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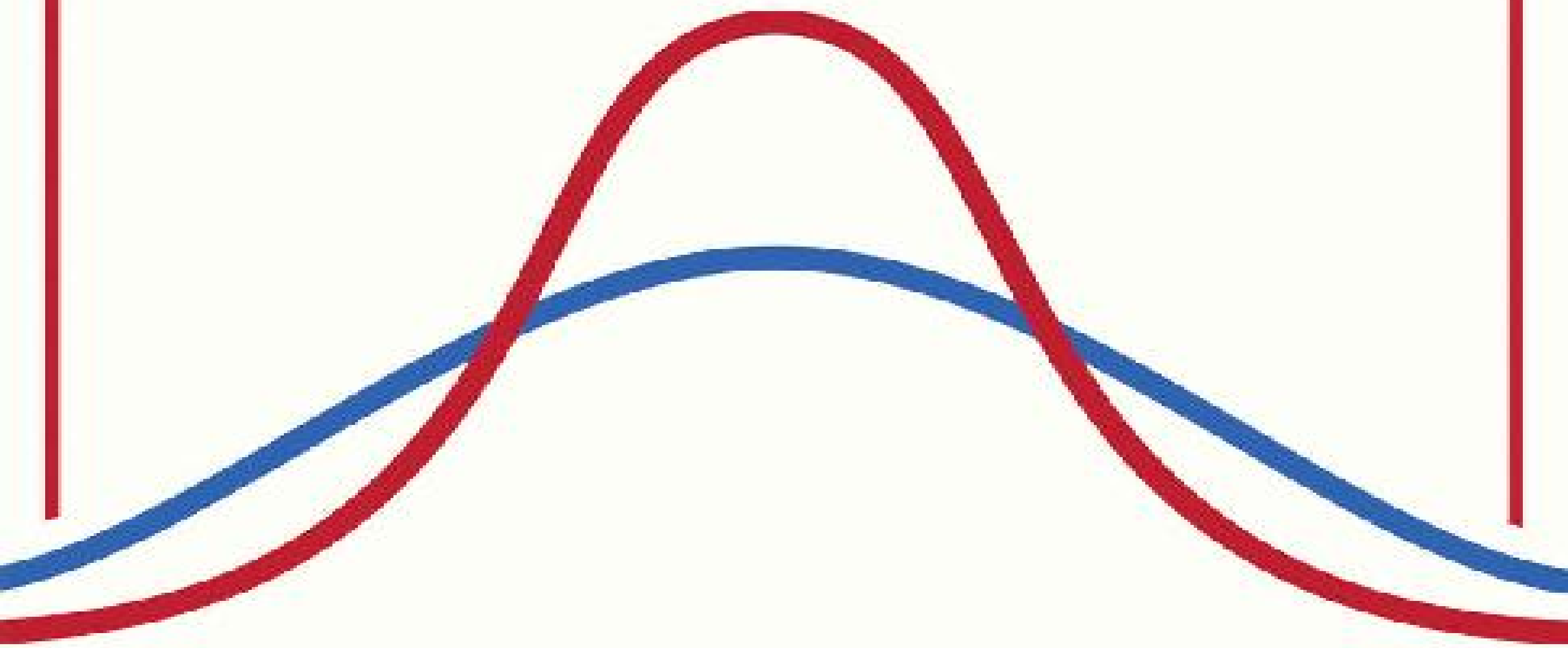

SEX DIFFERENCES IN INTELLIGENCE

The Developmental Theory

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Chapter 1

Introduction

A number of books and many thousands of papers have been published during the last century and a half on sex differences in intelligence as defined by Johnson, Carothers and Deary (2009) “to mean the ability to use combinations of pre-existing knowledge and abstract reasoning to solve any of a variety of problems designed to assess the extent to which individuals can benefit from instruction or the amount of instruction that will be necessary to attain a given level of competence” and measured as the IQ derived as the average of cognitive abilities obtained in tests like the Wechsler, the Stanford-Binet, the Cattell Culture Fair and numerous others. From the early twentieth century, virtually all authorities have contended that males and females have the same average intelligence. This book disputes this position and presents the developmental theory which states that in infants aged up to 4 years, girls have a higher average intelligence than boys, from the age of 6 to 15 there is little or no sex differences in intelligence, while from the age of 16 males begin to have higher average intelligence than females reaching an advantage of 4 to 5 IQ points in adults aged 21 and older.

The Nineteenth Century

In the nineteenth century, several authorities contended that men have a larger average brain size than women, that brain size is a determinant of intelligence and consequently that men have a higher average intelligence than women. This contention was advanced by Paul Broca (1861), the French physician and professor of medicine at the University of Paris, who is best known for his discovery that language is normally located toward the front of the brain's left hemisphere, a region that is known as Broca's area. A decade later, the same contention was asserted by Charles Darwin, who wrote in *The Descent of Man*: "The chief distinction in the intellectual powers of the two sexes is shown by man attaining to a higher eminence, in whatever he takes up, than woman can attain — whether requiring deep thought, or imagination, or merely the use of the senses and hands" (Darwin, 1871). In the next decade, George Romanes, professor of medicine at the University of Oxford, took the same view: "Seeing that the average brain weight of women is about five ounces less than that of men, on merely anatomical grounds we should expect a marked inferiority of intellectual power in the former… In actual fact, we find the inferiority displays itself most conspicuously in a comparative absence of originality, and this more especially in the higher levels of intellectual work" (Romanes, 1887).

The Twentieth Century

With the invention of the intelligence test in the early twentieth century in France by Binet & Simon (1905a, 1905b), studies began to be published on sex differences in intelligence in which most authorities asserted that there is no difference between males and females. One of the first to advance this conclusion was Thorndike (1910, p. 35), who wrote of “the trivial difference between the central tendency of men and women which is the common finding of psychological tests”. This contention was also advanced in early studies in the United States by Terman (1916), who wrote that in the American standardisation sample of the Stanford-Binet test on 4–16 year-olds “the superiority of girls over boys is so slight … that for practical purposes it would seem negligible”, and in England by Burt & Moore (1912).

