerland	0.71	0.47
Iceland	0.44	0.68	United Kingdom	0.68	0.45
Ireland	0.31	0.73	United States	0.56	0.28
Italy	0.43	0.68	Average	0.49	0.58

### 2.2. The PISA 2003 study

A second PISA study of 15-year-olds in 40 countries was carried out in 2003. The results in reading comprehension are shown in Table 2 (Learning for Tomorrows World 2003, Table 6.3). It shows that in all countries girls obtained higher average scores than boys. The average advantage of the girls is 0.36*d*. The boys showed greater variance than the girls in all countries by an average variance ratio of 1.20.

**Table 2. Sex differences in PISA 2003 and 2006 reading comprehension tests**

Country	PISA 2003				PISA 2006		
	Boys' mean score	Girls' mean score	Effect size (G - B)	Variance ratio (B/G)	Boys' mean	Girls' mean	Effect size
Argentina					345	399	0.43
Azerbaijan					343	363	0.28
Australia	506	545	0.41	1.25	495	532	0.39
Austria	467	514	0.47	1.23	468	513	0.41
Belgium	489	526	0.34	1.23	482	522	0.36
Brazil	384	419	0.31	1.23	376	408	0.31
Bulgaria					374	432	0.50
Canada	514	546	0.36	1.26	511	543	0.33
Chile					434	451	0.16
Chinese Taipei					486	507	0.25
Colombia					375	394	0.17
Croatia					452	502	0.56
Czech Republic	473	504	0.33	1.05	463	509	0.41
Denmark	479	505	0.29	1.11	480	509	0.33
Estonia					478	524	0.54
Finland	521	565	0.56	1.26	521	572	0.62
France	476	514	0.40	1.22	470	505	0.34
Germany	471	513	0.39	1.19	475	517	0.38
Greece	453	490	0.36	1.33	432	488	0.55
Hong Kong-China	494	525	0.38	1.45	520	551	0.38
Hungary	467	498	0.34	1.11	463	503	0.42
Iceland	464	522	0.62	1.31	460	509	0.50
Indonesia	369	394	0.32	1.00	384	402	0.24
Ireland	501	530	0.34	1.09	500	534	0.37
Israel					417	460	0.35
Italy	455	495	0.40	1.31	448	489	0.38
Japan	487	509	0.21	1.25	483	513	0.30
Jordan					373	428	0.59
Korea	525	547	0.26	1.09	539	574	0.40
Kyrgyzstan					257	308	0.50
Latvia	470	509	0.44	1.25	454	504	0.55
Liechtenstein	517	534	0.19	1.18	486	531	0.47
Lithuania					445	496	0.54
Luxembourg	463	496	0.34	1.23	464	495	0.32
Macao-China	491	504	0.20	1.18	479	505	0.34
Mexico	389	410	0.23	1.07	393	427	0.35
Montenegro					370	415	0.50
Netherlands	503	524	0.25	1.08	495	519	0.25
New Zealand	508	535	0.27	1.14	502	539	0.36
Norway	475	525	0.49	1.26	462	508	0.44
Poland	477	516	0.42	1.29	487	528	0.40
Portugal	459	495	0.40	1.31	455	488	0.33
Qatar					280	346	0.61
Romania					374	418	0.48
Russian Federation	428	456	0.31	1.28	420	458	0.41
Serbia	390	433	0.55	1.28	381	422	0.45
Slovak Republic	453	486	0.36	1.08	446	488	0.40

Country	PISA 2003				PISA 2006		
	Boys' mean score	Girls' mean score	Effect size (G - B)	Variance ratio (B/G)	Boys' mean	Girls' mean	Effect size
Slovenia					467	521	0.61
Spain	461	500	0.42	1.25	443	479	0.40
Sweden	496	533	0.39	1.11	488	528	0.41
Switzerland	482	517	0.38	1.15	484	515	0.33
Thailand	396	439	0.57	1.17	386	440	0.66
Tunisia	362	387	0.27	1.01	361	398	0.39
Turkey	426	459	0.36	1.28	427	471	0.47
United Kingdom					480	510	0.29
United States	479	511	0.32	1.17			
Uruguay	414	453	0.33	1.20	389	435	0.37
Average	463	497	0.36	1.20	440	479	0.41

### 2.3. The PISA 2006 study

A third PISA study of 15-year-olds in 56 countries was carried out in 2006. The results in reading test are shown in Table 2 (PISA 2006, Table 6.1c) – in all countries girls obtained higher average scores than boys. The average advantage of the girls is 0.41*d*.

