Modern women match men on Raven's Progressive Matrices

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Modern women match men on Raven's Progressive Matrices

James R. Flynn [a,*], Lilia Rossi-Casé [b]

[a] University of Otago, Dunedin, New Zealand
[b] Universidad Nacional de La Plata, La Plata, Argentina

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ABSTRACT

Raven's Progressive Matrices data of high quality from five advanced nations show that females matched males both below and above the age of 14. This counts against hypotheses that genetic factors cause general intelligence differences between the genders. Evidence unfriendly to gender parity at mature ages is based on suspect samples. At ages 15–18, more males than females are school dropouts. At ages 18–24, female deficits among university students may be caused by an IQ/academic achievement gap.

1. Introduction

Lynn and Irwing (2004) conclude that males begin to show a significant advantage on Raven's Progressive Matrices at age 15, which escalates to about five IQ points by maturity. The best data nation-by-nation shed light on the question of greatest interest: whether there is a male advantage that suggests genetic superiority.

2. University samples

2.1. Gender parity hypothesis

In the general population of 17–22 year olds, males and females have the same mean (100) and standard deviation (15). But the university IQ threshold for males is 100 and for females 95. If so, male university students would have a mean IQ of 111.97 (the bottom half of the curve gone) and an SD of 9.04 (60% of the full curve's SD). Females would have a mean of 108.99 (the bottom 37% of the curve gone) and an SD of 9.97. Therefore, the male mean would be 2.98 points higher; and the female SD would be 110% of the male (9.97/9.04).

2.2. Male advantage hypothesis

In the general population, males have a mean IQ of 100, females a mean of 95, and both a SD of 15. But the IQ threshold for males and females is the same at 100. If so, male university students would still have a mean of 111.97 and an SD of 9.04. Females would have a mean of 110.30: the bottom 63% of the curve gone would raise the mean of the remainder by 1.02 SDs; and $1.02 \times 15 = 15.30$, which plus $95 = 110.30$. Females would have an SD of 8.18 (with the bottom 63% gone). Therefore, the male mean would be 1.67 points higher; and the female SD would be just over 90% of the male SD (8.18/9.04).

Table 1 is based on Irwing and Lynn (2005). Our thesis of gender parity applies to the current generation in nations or groups where women enjoy modernity. Therefore, we set aside the data from 1964 to 1986 in favor of that from 1998 to 2004, all data from developing nations, and one set in which the nature of the Raven's test was not specified. The data remaining cover 6230 subjects from four nations. The male SD was used to calculate the gender gap in mean IQ because it is constant between the two hypotheses. As an example, the first row shows a male advantage of 0.4826 male SDs. That is inflated by the fact that the within sample SD is only 0.6 of the population SD, so $0.4826 \times 0.6 = 0.2895$ SDs; and that $\times 15 = 4.34$ IQ points.

The total results confirm the gender parity hypothesis: males have an IQ advantage of 2.73 points (predicted 2.98); the female SD is 106% of the male (predicted 110). We suspect that the latter shortfall is because females do not quite have SD parity in the general population.

In any event, the results are far from those predicted by the male advantage hypothesis, namely, a 1.67-point male advantage and a female SD at only 90% of male. The fact that the within sample female SD is so much larger than the male is devastating. How could the female SD soar above the male SD among university students except due to a lower IQ threshold, one that allowed a larger

* Corresponding author. Tel.: +64 3 479 8668.
E-mail address: jim.flynn@stonebow.otago.ac.nz (J.R. Flynn).

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Table 1
Recent university samples confirm gender parity.