In 1932, this contention was confirmed in the survey of the intelligence of all 11-year-olds in Scotland, in which boys (N=44,210) obtained a score of 34.506 and girls (N=43,288) obtained an almost identical score of 34.411 (Scottish Council, 1933). This study also found that the range of IQs was significantly greater in boys than in girls, given as IQ standard deviations of 14.9 for boys and 14.1 for girls by Deary (2020, p. 41). The effect of this is that 58.6 per cent with IQs below 60 were boys and 57.7 per cent with IQs above 130 were boys. Many later studies have confirmed that males have greater variance of intelligence than that of females, e.g., Lohman & Lakin (2009).

Many subsequent studies repeated the contention that males and females have equal intelligence. Thus Roberts (1945, p. 727): “It is a striking fact that in mean performance on intelligence-test scales there should be no difference between boys and girls”; Cattell (1971, p. 131): “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”; Hutt (1972, p. 88): “There is little evidence that men and women differ in average intelligence”; Maccoby & Jacklin (1974, p. 65): “It is still a reliable generalisation that the sexes do not differ consistently in tests of total (or composite) abilities”;

Brody (1992, p. 323): "Gender differences in general intelligence are small and virtually non-existent"; Eysenck (1981, p. 40): "Men and women average pretty much the same IQ"; Herrnstein & Murray (1994, p. 275): "The consistent story has been that men and women have nearly identical IQs"; Jensen & Johnson (1994, p. 330): "It remains a major unresolved puzzle in differential psychology and neuroscience that the large sex difference in head and brain size is not reflected by the mean IQ difference between males and females, which is virtually nil"; Mackintosh (1996): "There is no sex difference in general intelligence worth speaking of"; Geary (1998, p. 310): "The overall pattern suggests there are no sex differences, or only a small and unimportant advantage of boys and men, in average IQ scores".

The assertions that males and females have the same average IQ continued to be made in the twenty-first century. Thus: Lubinski (2000): "Most investigators concur on the conclusion that the sexes manifest comparable means on general intelligence"; Colom et al. (2000): "We can conclude that there is no sex difference in general intelligence"; Loehlin (2000, p. 177): "There are no consistent and dependable male-female differences in general intelligence"; Lippa (2002): "There are no meaningful sex differences in general intelligence"; Jorm et al. (2004): "There are negligible differences in general intelligence"; Bartholomew (2004, p. 91): "Men on average have larger brains than women but display no significant advantage in cognitive performance"; Anderson (2004, p. 829): "The evidence that there is no sex difference in general ability is overwhelming"; Haier, Jung, Head & Alkire (2004, p. 1): "Comparisons of general intelligence assessed with standard measures like the WAIS show essentially no differences between men and women"; Camarata & Woodcock (2006, p. 231): "There appears to be general consensus for the view that males and females are not different in terms of general intellectual ability"; Spelke & Grace (2007, p. 65): "Men and women have equal cognitive capacity"; Hines (2007, p. 103): "There appears to be no sex difference in general intelligence; claims that men are more intelligent than women are not supported by existing data"; Haier (2007): "General intelligence does not differ between men and women"; Halpern (2007, p. 123):"There is no difference in intelligence between males and females… overall, the sexes are equally smart"; Pinker (2008, p. 13): "The two sexes are well matched in most areas, including intelligence"; Mackintosh (2011, p. 380): "The two sexes do not differ consistently in average IQ"; Halpern (2012, p. 233): "Females and males score identically on IQ tests"; Lakin (2013, p. 263): "Research indicates that men and women have equal or nearly equal ability in general intelligence"; Dunst, Benedek, Koschutnig, Jauk & Neubauer (2014): "There are no sex differences in general intelligence"; Sternberg (2014, p. 178): "There is no evidence, overall, of sex differences in levels of intelligence"; Ritchie (2015, p. 105): "Women tend to do better than men on verbal measures, and men tend to outperform women on tests of spatial ability; these small differences balance out so that the average general score is the same"; Saini (2017, p. 85): "When it comes to intelligence, it has been convincingly established that there are no differences between the average woman and man"; Halpern & Kanaya (2017): "There are no overall differences in female and male intelligence"; Toivainen, Papageorgiou, Tosto & Kovas (2017, p. 81): "Sex differences in general cognitive ability are overall small, if not negligible"; Ackerman (2018, p. 8):"There are negligible gender differences in omnibus IQ assessments"; Warne (2020, p. 245): "Males and females are equal in average intelligence"; Halpern & Wai (2020, p. 335): "Data showing differences between men and women in intelligence do not support the notion of a smarter sex"; Deary, Cox & Hill (2021): "There are very small or no sex differences in mean intelligence".

Despite the contention of all these numerous experts that there is no sex difference in intelligence, there remains the problem noted by Paul Broca, Charles Darwin and George Romanes that males have a larger average brain size than females, that there is a positive association between brain size and intelligence, and that it appears to follow from this that the larger average brain size of men should give them a higher average IQ than that of women.

Subsequent work has confirmed these associations. The positive association between brain size and cognitive ability was first shown quantitatively by Galton (1888) in a study of students at Cambridge University that reported a correlation of .11 between head size and examination results. Although this correlation is positive, it is quite low because examination results are only a moderately good measure of intelligence and the restriction of range of the sample. Subsequent studies have reported higher correlations. A review of studies of head circumference and IQ giving a correlation of .30 was reported by Van Valen (1974). Brain size is measured more accurately by MRI (Magnetic Resonance Imaging) and the first study of the association of this with intelligence was carried out by Willerman, Shultz, Rutledge & Bigler (1991) and reported the correlation as .35. This association has been confirmed in subsequent studies, e.g. at $r = .43$ (Raz, Torres, Spencer et al., 1993), at $r = .40$ for college students in Turkey (Tan, Tan et al., 1999), at $r = .43$ (Gignac, Vernon & Wickett, 2003) and at $r = .33$ in a meta-analysis of 37 studies (McDaniel, 2005). In a more recent meta-analysis, a lower correlation of $r = .24$ was reported by Pietschnig, Penke, Wicherts, Zeiler & Vorocek (2015) but Gignac & Bates (2017) showed that this result needs to be corrected for restriction of range and data quality to $r = .31$. These results have been further confirmed in a study by Van der Linden, Dunkel & Madison (2017) that reported partial correlations (controlling for body height) of brain size with the g factor of .245 for men and .265 for women. It has also been shown that cortical thickness is positively correlated with intelligence (Karama, Ad-Dab'bagh, Haier & Deary, 2009; Karama, Colom, Johnson & Deary, 2011).