### 2.4. The PIRLS 2001 reading study

World-wide measurement of reading ability is carried out also by IEA – International Association for the Evaluation of Educational Achievement. The association has assessed reading comprehension twice, in 2001 and in 2006. The first PIRLS study (Progress in International Reading Literacy Study) evaluated reading achievement of fourth grade students (10-year olds) in 35 countries (Mullis et al. 2003). In all countries, girls achieved significantly higher reading test results than boys. The sex effect size by countries is given in Table 3 (data from Mullis et al. 2003, Exhibit B. 2). In average, girls in fourth grade outperformed boys in reading by 0.25*d*. The variance of boys' results was larger than that of girls.

### 2.5. The PIRLS 2006 reading study

The study assessed children's reading literacy achievement and collected data about the impact of home environment on the achievement. The study was conducted in 40 countries and about four-five thousand students participated in every country. Relying on the submitted data (Mullis et al., 2007, Exhibit C. 2), the superiority of girls in reading can be calculated (Table 3). The average sex effect size ( $d = 0.21$ ) is almost the same as in previous study and the variance in boys' results is once more larger by eight percent.

Table 3. Sex effect on international reading achievement in the PIRLS studies

Country	PIRLS 2001						PIRLS 2006					
	Girls' mean	Girls' SD	Boys' mean	Boys' SD	Effect size G-B	Var. ratio B/G	Girls' mean	Girls' SD	Boys' mean	Boys' SD	Effect size G-B	Var. ratio B/G
Argentina	428	96	410	94	0.19	0.96						
Austria							543	62	533	65	0.16	1.10
Belgium Flemish							550	54	544	57	0.11	1.11
Belgium French							502	67	497	70	0.07	1.09
Belize	341	105	314	104	0.26	0.98						
Bulgaria	562	79	538	85	0.29	1.16	558	80	537	84	0.26	1.10
Canada, Alberta							564	67	556	67	0.12	1.00
Canada, British Columbia							562	68	554	70	0.12	1.06
Canada, Nova Scotia							553	73	531	78	0.29	1.14
Canada, Ontario							562	68	549	72	0.19	1.12
Canada, Quebec							539	61	527	65	0.19	1.14
Canada(O,Q)	553	71	536	72	0.24	1.03						
Chinese Taipei							542	62	529	66	0.20	1.13
Colombia	428	82	416	79	0.15	0.93						
Cyprus	506	79	482	82	0.30	1.08						
Czech Republic	543	62	531	66	0.19	1.13						
Denmark							553	69	539	69	0.20	1.00
England	564	84	541	88	0.27	1.10	549	87	530	86	0.22	0.98
France	531	69	520	71	0.16	1.06	527	65	516	67	0.17	1.06
Georgia							480	73	463	76	0.23	1.08
Germany	545	67	533	67	0.18	1.00	551	66	544	68	0.10	1.06
Greece	535	69	514	76	0.29	1.21						
Hong Kong, SAR	538	59	519	65	0.31	1.21	569	56	559	61	0.17	1.19
Hungary	550	64	536	67	0.21	1.10	554	70	548	70	0.09	1.00
Iceland	522	72	503	76	0.26	1.11	520	65	501	70	0.28	1.16
Indonesia							415	76	395	80	0.26	1.11
Iran, Islamic Rep. of	426	91	399	92	0.30	1.02	429	94	414	95	0.16	1.02
Israel	520	90	498	96	0.24	1.14	520	96	506	101	0.14	1.11
Italy	545	71	537	71	0.11	1.00	555	67	548	68	0.10	1.03
Kuwait	422	81	373	90	0.57	1.23	364	101	297	109	0.64	1.16
Latvia	556	61	534	60	0.36	0.97	553	60	530	63	0.37	1.10
Lithuania	552	63	535	64	0.27	1.03	546	56	528	56	0.32	1.00
Luxembourg							559	66	556	67	0.05	1.03
Macedonia, Rep. of	452	103	431	102	0.20	0.98	453	101	432	100	0.21	0.98
Moldova, Rep. of	504	71	479	77	0.34	1.18	507	67	493	70	0.20	1.09
Morocco	361	115	341	115	0.17	1.00	332	106	314			
Netherlands	562	56	547	58	0.26	1.07	551	53	543	53	0.15	1.00
New Zealand	542	90	516	95	0.28	1.11	544	81	520	90	0.28	1.23
Norway	510	77	489	83	0.26	1.16	508	64	489	67	0.29	1.10
Poland							528	74	511	76	0.23	1.05
Qatar							372	90	335	97	0.40	1.16
Romania	519	87	504	92	0.17	1.12	497	91	483	92	0.15	1.02