Place	Study		Means		Difference (M–F)			Standard deviations		
	Date	No.	Male	Female	Raw	Male SDs	IQ pts (×0.6 & × 15)	M	F	F/M = %
Standard Progressive Matrices (∗ = short form)										
1. Canada	2000	111	16.57*	14.77*	1.80	0.48	4.34	3.73	3.87	104
2. South Africa (W)	2000	136	54.44	53.33	1.11	0.24	2.19	4.57	3.76	82
3. USA	1998	124	55.26	53.77	1.49	0.49	4.44	3.02	3.60	119
4. USA	1998	218	22.5*	21.6*	0.90	0.24	2.13	3.80	3.69	97
Advanced progressive matrices										
5. Canada	1998	506	23.00	21.68	1.32	0.27	2.45	4.85	5.11	105
6. Spain	2002	604	23.90	22.40	1.50	0.31	2.81	4.80	5.30	110
7. USA	2004	2222	25.78	24.22	1.56	0.33	2.93	4.80	5.30	110
8. Spain	2004	1970	24.19	22.73	1.46	0.27	2.47	5.37	5.47	102
9. Spain	2004	339	24.57	23.32	1.25	0.30	2.72	4.13	4.52	109
Summary comparisons										
Standard progressive matrices – averages							3.27			101
Standard progressive matrices – weighted averages							3.05			100
Advanced progressive matrices – averages							2.68			107
Advanced progressive matrices – weighted averages							2.70			107
All – averages							2.94			104
All – weighted averages							**2.73**			**106**
Predicted: gender parity with lower female threshold							**2.98**			**110**
Predicted: male advantage with common threshold							1.67			90

Sources: 1. Silverman et al. (2000), 2. Rushton and Skuy (2000), 3. Lovaglia, Lucas, Houser, Thye, and Markovsy (1998), 4. Crucian and Berenbaum (1998), 5. Bors and Stokes (1998), 6. Colom and Garcia-Lopez (2002), 7. Lynn and Irwing (2004), 8. Abad, Colom, Rebollo, and Escorial (2004), 9. Colom, Escorial, and Rebollo (2004).

proportion of females into university? The alternative would be to assume that the general population SD for females was huge. If they have a mean IQ of 95 and only the top 37% qualify for university, the university sample SD would be only 0.5453 of the population SD. Yet it is 1.06 times the male SD. The latter is the equivalent of 9 IQ point; so the female within-sample SD is 9.54 points (1.06 × 9); and that divided by 0.5453 = 17.5 points.

3. Students at a magnet school

Duckworth and Seligman (2006) studied 198 students (age 13.4 years) who had qualified (3 years earlier) for admission to a magnet school on the basis of grades and standardized tests. On the Otis-Lennon, girls had a mean IQ of 106.94, which implies a threshold of 91.1 (the bottom 27.7% missing); and boys 111.21, which implies a threshold of 98.8 (the bottom 46.8% missing). So for admission to this school, the female threshold was 7.7 IQ points lower.

Girls had a Grade Point Average (GPA) 0.6 male SDs higher than boys. However, the within sample SD is attenuated and should be corrected: 0.6 × 0.62 = 0.372 population SDs or the equivalent of 5.6 IQ points. In other words, girls could spot boys 4.27 IQ points and outperform them by over 5 points. Using delay of gratification measures and estimates of self-control, Duckworth and Seligman concluded that the girls had more self-discipline.

On a standardized academic achievement test, girls scored only 1.3 points above boys. Because universities emphasize SAT (Scholastic Aptitude Test) scores for admission, we would expect a lower female IQ threshold for university students of over 5 points. (1.3 + 4.27 = 5.57).

4. Students in general

Between 1990 and 2000, female high school graduates in America had a GPA well above boys (Coates & Draves, 2006). The only values given for a GPA SD show that the female mean would be 0.342–0.402 SDs above the male. Gurian (2001) estimates that boys get 70% of the Ds. and Fs and girls get 60% of the As. About 80% of high school dropouts are boys. Coates and Draves find a similar pattern in the United Kingdom, Ireland, Scandinavia, Australia, New Zealand, and Canada.

The Organization for Economic Co-operation and Development (OECD) compared 15-year olds on a test of reading proficiency. In 57 nations, high school girls outperformed boys. Table 2 gives results for Western European nations plus the US and Canada; and for five nations of particularly interest.

The overall female reading advantage is 0.385 SDs. For each nation, we multiply the female SD advantage by 15 to make it analogous to IQ points. We put the correlation between reading proficiency and IQ at 0.50. Multiplying the female reading advantage by 0.50 gives how many IQ points a female would be below a male of the same reading proficiency. Jensen (1980, p. 325) gives 0.58 but warns that the value is lower for lower SES subjects.