The larger average brain size of males than of females is also well-established. It is present in the fetus (Wheelock, Hect, Hassan et al., 2019) and at birth, when the average male brain is approximately 12 percent heavier than that of females (Swaab & Hoffman, 1984). The larger average brain size of adult males was shown when controlled for body size by Ankney (1992) and Rushton (1992). It was confirmed in a meta-analysis of 77 studies of sex differences in human brain structure by Ruigrok, Salimi-Khorshidib, Laia, Baron-Cohen et al. (2014), who concluded that men have a 12 percent greater average brain volume than women. These results have been further confirmed in a study by Ritchie, Cox, Shen et al. (2018) that compared 2,750 females (mean age = 61.12 years, SD = 7.42, range = 44.64–77.12) and 2,466 males (mean age = 62.39 years, SD = 7.56, range = 44.23–76.99) and reported that average male brains were larger with a 1.4*d* effect size, meaning that 92% of men have a brain size above the mean for women.

Thus, the problem remains that brain size is positively associated with intelligence, and that males have a larger average brain size than females. It appears to follow that males should have a higher average IQ than females, yet numerous experts have asserted that males and females have the same average intelligence. There has been some acknowledgement of this problem. Butterworth (1999, p. 293) noted the problem, writing that "[w]omen's brains are 10% smaller than men's, but their IQ is on average the same" but he did not offer a solution. Halpern (2012, p. 233) also noted that women have a smaller average brain size than men but asserted that "[t]here is no evidence that larger brains are, in any way, better than smaller brains". This is a remarkable contention in view of the results of the numerous studies noted above, including the meta-analysis of 37 studies by McDaniel (2005) concluding that brain size is positively correlated with intelligence at .33.

An attempt to resolve the problem was made by Jensen (1998), who suggested that females have the same number of neurons in the brain as males but these are smaller and more closely packed. This is an improbable hypothesis and has been shown to be incorrect by Pakkenberg & Gundersen (1997), who reported that men have an average of four billion more neurons in the brain than have women, a difference of 16 percent. Further data showing that men have more neurons than have women have been given by Pelvig et al. (2008) and by Escorial, Roman, Martinez et al. (2015). Deary, Cox & Hill (2021) have also noted the problem, writing that "[t]he fact that there are substantial sex differences in brain size but very small or no sex differences in mean intelligence is likely to be because multiple aspects of the brain's structure, function, and connectivity are compensatory for any apparent brain size difference". They do not elaborate this suggestion.

Chapter 2

The Developmental Theory

In the 1990s, I published a series of papers advancing the *Developmental Theory* as a solution to the problem that intelligence is positively associated with brain size and that males have a larger average brain size than females, yet numerous experts have asserted that males and females have the same average intelligence (Lynn, 1994, 1996, 1998, 1999). This stated that boys and girls do have about the same IQ up to the age of 15 years but that from the age of 16 years the average IQ of males becomes higher than that of females with an advantage increasing to approximately 4 IQ points in adulthood. The reason for this is that the brain size of males increases relative to that of females from the age of 16 shown by Lenroot, Gogtay, Greenstein, Wells et al. (2007) and Lenroot & Giedd (2010) and confirmed by neurological studies that have shown that white matter in the brain continues to grow more in males than in females from mid-adolescence (Simmonds, Hallquist, Asato & Luna, 2014; Wang, Adamson, Yuan, Altaye, Rajagopal, Byars & Holland, 2012). This thesis has been further supported by studies showing that males have later physical maturation (Hills & Byrne, 2010), behavioural maturation (Greenstein, Blachstein & Vakil, 2010; Keulers, Evers, Stiers & Jollies, 2010; Yurgelun-Todd, 2007), brain maturation (De Bellis, Keshavan, Beers et al., 2001) and brain development shown by neuroimaging by Bramen, Hranilovich, Dahl et al. (2010) and by Tiemeier, Lenroot, Greenstein et al. (2010).

The effect of the increasing brain size of males compared with that of females from the age of 16 years is that male intelligence increases relative to that of females. A number of studies showing this are given in Table 2.1.

Table 2.1. Sex differences in intelligence at ages 12 through 21 (*d*s; positive signs denote males score higher). AR: abstract reasoning.

Age	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**Reference**
Female per cent brain size	92.2	92.5	92.6	91.5	91.2	89.2	-	-	-	86.6	Roche & Malina, 1983; Rushton, 1992

Sex diffs brain size cc	110	120	127	133	140	150	160	170	-		Giedd et al., 2012
USA: AR	-	-	0	.04	.09	.10	.16	-	-	-	Feingold, 1988
UK: AR	-	-	.06	.08	.08	.19	.25	-	-	-	Lynn, 1992
Spain: AR	.05	-.20.	.14	.31	.32	.38	.36	-	-	-	Colom & Lynn, 2004
USA: whites: g	-	-	-	-.03	.26	.29	.17	.23	.32	.41	Meisenberg, 2009
USA: blacks: g	-	-	-	-.11	.07	.05	.07	.00	.10	.10	Meisenberg, 2009
UK: g	-.06	-	-	-	.12	-	-	-	-	-	Lynn & Kanazawa, 2011
USA:DAT	-.80	-	-	.60	-	-3	-	-	-	-	Keith et al., 2011
USA: CogAT	-.03	-.01	-	-.01	-	.03	-	-	-	-	Lakin, 2013
USA: whites: g	.08	.10.	.02	.16	.23	.26	-	-	-	-	Nyborg, 2015
USA: blacks: g	-.13	-.18	-.04	-.19	-.34	.43	-	-	-	-	Nyborg, 2015
USA: hispanics: g	.02	.11	-.08	.24	-.23	.30	-	-	-	-	Nyborg, 2015
Spain: IQ	.07	.01	.08	.19	.27	.25	.32	-	-	-	Arribas-Agula et al., 2019
Spain: Verbal ability	-.03	-.07	-.06	.05	.15	.09	.15	-	-	-	Arribas-Agula et al., 2019

Row 1 gives the cranial capacity of females as a percentage of that of males calculated from the head width, length and height data given by Roche & Malina (1983, p. 483) and Rushton (1992), using the Lee & Pearson (1901) formula for converting these dimensions to cranial capacity. Note that the cranial capacity of females as a percentage of that of males declines from the ages of 15 to 17 (data from Roche & Malina, 1983) and declines further at age 21+ (data from Rushton, 1992).