Country	PIRLS 2001						PIRLS 2006					
	Girls' mean	Girls' SD	Boys' mean	Boys' SD	Effect size G-B	Var. ratio B/G	Girls' mean	Girls' SD	Boys' mean	Boys' SD	Effect size G-B	Var. ratio B/G
Russian Federation	534	65	522	67	0.18	1.06	572	67	557	69	0.22	1.06
Scotland	537	83	519	84	0.22	1.02	538	78	516	80	0.28	1.05
Singapore	540	88	516	94	0.26	1.14	567	73	550	79	0.22	1.17
Slovak Republic	526	68	510	72	0.23	1.12	537	73	525	75	0.16	1.06
Slovenia	512	69	491	73	0.30	1.12	532	67	512	73	0.29	1.19
South Africa							319	136	283	134	0.27	0.97
Spain							515	71	511	71	0.06	1.00
Sweden	572	63	550	67	0.34	1.13	559	62	541	64	0.29	1.07
Trinidad and Tobago							451	98	420	106	0.30	1.17
Turkey	459	84	440	87	0.22	1.07						
United States	551	79	533	86	0.22	1.19	545	71	535	77	0.14	1.18
Mean	510	78	490	80	0.25	1.08	514	74	498	77	0.21	1.08

### 3. Why do girls have higher reading ability?

Marks has recently (2008) studied the problem. He found that higher achievement of girls in reading and mathematics is associated with the school system factors and macro-societal factors. We searched the living conditions and activities of girls and boys to find some explanation to the higher test scores of girls. The data for the comparison were taken from the PISA online database (<http://pisa2006.acer.edu.au/>). The student questionnaire included relatively few questions whose answers might correlate with the results of reading test, however, some interesting information can be found in Table 4. The table includes the numbers of girls and boys who selected the given answer in their questionnaire in all 56 countries. The percentages have been calculated in relation to the overall number of girls and boys who took the test. Significance test was applied to the percentages. All the differences are statistically significant although many of them are minor.

We see in the table that boys have more often their own room than girls. This is fully unexpected and does not explain why girls had a higher score in the reading test. Boys have more often also DVR or VCR players. This may take time from reading and contribute to lower scores. Boys have a little bit more books at home but nevertheless they are not so good in reading.

Girls have a little bit more often their own study desk that may contribute to their higher reading test results. According to the evaluation of girls, there is more classic literature and poetry in their homes. Children influence the home culture and so this literature is bought more often for girls. More girls are from homes without a computer. Working on computers may reduce the boys' time for reading books and magazines.

**Table 4. Some differences in living conditions and activities of girls and boys according to PISA 2006 data**

Question No	PISA 2006 characteristic	Number of		Percentage		t
		Girls	Boys	G	B	
ST4	Number of participants	196989	192504	100	100	0.00
ST13Q02	Possession own room	148453	151625	75	79	-19.26
ST13Q14	Possession DVD or VCR player	169283	168525	86	88	-8.08
ST13Q01	Possession desk	172464	167323	88	87	3.15
ST13Q08	Possessions classic literature	110146	96722	56	50	46.63
ST13Q09	Possession poetry	115712	91930	59	48	90.41
ST14Q03	No computer	44659	38295	23	20	57.01
ST15Q01	Over 100 books at home	70876	70876	36	37	-10.04
ST31Q07	Regular lessons in language	92378	77951	47	40	64.04
ST31Q08	No out of school lesson in language	107653	104224	55	54	4.07
ST31Q09	Less than 2 hours language self study	118110	131012	60	68	-55.27
ST36Q03	Self assessment: Do well in Language	171935	152214	87	79	43.08

In school, girls have more regular lessons in language. This could contribute to their higher test results in reading. However, a little bit more girls have no out of school language lessons. We may suppose that families do not consider it important to pay money for girls to have out of school lessons. Anyway, this does not impair their reading. More girls are confident that they are doing well in language. The self-evaluation supports learning language and is a result of good learning.