The next to last column of Table 2 estimates how far the female IQ threshold for university would be below the male threshold. It should be noted that males do marginally better than females for mathematics (PISA, 2006, Table 6.2c). We assume that reading and good grades bolster confidence to go to university; and that lacking mathematics proficiency discourages few students. Rather they choose a non-science major.

The difference in the IQ threshold of two groups is greater than the resulting mean IQ difference. Therefore, in the final column in Table 2, we multiply the threshold difference by 0.68. This is the value if one-third of males attend university, and would differ nation by nation. Even if male and female IQ were identical in the general population, nations herein would show a female threshold for university 3 points below the male, and a 2-point IQ deficit for female university students. US data were not available from the OECD, but the Nation's Report Card shows that the median for girls' reading proficiency was at the 67th percentile of the boys' curve, which means that US gender gap is typical.

We state what we think a judicious conclusion: until the possibility of different gender IQ thresholds is investigated, university samples are suspect.

5. Argentina

The Universidad Nacional of La Plata standardized Raven's between 1996 and 2000 on 1695 students, 13–30 years of age,

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Table 2
Female university IQ deficit: Predicted by female reading advantage at age 15.

Nation/s	F–M raw score	SD	Female SD advantage	Female Pts. Advantage (SD = 15)	Female IQ deficit threshold	Female IQ deficit mean
OECD	38	98.7	.3850	5.78	2.89	1.97
Austria	45	98.7	.4559	6.84	3.42	2.33
Belgium	40	98.7	.4053	6.08	3.04	2.07
Canada	32	98.7	.3242	4.86	2.43	1.65
Denmark	30	98.7	.3040	4.56	2.28	1.55
Finland	51	98.7	.5167	7.75	3.88	2.64
France	35	98.7	.3546	5.32	2.66	1.81
Germany	42	98.7	.4255	6.38	3.19	2.17
Iceland	48	98.7	.4863	7.29	3.65	2.48
Ireland	34	98.7	.3445	5.17	2.58	1.75
Italy	41	98.7	.4154	6.23	3.12	2.12
Netherlands	24	98.7	.2433	3.65	1.82	1.24
Norway	46	98.7	.4661	6.99	3.50	2.38
Spain	35	98.7	.3546	5.32	2.66	1.81
Sweden	40	98.7	.4053	6.08	3.04	2.07
Switzerland	31	98.7	.3141	4.71	2.36	1.60
United Kingdom	29	98.7	.2938	4.41	2.20	1.50
USA	–	–	.4400	6.60	3.30	2.24
Argentina	54	128.4	.4266	6.31	3.15	2.14
Australia	37	93.5	.3957	5.94	2.97	2.02
Estonia	46	83.1	.5534	8.30	4.15	2.82
Israel	42	126.2	.3329	4.99	2.50	1.70
New Zealand	37	105.4	.3511	5.27	2.63	1.79

Notes:
(1) For an account of the computations, see text.
(2) For the nations from Austria to the United Kingdom, the SD for the OECD as a whole has been used to provide a common metric.
(3) For the nations from Argentina to New Zealand, SDs specific to each nation have been used as these are of special interest.
(3) For the US, the fact that the female median is at the 67th percentile of the male curve, which implies an advantage of .4400 SDs, was used to get an estimate.
Sources:
(1) USA: USDE (2003) (2) All others: PISA (2006), Table 6.1c.

designed to simulate a random sample of the city's in-school population (Rossi-Casé, 2000). See Appendix for details.

Table 3 sets male IQ at 100 and shows that males and females had virtually identical scores at all ages from 13 to 30. The nearest census (1991) shows that the in-school sample approaches randomness. Among those aged 15–24, females comprise 50.56% (573 males and 585 females) and census data show that the true value is 50.81% (Karmona, 2003).