Row 2 gives the differences in brain size in cubic centimetres between males and females obtained by magnetic imaging, showing that the differences increase over the ages 12 through 19. Rows 3, 4 and 5 give data for Abstract Reasoning from the Differential Aptitude Test for the United States, the United Kingdom and Spain all showing a male advantage from ages 14 through 18. Row 6 gives results for 15- to 21-year-old whites for the ASVAB (Armed Services Vocational Aptitude Battery) scored for *g*, showing a female advantage at age 15 followed by increasing male advantages from age 16 reaching .41*d* (6.15 IQ points at age 21 [average of 21–23]). Row 7 gives results from the same data for blacks, also showing a female advantage at age 15 followed by male advantages from age 16 but these are very small and not statistically significant. Row 8 gives the differences in *g* for a UK longitudinal sample, showing girls at age 12 had a significantly higher score than boys but at age 16 the same boys had a significantly higher score than girls. Row 9 gives results for the American DAT averaged from Gv (visual-spatial) (verbal), Glr (free recall memory), Gsm (short-term memory) and Gs (processing speed), showing girls scored higher at age 12 (also at ages 5–7 and 8–10) while boys scored higher at ages 14–15 and 16–17. Row 10 gives results for the American CogAT averaged from verbal, quantitative and non-verbal reasoning ability, showing girls scored higher at age 12, 13 and 15 while boys scored higher at age 17. Rows 11 through 13 give results for the NLSY 97 (National Longitudinal Study of Youth) scored for *g* for whites, blacks and Hispanics, showing generally small sex differences from ages 12 through 15 but significant male advantages at age 17. Row 14 gives results for *g* (general intelligence) for Spain, showing no significant sex differences at ages 12 through 14, and increasingly higher scores by boys from ages 15 through 18. Row 15 gives results for verbal ability for Spain, showing girls scored higher at age 12. In a Spanish sample there was a female advantage in 12- through 14-year-olds and male advantages from the age of 15 through 18 years of .05*d* increasing to .15*d*.

In addition to these studies, Gur, Richard, Calkins et al. (2012) give data for sex differences in performance on a computerized neuro-cognitive battery for a sample of 3,448 aged 8 to 21. On verbal and non-verbal reasoning, there were no significant sex differences for 8–13 year-olds, while from age 14–15 males obtained increasingly higher scores than those of females. This study gives sex differences on a number of other tests. The authors write: “There were few age group sex interactions. These interactions were noted only for spatial memory accuracy and speed, non-verbal reasoning accuracy and speed and all social cognition tests on speed. Motor speed also showed a significant interaction. All these interactions indicated that sex differences became more pronounced in the age groups following mid-adolescence. Across all domains, except for memory, females reached plateau before males. The exception in our study is for memory, where males peaked by age 18–19 whereas females continued to improve in word and face memory into the 20–21 age group. Age group sex interactions for complex and social cognition were seen in speed, where females continued to improve while males reached a plateau in mid-adolescence and then showed decline. While we are unaware of earlier studies where both social cognition and a broad range of other neuro-behavioral domains have been examined across this age range for both accuracy and speed, our findings generally comport with studies examining developmental sex differences in comparable domains (e.g., Reynolds, Keith, Ridley & Patel, 2008)".

Rojahn & Naglieri (2006) published data that they claimed did not support the developmental theory. This study presented means for boys and girls aged 5–17 years on the Naglieri Non-Verbal Ability Test. They showed in their Table 1 that in the 15–17 year-old age group girls obtained a slightly higher score than boys (.03*d*). They showed in their Figure 3 that this is because at age 15 girls scored substantially higher than boys, but at ages 16 and 17 boys scored higher than girls. They do not give the data for these three ages and a request for these has been declined. Nevertheless, the results given in their graph in their Figure 3 support the developmental theory that at ages 16 and 17 boys obtain higher average IQs than girls contrary to their claim.

To calculate the magnitude of the higher adult male IQ that would be predicted from the larger male brain size I took Ankney's figure of the male-female difference in brain size expressed in standard deviation units of 0.78*d* and Willerman et al.'s (1991) estimate of the correlation between brain size and intelligence of 0.35. These figures would give adult males a higher average IQ of 4.0 IQ points (0.78 multiplied by 0.35 = .27*d* = 4.0 IQ). In my 1994 paper I presented data showing adult male advantages of 1.7 IQ points on verbal ability, 2.1 IQ points on verbal and non-verbal reasoning ability, and 7.5 IQ points on spatial ability, giving an average male advantage among adults of 3.8 IQ points and thus very close to the predicted advantage of 4.0 IQ points. I published further data for this male advantage in Lynn (1998, 1999).

The male advantage given by Meisenberg (2009) in Table 2.1 for 20–21 year-olds averaged to .365*d* (5.475 IQ) for whites is greater than this figure but the male advantage of .10*d* for blacks is smaller. Further studies showing that a male IQ advantage begins to appear from the age of 16 years have been reported by Nyborg (2003, p. 212; 2005) giving a male advantage of 5.5 IQ points in a Danish adult sample and by Jackson & Rushton (2006) who reported a male advantage of 3.6 IQ points in a sample of 100,000 17–18 year-olds on the American Scholastic Assessment Test.