There are more boys among students who have fewer than 2 hours for self-study of language. Once more girls devote more time to language studies and boys have other interests.

#### 4. Discussion

The three PISA studies with 15-year old students all show that girls obtain higher average scores than boys in reading ability. In 2000, 2003 and 2006 the girls' advantage was  $0.49d$ ,  $0.36d$ , and  $0.41d$ , respectively. These can be averaged to  $0.42d$ . In the PIRLS studies with 10-year-olds, the sex effect in favour of girls was  $0.25d$  in 2001 and  $0.21d$  in 2006 or  $0.23d$  in average. The girls' superiority grows with age and practising language.

Both of our effect sizes are substantially greater than the  $0.19d$  calculated by Lietz in her meta-analysis (2006). Reading ability as defined in the PISA studies is essentially the same as the concept of verbal comprehension used by psychologists as a component of intelligence, and for which Hyde and Linn (1988) found in their meta-analysis of American studies that the average sex difference was  $0.14d$ .

One explanation of the very big advantages of 15-year-old girls is that PISA test usually indicates a rather large difference in boys' and girls' results. In the above-mentioned meta-analysis by Lietz, the sex effect size for PISA test was

0.25*d* (Lietz, 2006:334). However, the sex effect is even bigger in recent PISA studies and this leads to the idea that girls' superiority in reading is rising.

Last year a new study of sex differences in science attainment was published (Lynn and Mikk 2008). The study confirmed boys' superiority in science that was bigger in the seventies than in recent ten years, when it was negligible. According to PISA studies in 2000, 2003, and 2006, there was no difference in average science attainment of 15-year-old girls and boys but girls outperformed boys by 0.42*d* in reading. According to OECD studies in 2001, 2003, and 2006, girls were as good in science as boys were, but girls outperformed boys in reading by 0.23*d*. Marks (2008) recently found analogous trends for sex gap in mathematics and reading. Hyde et al. (2008:494) have studied standardized test results in the U.S. and conclude "that girls now score just as well as boys in math". In these areas together, girls have an advantage. What might be the reasons?

The correlates of academic achievement have been presented in very many studies, including PISA (Mullis et al. 2003; 2007). Relying on this knowledge, we searched and found some differences in living conditions and activities of girls and boys. Girls were reading more at home and school; boys were busy with computers and DVD players. Interests are related to activities and achievement. The inference is supported by the conclusions of Chiu and McBride-Chang (2006:331) who found analyzing the PISA 2000 data that "reading enjoyment mediated 42% of the gender effect" on reading achievement.

The advantage of girls in reading leads to the preference of professions in which reading and writing are an important part of a job. There are more women in the professions of social sphere because they have higher verbal abilities than men have in general. For example, we have so many female teachers because men are not so well fitted for the job.

The explanation above is only one aspect in the complicated process of selecting a profession. It is insufficient in explaining, for example, why there are more men among politicians than women. Variance ratios in reading achievement add another aspect into the explanation.

We found sex differences in the variance of reading achievement in all three studies analysed. The biggest variance ratio 1.20 was in the PISA 2003 study and it was 1.08 in both PIRLS studies. In the PISA study, boys showed greater variance in reading comprehension than the girls in all countries, and in the PIRLS studies, the boys' variance was larger in most countries. Analogous results in the variability of achievement were found for international science tests (Lynn and Mikk 2008).

This is consistent with the frequent assertion that men have greater variability of intelligence than women, i.e. there are more men with high and low intelligence, while women cluster around the mean. This contention was advanced in the early years of the twentieth century by Ellis (1904), Thorndike (1910) and Terman (1916) to explain why men are so greatly over-represented among geniuses. When they found that there is no sex difference in general intelligence, a greater variability among men entailing more men among those with very high

intelligence (as well as more men with very low intelligence) seemed to provide a solution to this problem. Many subsequent scholars have continued to advance this contention, e.g. Eysenck (1981:42), and Deary et al. (2007). The present results from the PISA and PIRLS studies provide further confirmation.

However, the reasons for greater variability among men are still not understood. We may just hypothesise that women have greater responsibility in bringing up the new generation and the fulfilment of this important task may be in danger in the case of big variability which sometimes is a disadvantage in life.

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