The sample has an anti-female bias because a majority of high school dropouts are boys. Herrnstein and Murray (1994, pp. 145–146) give data that yield 0.60 as the correlation for IQ and staying in high school to get a diploma. Having no value for Argentina, we used 0.50 as a conservative estimate. Because almost all Argentine children are still in school at ages 13–14, we selected the largest SD for those ages (the male SD of 6.26) as an estimate of unattenuated SD.

Adjusting for ages 15–19 is straightforward. Census data provide the numbers in secondary or tertiary institutions or with a secondary or tertiary qualification: 76.26% females and 70.63% males (Karmona, 2003). Table 3 shows how we adjusted for this difference. The same method was used at ages 20–24 where the percentage of male dropouts was 48 and female 44.

As Table 3 shows, the La Plata university age group is atypical in that it shows no female deficit for IQ. There were peculiar local conditions. High unemployment put secondary school graduates under great pressure to continue their education. The percentage of those in tertiary education is extraordinary, about 54%, midway between the secondary levels and the tertiary levels that prevail elsewhere. At ages 25–29, we did not attempt to compensate for those absent from the in-school sample. By then, the reasons for being absent would be legion.

The La Plata unadjusted values show that the largest female deficit at any of the seven age categories is 0.19 IQ points. Adjusted values put female IQ at 100.39 for ages 13–30, 100.59 at 15–24, and 100.79 at 15–19.

Table 3
La Plata: the 1998 standardization of Raven's and gender.

Ages	Male		Female		
	Raw score	IQ	Raw score	IQ	IQ adj
Means by age: census categories					
13–14	46.82	100.00	46.87	100.12	
15–19	49.29	100.00	49.36	100.17	100.79
20–24	51.18	100.00	51.16	99.95	100.39
25–29	51.03	100.00	51.08	100.13	
30	49.80	100.00	49.93	100.31	
13–30	49.86	100.00	49.92	100.14	100.39
15–24	50.26	100.00	50.28	100.06	100.59
15–19	49.29	100.00	49.36	100.17	100.79

Examples of calculations ages 15–19. See Appendix for description and further data.
Female IQ: (1) 49.36 (F) – 49.29 (M) = 0.07; (2) 0.07/6.26 (SD: males 13–14) = 0.0112 SDU; (3) 0.0112 × 15 = 100.17.
Adjusted female IQ: (1) Male percentage in school or graduates = 70.63%; (2) Bottom 29.37% of normal curve missing raises mean by 0.488 SDs; (3) Female percentage in school or graduate = 76.26%; (4) Bottom 23.74% of normal curve missing raises mean by 0.405 SDs; (5) Male advantage 0.488–0.405 = 0.083 SDs; (6) Correlation between not in school and IQ = .50 – see text; (7) 0.083 × .50 = 0.0415 SDs × 15 = 0.62 IQ points as male bias; (8) 100.17 + 0.62 = 100.79 as adjusted female IQ. The adjusted female IQs for ages 20–24 are less reliable; adjustment for ages 13–14, 25–29, and 30 would be inappropriate. See text.

6. New Zealand, Australia, and South Africa

Australian (1986) and New Zealand data (1984) are from standardization samples (de Lemos, 1988; Reid & Gilmore, 1988).

In New Zealand, Table 4 shows that for ages 15–16, girls had a mean IQ of 101.37 (boys = 100). Efforts to locate gender in-school data for 1984 failed. In Australia (circa1986), the percentage of girls in school was 1.04 times that of boys (Lamb, 2003). If New Zealand were similar, a value corrected for bias would be about 101.70. The Australians administered Raven's both timed and

Table 4
Raven's IQs and female/male in-school ratios from three nations; South Africa broken down by ethnic group.