These male advantages for whites are also greater than the 2.8 IQ points advantage given by Pietschnig, Penke, Wicherts, Zeiler & Vorocek (2015) in their meta-analysis of the positive association between brain size and intelligence. These authors acknowledge that their meta-analysis of the positive association between brain size and intelligence and the larger average brain size of men may imply that males should have a higher average IQ but state that "careful analyses of datasets not limited by range restriction clearly indicate the absence of sex differences in IQ (Dykiert et al., 2009; Flynn, 2012; Johnson et al., 2009)". This is not the correct conclusion. None of these three citations support the authors' assertion that there is no sex difference in IQ. The paper by Dykiert et al. (2009) showed that in 10-year-olds tested in the 1970 British Cohort study, boys had a significantly higher IQ of .081*d*. In a subsequent follow-up at age 26, the attrition rate was 43% and was greater for males and the male advantage had increased to .124*d*. The authors conclude that "a proportion of the apparent male advantage in general cognitive ability reported by some researchers might be attributable to the combination of greater male variance and sample restriction..." (p. 42). All this paper showed was that in longitudinal studies the follow-up samples are no longer representative because of attrition and cannot be relied on to give accurate data on sex differences. In no way does it support the assertion that the male advantage of 1.86 IQ points at age 26 "clearly indicates the absence of sex differences in IQ". The authors' citation of Flynn (2012) refers to a study of young adults in Argentina in which there was no sex difference on the Progressive Matrices, but the authors chose to ignore the meta-analysis of sex differences on the Progressive Matrices in general population samples that gave the results of ten studies of adults in all of which males obtained higher scores with an average advantage of 0.33*d* equivalent to 5 IQ points (Lynn & Irwing, 2004) and the subsequent later studies confirming this male advantage summarised in Chapter 4. The authors' third citation (Johnson et al., 2009) gives the results of two studies of 10–12 year-olds in which there was no sex difference in IQ. They do not acknowledge my theory that the male advantage only appears from the age of 16 years or the large number of studies supporting this theory. They conclude that males and females have the same IQ and "thus large brains and neuron numbers do not need to translate into higher intelligence among humans" but they do not offer any explanation for this exception to the numerous studies showing a positive association between brain size and intelligence.

Chapter 3

Infants

Girls have higher average cognitive abilities than boys in infancy up to the age of 4 or 5 years but this advantage is not present from the age of 6. The girls' advantage is shown in vocabulary reviewed in Section 1 and in intelligence reviewed in Sections 2, 3 and 4. This review does not include studies with a sample size below 100 on the grounds that this is too low to give reliable differences.

1. Vocabulary

Vocabulary size is a very good measure of intelligence. This was shown in an early study by Terman (1921, p. 308), who reported a correlation of .91 between vocabulary size and intelligence assessed by the Stanford-Binet. A number of studies have reported that in infancy girls have a larger vocabulary than that of boys. In an early statement, Doran (1907, p. 425) wrote: “It is generally conceded that girls develop more rapidly in infancy. Boys speak but little under 24 months. This will account for the superior vocabularies of girls during the first few years”. He reported that in a sample aged 24 months, girls had a vocabulary of 573 words and boys had a vocabulary of 367 words. In a later review, Garai & Scheinfeld (1968, p. 252) wrote: “Girls begin to speak earlier than boys, with the difference varying from 1 month with gifted to 6 months in retarded children. The earlier speech development and greater verbal fluency of girls appear to be related to the earlier maturation of their speech organs, their innate tendency to more sedentary pursuits, their closer contact with their mothers, and their greater interest in people”.

A number of reports have confirmed that between the ages of 12–36 months girls have a greater vocabulary than that of boys. In the United States, Huttenlocher, Haight, Bryk, Seltzer & Lyons (1991) reported that girls had a 13-word-vocabulary advantage compared with boys at 16 months, a 51-word-advantage at 20 months and a 115-word-advantage at 24 months. Rescorla (1989) reported that in a study of 600 girls and boys, girls at 24 months had a vocabulary of 169 and boys of 132. Further American studies showing that between the ages of 12–36 months girls have a greater vocabulary than that of boys have been reported by Gazzaniga, Ivry & Mangun, 1998; Horgan, 1975; Moore, 1967; Nelson & Bonvillian, 1973; and Shucard, Shucard &Thomas, 1987. Girls also show better language skills than boys in infants between 8 and 36 months of age (Simonsen et al., 2014) and in preschool (Blair, Granger, & Razzam, 2005).

Greater vocabulary in infant girls has been reported in England in a study carried out on a larger and representative sample of 1,015 parents who were asked when their children began to talk (Sugden, 2010). The parents reported that more girls than boys said their first word before they reached the age of 9 months (34 per cent against 27 per cent) and that 20 per cent of girls joined words together by the age of 1 year, compared with 16 per cent of boys. The larger average vocabulary of girls than of boys in infancy has been reported in Finland where Rantakallio, von Wendt & Makinen (1985) reported that in a sample of 12,058 children at the age of 1 year, 59.7 percent of girls and 51.7 percent of boys had a vocabulary of 3 or more words. Eriksson et al. (2012) reported that girls had a larger average vocabulary than boys in infants aged up to 3 years in 10 countries. Studies of sex difference in vocabulary in 1- to 7-year-olds expressed as *d*s are given in Table 3.1. The medians of the results given in the bottom row show that girls have a higher average vocabulary than boys among 1- to 4-year-olds but not at ages 5 through 7.

Table 3.1. Sex difference in vocabulary in 1- to 7-year-olds (*d*s: positive signs denote higher scores by boys)

Country	**N**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Reference**
USA	278	-.31	-.30	-	-	-	-	-	Rescorla & Achenbach, 2002
USA	422	-	-.47	-	-	-	-	-	Rescorla & Alley, 2001
England	168	-	-.64	-	-	-	-	-	Lutchmaya et al., 2002
USA	299	-	-.57	-	-	-	-	-	Klee et al., 1998
USA	127	-	-	-	-.44	-	-	-	Mehrabian, 1970
USA	1198	-	-	-	-.07	-	-	-	Shipman, 1971
USA	108	-	-	-	.14	-	-	-	Stoner & Spencer, 1983
USA	503	-	-	-	-0.35	-	-	-	Desai et al, 1989
USA	288	-	-	-	.05	.20	-.08	-	Levine et al., 1999
N. Zealand	145	-	-	-	-	.08	-	-	Prochnow et al., 2001
UK	13420	-	-	-.24	-	-.05	-	-	Lynn & Cheng, 2021
USA	320	-	-	-	-	-	.12	-	Lesser et al., 1965
USA	2352	-	-	-	-	-	.20	.24	US DHEW, 1971

Canada	109	-	-	-	-	-	.03	-	Miller & Vernon, 1996
China	1331	-	-	-	-	-	-.12	-	Liu & Lynn, 2011
England	150	-	-	-	-	-	.12	-	Yule et al, 1969
Japan	599	-	-	-	-	-	-.06	-	Hattori, 2000
Taiwan	900	-	-	-	-	-	-.05	-	Chen & Lynn, 2021a
Taiwan	924	-	-	-	-	-	.31	-	Chen & Lynn, 2021b
USA	1199	-	-	-	-	-	.05	-	Kaiser & Reynolds, 1985
Median	-	-.31	-.52	-.24	-0.07	.08	.04	.19	

2. Intelligence: Wechsler IQs

Studies of sex difference in intelligence in the Wechsler tests in 1- to 7-year-olds expressed as *d*s are given in Table 3.2. The median IQs given in the bottom row show that girls obtain a higher average IQ than boys at the age of 3 at .37*d* but not at the ages of 5 and 7 where there is virtually no sex difference.

Table 3.2. Sex difference in intelligence in the Wechsler tests in 1- to 7-year-olds (*d*s: positive signs denote higher scores by boys)

Country	**Test**	**N**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Reference**
Canada	WPPSI	169	-	-	-	-	-.03	-	-	Miller & Vernon, 1996
China	WPPSI	1331	-	-	-	-	.14	-	-	Liu & Lynn, 2011
England	WPPSI	144	-	-	-	-	.14	-	-	Yule et al, 1969
Japan	WPPSI	599	-	-	-	-	.06	-	-	Hattori, 2000
Taiwan	WPPSI-R	900	-	-	-	-	-.05	-	-	Chen & Lynn, 2021a
Taiwan	WPPSI-IV	924	-	-	-	-	.05	-	-	Chen & Lynn, 2021b
USA	WPPSI	199	-	-	-	-	-.06	-	-	Kaiser & Reynolds, 1985
USA	WPPSI-R	1700	-	-	-	-	-.03	-	-	Sellers et al., 2002
USA	WPPSI-IV	1700	-	-	-.37	-	-.17	-	-	Palejwala & Fine, 2015
USA: whites	WISC IQ	1123	-	-	-	-	-	-	.01	Jensen & Johnson, 1974
USA: blacks	WISC IQ	813	-	-	-	-	-	-	-.04	Jensen & Johnson, 1974
Median	-	-	-	-	-.37	-	.05	-	-.02	-

3. Intelligence: Other Tests

Studies of sex differences in other tests of intelligence in 1- to 7-year-olds expressed as *d*s are given in Table 3.3. The medians of the results given in the bottom row show that girls obtain higher IQs than boys at the ages of 1 to 5 but not at age 6 where boys have a higher IQs than girls at .12*d* or at age 7 where there is virtually no sex difference at -.03*d*. Note that the only study showing boys obtain a higher IQ than girls is in 4-year-olds for spatial ability.

Table 3.3. Sex difference in intelligence in 1- to 7-year-olds (*d*s: positive signs denote higher scores by boys)

Country	**Test**	**N**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Reference**
England	IQ	1483	-	-	-	-	-.16	-.16	-.12	Wisenthal. 1964
Germany, Netherlands	Son-R-2-8	1727	-	-.40	-.12	-.26	-.13	.11	.03	Buczylowska et al., 2019
Malta	Verbal IQ	132	-	-	-	-	-	-.51	-	Martinelli & Lynn, 2005
Mauritius	Verbal IQ	1387	-	-	-.10	-	-	-	-	Raine et al., 2002
Mauritius	Boehm	722	-	-	-.11	-	-	-	-	Lynn et al., 2005
Scotland	Non-verbal	2931	-	-	-	-	-	-	-.02	Nisbet & Entwistle, 1966
Scotland	Non-verbal	3228	-	-	-	-	-	-	.03	Nisbet & Entwistle, 1969
Sweden	Griffiths	408	-.04	-	-	-.49	-	-	-	Norberg et al., 1991
UK	PARCA	10742	-	-.39	-.34	-.17	-	-	-.06	Arden & Plomin, 2006
UK	PARCA	14187	-	-.02	-.02	-.01	-	-	.00	Toivanen et al., 2017
UK	BAS	14413	-	-	-	-	-.05	-	-	Lynn & Chen, 2021
USA	S Binet	262	-	-	-	-	-0.03	-0.02	-	Terman, 1921
USA	S Binet	2000	-	-.34	-.17	-.10	.00	.12	.14	McNemar, 1942
USA	McCarthy	926	-	-.33	-.04	-.11	-.10	-.21	-.18	Kaufman & Kaufman, 1973

USA	Verbal IQ	151	-	-	-	-	-.08	-	-	Long, 1976
USA	Verbal	202	-	-	-	-	-.16	-	-	Perney et al., 1976
USA	Analogies	121	-	-	-	-.16	-	-	-	Elfman, 1978
USA	Verbal	100	-	-	-	-	-.43	-	-	Averitt, 1981
USA	Verbal	3013	-	-	-	-	-	-	-.05	Denno et al., 1981
USA: whites	S Binet	844	-	-	-	-.20	-	-	-	Jensen & Johnson, 1974
USA: blacks	S Binet	537	-	-	-	-.21	-	-	-	Jensen & Johnson, 1974
USA	K-ABC	2615	-	-	-.24	-	-	-	-	Burns & Reynolds, 1988
USA	Spatial	288	-	-	-	.16	.50	.23	-	Levine et al., 1999
USA	IQ	801	-	-	-	-	-	-.31	-	Naglieri & Rojahn, 2001
USA	WJ 111:g	697	-	-	-	-	-	.13	-	Keith et al., 2008
USA	DAS-11:g	590	-	-	-	-	-	.06	-	Keith et al., 2011
USA	KABC-11:g	600	-	-	-	-	-	-	-.11	Reynolds et al., 2008
UK	Verbal	14469	-	-	-	-	-	-	-0.07	Lynn & Kanazawa, 2011
Median	-		-.04	-.34	-.12	-.16	-.16	0.11	-.03	

4. Coloured Progressive Matrices

Studies of sex difference in the Coloured Progressive Matrices are given in Table 3.4. The results show a small female advantage of .08*d* at age 4 and median male advantages of .11*d*, .15*d* and .18*d* for 5, 6 and 7 year-olds.