Nation and age	Gender	Raw score[a]	IQ[b]	IQ (adj)[c]	Number	F/M[d] ratio
New Zealand	Male	49.33	100.00		223	–
15–16	Female	49.93	101.37	(101.37)	277	
Australia	Male	45.40 (T)[e]	100.00		548	1.04
14.5–16.5	Female	45.30 (T)	99.78	100.11	718	
	Male	47.80 (UT)[e]	100.00		636	1.04
	Female	47.53 (UT)	99.41	99.74	663	
White SA	Male	45.18	100.00		490	1.10
15	Female	45.34	100.38	100.80	566	
Indian SA	Male	43.01	100.00		530	–
15	Female	40.97	96.38	(96.38)	533	
Coloured SA	Male	37.50	100.00		386	–
15–16	Female	35.86	97.36	(97.36)	381	
Black SA	Male	29.29	100.00		554	–
16–17	Female	25.96	95.29	(95.29)	539	

Note: "SA" appended to a group means the sample is from South Africa.
[a] All nations took Raven's at roughly the same time, so the raw scores demonstrate the superiority of New Zealanders to Australians, something long suspected.
[b] For South Africa, we have converted raw score differences (between male and female) into IQs using the SD of whichever sex had the larger SD at the earliest secondary school age available. This produced tiny differences from Lynn's values.
[c] The method of adjusting IQs for the fact that a school sample of one sex may be more elite than the other is exemplified at the bottom of Table 1. Bracketed values under IQ adjusted were actually left unadjusted – see text.
[d] The ratio of F/M is ideally: the females in school as a percentage of the total number of females in the age cohort; divided by the male percentage. For South Africa, sample ratios have been assumed to be identical to population ratios and the adjusted female IQs should be taken as rough estimates – see text for why certain groups have no adjusted female IQ.
[e] T and UT distinguish the timed and untimed Australian administrations of the SPM. The administration of the SPM elsewhere was untimed.

untimed (all other administrations herein were untimed). At ages 14.5–16.5, timed gave females 99.78 rising to 100.11 (corrected) and untimed 99.41 rising to 99.74.

Lynn (2002) provides Raven's data for Standard seven pupils from South Africa that Owen (1992) tested between 1985 and 1988. Mrs. van Niekek and Mr. Zenzo provided unpublished data from the South Africa census of 1985 to derive in-school gender ratios.

As Table 4 shows, at age 15, the female IQs for white South Africans are 100.38 unadjusted and 100.80 adjusted. Since age 15 begins the ages of supposed female IQ decline, this might seem of little interest. It gains significance from the values for non-white ethnic groups in South Africa. Going from whites to Indian and Coloured to Blacks, Females' IQ declines from almost 101 to 95. Females lose ground going from a group like the population of advanced nations to groups in which their status is subordinate.

7. Estonia

In 2000, Raven's was standardized in 27 Estonian-speaking schools (Lynn, Allik, Pullman, & Laidra, 2002b) on students aged 12–18 (1250 males and 1441 females). The samples for ages 16–18 show radically reduced SDs thanks to the elite character of those tested at those ages. Using a proper value for SD (6.71) shows that males aged 16–18 outscored females by 1.05 IQ points. Initially, the data seemed too flawed to use, for example, they showed girls aged 13 with a lower raw score than those aged 12, something that could not be true of the general population. However, we perceived sources of sample bias that accounted for such anomalies and devised corrections.

First, the standardization included only students in academic secondary schools (grades 10–12), that is, gymnasia and "keskkools" (schools just as academic as gymnasia). This means that the sample omits Estonian youth who drop out of the academic stream after the age of 15, youths we will call the "the non-academic group". A majority of this group are not dropouts in the literal sense: almost 50–60% of them are in vocational high schools. Nonetheless the non-academic group includes many genuine dropouts and more males than females.

Second, they tested grades 6, 8, 10, and 12 rather than all grades. This affected sample quality from age to age. If most 12-year-olds come from grade 6, you lose the slow students who are in grades 5 and below – and get mean IQ *inflation* for that age. If most 13-year-olds also come from grade 6, you lose the quick students who are in grade 7 – and get mean IQ *deflation* for that age. This can affect gender comparisons from age to age because girls go through school faster than boys. In this case, the method of sampling happened to favor girls at age 13 and boys at ages 16 and 18. To estimate the biases, we constructed 14 normal curves: one for each sex at each age from 12 to 18. The Appendix gives detail.