Table 3.4. Sex difference in the Coloured Progressive Matrices in 4 through 7 year-olds (*d*s: positive signs denote higher scores by boys)

Country	**N**	**4**	**5**	**6**	**7**	**Reference**
Germany	1421	-	-.03	.22	.18	Von Winkelmann, 1972
Netherlands	104	-	.53	-	-	Freyberg, 1966
USA	104	-	.02	-	-	Levinson. 1960
Australia	700	-	-.02	.14	.31	Reddington & Jackson, 1981
Brazil	1546	-	.06	.25	.12	Angelini et al., 1999
India	1017	-	.21	-	-	Rao and Reddy, 1968
Switzerland	290	-	.13	-	-	Dupont, 1970
Taiwan	43825	-	.20	-	-	Hsu, 1976
Hong Kong	4858	-	.12	-	-	Chan & Lynn, 1989
Taiwan	1965	-	.14	.25	.32	Hsu, 1971
USA: Blacks	349	-	.09	.12	.31	Higgins & Sivers, 1958
USA: Whites	440	-	.01	.01	.04	Higgins & Sivers, 1958
India	1534	-	.11	-.04	-.06	Despande, 1971
Belgium	845	-	.91	.19	.19	Goosens, 1952
Kenya	1222	-	.30	-	-	Costenbader & Ngari, 2000
Malta	136	-	.15	-	-	Martinelli & Lynn, 2005
Italy	1464	-.08	-.04	.15	.22	Belacchi et al., 2008
Sudan	719	-	-	.21	.04	Bakhiet et al., 2017

Sudan	1500	-	.05	.09	-.05	Elbanna et al., 2018
Egypt	626	-	-.27	.02	.03	Zaida et al., 2019
Median	-	-.08	.09	.14	.15	

These studies are consistent in showing that girls have higher average intelligence than boys at the ages of 1 through 4 years. The results in Table 3.1 show that girls have a higher average vocabulary than boys among 1–4 year-olds but not at ages 5 through 7. The results in Table 3.2 show that in the Wechsler tests girls have a higher average IQ than boys at the age of 3 at .37*d* but not at the ages of 5 and 7 where there is virtually no sex difference. The results in Table 3.3 show that in other intelligence tests girls have a higher average IQ than boys among 2- to 5-year-olds but not at ages 6 and 7. The results in Table 3.4 show that in the Coloured Progressive Matrices there is a small female advantage at age 4 of .08*d* and male advantages of .09*d*, .14*d* and .15*d* for 5, 6 and 7 year-olds. The evidence on the sex difference at the age of 5 years is conflicting with no difference in vocabulary (Table 3.1) in the Wechsler tests (Table 3.2), a girls' advantage in intelligence in Table 3.3 and a boys' advantage in the Coloured Progressive Matrices (Table 3.4). All studies show that the girls' advantage has disappeared at the ages of 6 and 7 years. The higher average intelligence of girls than of boys at the ages of 1 through 4 years is attributable to the earlier maturation of girls than of boys. This has been shown for physical development by Tanner, Whitehouse & Takaishi (1966) and for brain development by Lenroot, Gogtay, Greenstein et al. (2007).

Chapter 4

The Progressive Matrices

Raven's Progressive Matrices is one of the best measures of reasoning ability and "is typically among the two or three tests having the highest *g* loadings, usually around .80" (Jensen, 1998, p. 38*)*. In this chapter, we examine sex differences in the Progressive Matrices to see whether these support the equalitarian theory or the developmental theory. The equalitarian theory was argued by Mackintosh (1996, p. 567) who contended that on Raven's Progressive Matrices "there is no sex difference in general intelligence worth speaking of …large scale studies of Raven's tests have yielded all possible outcomes, male superiority, female superiority and no difference… there appears to be no difference in general intelligence". Mackintosh relied for this assertion on a literary review by Court (1983) and on some unpublished data by Flynn on 17-year-old military conscripts in Israel. He did not acknowledge my work showing that the male advantage only begins to appear at the age of 16 years. His citation of Flynn's data was found to be incorrect two years later when Flynn published the data revealing that the test was not the Raven's Progressive Matrices but a similar test, and that males had a higher average IQ than females of 1.4 points (Flynn, 1998, Table 3). Mackintosh (1998) reiterated his contention in a subsequent paper, asserting that there is at most "only a very small difference consisting of no more than 1–2 IQ points among adults either way".

In response to this criticism, Paul Irwing and I published a meta-analysis of sex differences on the Progressive Matrices among general population samples that showed that males obtained higher IQs than females from the age of 16 years reaching .33*d* (4.95 IQ points) among adults (Lynn & Irwing, 2004) based on 10 studies. We also published a meta-analysis of sex differences on the Progressive Matrices among college students, showing that males have a higher average IQ than females of.31*d* (4.6 IQ points) (Irwing & Lynn, 2005). Mackintosh published confirmations of this male advantage in a study of 17-year-olds, in which males had a higher average IQ than females of 6.4 IQ points (Mackintosh & Bennett, 2005) and in a further study of 17-year-olds, in which males had a higher average IQ than females of 3.3 IQ points (Mackintosh, 2007). In these papers, he conceded that males obtain higher average IQs than females on the Progressive Matrices but proposed that this advantage is only on some items (Mackintosh & Bennett, 2005; Plaisted, Bell & Mackintosh, 2011) but this contention was not replicated in a much larger sample by Colom & Abad (2007). Despite his own studies confirming that males obtain higher average IQs than females on the Progressive Matrices, Mackintosh's (2011, p. 380) curious final conclusion on sex differences in intelligence given in his book was that "the two sexes do not differ consistently in average IQ". It has been contended by Colom, Escorial & Rebollo (2004) that the Standard Progressive Matrices contains a visuo-spatial element and this accounts for the male advantage. It has been confirmed by Lynn, Allik & Irwing (2004) that the Standard Progressive Matrices does contain a visuo-spatial element and this probably explains the small male advantages present in some age groups. However, Waschl, Nettlebeck, Jackson & Burns (2016) failed to find a visuo-spatial component in the Advanced Progressive Matrices and it will be seen in Table 4.3 that in the 9 studies of these males obtained a higher a median score of .30*d*.