Table 5 corrects sample bias. The second column(s) show the effects of higher male percentages among those who have dropped out of the academic stream. The third column(s) show the effects of testing every other grade, namely, further distortions reflecting what percentiles happened to be sampled from age to age. It reveals why girls appeared to fall behind boys at age 16. By testing grade 8, they captured a few among the very slowest girls (those two years behind their normal grade of 10) or percentiles 15–19. By omitting grade 9, they missed those who were one year behind their normal grade. By testing grade 10, they captured a lot of females in their normal grade or percentiles 45–78. By omitting grade 11, they missed most of the atypical females, that is, who were one year ahead of their normal grade. By comparing the genders for percentiles captured at age 16, we see just how much the sampling disadvantaged females.

The final column of Table 5 shows that when female IQ is adjusted for bias, females match or outscore males at all ages. There is a large female advantage of almost 7 IQ points at age 12. This looks simply eccentric: the male sample underperformed in a way for which sample quality provides no explanation. Age 13 was atypically good for females, putting them at about 103; but age 15 is equally good. At ages 16 to 18, females have a steady advantage that averages at 100.43. This is close to their mean of 100.76 at age 14. See Appendix for detail and a bonus: Raven's performance and speed of progress through school correlate at about 0.70.

Table 5
Correction of the Estonian gender comparisons.

Age	Percentiles of age cohort in academic cohort		Percentiles of age cohort in sample (with sample percentages)[a]		Male bias in IQ points	F IQ	F IQ (adjusted)
	F	M	F	M			
12	2–100	2–100	43–90 (100%)	37–93 (100%)	−0.48	107.40	106.92
13	2–100	2–100	7–42 (90%)	10–40 (97%)	Nil	104.38	103.11
			89–100 (10%)	92–100 (3%)	−1.27		
14	3–100	4–100	4–7 (3%)	7–14 (7%)	+0.27	100.18	100.76
			41–85 (97%)	45–89 (92%)	+0.31		
15	6–100	9–100	12–40 (71%)	23–50 (83%)	+0.38	102.79	103.06
			82–100 (29%)	90–100 (14%)	−0.11		
16	13–100	21–100	15–19 (2%)	27–36 (8%)	+0.48	98.14	100.40
			45–78 (98%)	64–87 (91%)	+1.78		
17	22–100	39–100	29–46 (38%)	53–65 (47%)	+0.92	99.15	100.12
			78–100 (61%)	86–100 (49%)	+0.05		
18	36–100	56–100	55–80 (99%)	72–87 (98%)	+1.22	99.55	100.77

[a] The sample percentages do not quite add up to 100% because only the principal percentiles selected by the samples are given. For example, the male sample for age 16 was: 8.22% from grade 8 (percentiles 27–36); 91.32% from grade 10 (percentiles 64–87); and 0.46% from grade 12. See Appendix for calculation of male bias.

8. Israel

Flynn (1998) reports results from Israel for 17-year olds who took a shortened version of Raven's from 1976 to 1984. Men outscored women by the equivalent of 1.4 IQ points. The data are clearly from a past generation, but the circumstances that generated them may persist. The female deficit is due to the fact that about 20% of the women were primarily from orthodox homes of Eastern European origin. They were sheltered from modernity, that is, either married at age 17 and a half, or were wards of their fathers until passed onto their husbands.

9. Men and women and genes

Five advanced nations show gender parity on Raven's beyond age 14. Lynn (1994), Lynn (1999) and Lynn and Irwing (2004) has been consistent in naming 15 as the age at which males forge ahead, but this does not debar a hypothesis that the age of onset is 16 or 17. This would render inconclusive all data except those from Argentina and Estonia. But even two nations put a heavy burden on any hypothesis that women have inferior genes for general intelligence. It is possible that these two nations foster a cognitive environment that favors women, but the supporting evidence would have to go far beyond Raven's scores. Moreover, age 17 edges into the university age range, and university data cannot be taken seriously unless we evidence gender equality for IQ thresholds. Nothing herein denies that women born prior to the current generation performed worse on Raven's; or that women in developing nations still do so. The full effect of modernity on women may have been crucial.

10. Uncited references

INDEC (2002), Lynn and Kazlauskaite (2002), Lynn et al. (2002a), and Statistikaamet (2001, 2003).

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.paid.2010.12.035.

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