Our 2004 meta-analysis of sex differences on the Progressive Matrices among general population samples is updated to June 2021 in this chapter. Studies for this review for the years from 2002 to the end of June 2021 were obtained by computerized database searches of PsycINFO, ERIC and Web of Science. Table 4.1 gives results for studies of 6–12 year-olds showing negligible sex differences.

Table 4.1. Sex differences (*ds*) for the Standard Progressive Matrices in general population samples aged 6–12 years. Minus signs denote higher means obtained by females.

Country	**N: M**	**N: F**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Reference**
Britain	1,625	1,625	.18	.12	.01	-.06	-.21	-.29	.13	Raven, 1981
Poland	2,008	1,998	.07	-.05	-.11	-.06	-.14	.09	-.07	Jaworowska & Szustrowa, 1991
UAE	2,601	1,895	.23	.16	.19	.09	.28	.03	.	Khaleefa & Lynn, 2008a
Yemen*	1,076	938	.13	-.40	-.10	-.12	-1.5	-.07	.00	Bakhiet et al., 2015

Sudan	3,810	3,916	.01	-.12	-.07	-.01	0	-.09	.13	Bakhiet et al., 2015
Romania	621	662	0	.09	.07	.24	.	.	-.01	Iliescu et al., 2016
Oman	1,046	1,044	.29	.39	.43	.02	.59	.01	.20	Abdelrasheed et al., 2021
Iceland	270	279	-	.12	-	.00	-	.00	-	Pind et al., 2003
Estonia	951	882	-	-.06	-.24	-.16	-.25	-.33	.	Lynn et al., 2002
Mexico	472	448	-	.16	.10	.02	-.03	.	.	Lynn et al., 2005
Malaysia	2,763	2,621	.	-.01	.13	.16	.10	.03	.00	Chaim, 1994.
Croatia	240	229	-	-.11	.16	-.09	-.80	.22	.37	Žebec et al., 2016
Sudan	2,553	2,636	-	-.19	-.15	.04	-.35	-.25	-.11	Husain al., 2019
Taiwan	16,322	15,412	-	.07	.	.	-.12	.	.	Chen et al., 2010.
Syria	1,739	1,750	-	-.06	.27	.08	.18	.47	.10	Khaleefa & Lynn., 2008b
New Zealand	1,526	1,605	.	.	-.02	-.01	-.22	-.14	-.28	Reid & Gilmore, 198
Kuwait	3,278	3,251	-	-	-.14	-.23	-.21	-.11	-.06	Abdel-Khalek & Lynn, 2006
Australia	1,948	2,120	.	.	.02	.02	-.15	-.07	.03	De Lemos, 1989
Saudi Arabia	1,613	1,596	-	-	-.23	-.35	-.44	-.14	-.02	Batterjee, 201
Libya	900	900	.	.	-.10	-.21	-.52	-.71	-.05	Al-Shahomee & Lynn, 2010
Qatar	517	618	.	.	-.11	.	.	.	.	Khaleefa & Lynn., 2008c
Sudan	2,082	2,070	.	.	.	.11	.32	-.02	.07	Khaleefa et al., 2008
Argentina	840	840	.	.	.	.06	-.07	-.26	-.18	Rimoldi et al., 1947.
Iran	2,206	2,355	.	.	.	.25	.22	.28	.30	Baraheni, 1974
N. Ireland	93	112	.	.	.	.22	.	.	.	Lynn, Cooper & Topping, 1990
Ireland	605	594	.	.	.	.06	.	.	-.17	Lynn & Wilson, 1992
Ireland	1,732	1,732	.	.	.	-.06	.	.	.	Raven, 1981
New Zealand	375	433	.	.	.	-.18	.	.25	.	Reid & Gilmore, 1989
Nigeria*	5,583	5,581	.	.	.	.	-.06	.21	.10	Hur et al., 2017

Pakistan	91	112	.	.	.	.	-.32	.	-	Shama-tus-Sabah et al., 2012
India	100	100	.	.	.	.	.28	.	-	Lynn & Jindal, 1993
Hong Kong	120	77	.	.	.	.	.15	.	.	Lynn, Pagliari et al., 1988
Britain	75	95	.	.	.	.	.00	.	.	Lynn et al., 1988.
Brazil	997	1,102	.	.	.	.	-.08	.	.	Flores-Mendoza et al., 2013
Cyprus	2,003	1,828	.	.	.	.	-.06	-.11	.00	Spandoudis & Lynn, 2016
Taiwan*	2,363	2,241	.	.	.	.	-.10	.	.	Lynn & Chen, 2011
Italy	587	572	.	.	.	.	.	.22	.	Young et al., 1962
South Africa	197	182	.	.	.	.	-	.35	.	Knoetze, Bass & Steele, 2005.
Italy	1,218	1,218	.	.	.	.	.	-.04	-.03	Tesi & Young, 1962
USA	184	172	.	.	.	.	.	.00	.	Tulkin & Newbrough, 1968.
Israel	370	383	.	.	.	.	.	.11	-.49	Nathan & Schnabl, 1976
Spain**	1,621	1,650	.	.	.	.	-	.02	-.22	Albade Paz & Monoz Cantero, 1993
England	2,200	2,699	.	.	.	.	-	-	-.04	Adams, 1952
Cuba	640	878	.	.	.	.	-	-	-.02	Alonso, 1974
Estonia	1,250	1,441	.	.	.	.	-	-	-.54	Allik et al., 2003
Morocco	723	454	.	.	.	.	-	-	.01	Shaibi et al., 2014
Britain*	323	340	.	.	.	.	-	-.01	-	Savage McGlynn, 2012
Bosnia	310	245	.	.	.	.	-	-	-.28	Diapo & Lynn, 2010
Bosnia	251	304	.	.	.	.	-	-	-.27	Diapo & Kolenovic-Diapo, 2012
Pakistan	853	809	.	.	.	.	-	-	.15	Ahmad et al., 2008
Canada	2,610	2,352	.	.	.	.	-	-	.07	Pagani et al., 2017
Denmark	299	329	.	.	.	.	-	-	-.15	Vejleskoy, 1968
Median	-	-	.13	.07	-.01	.02	-.08	.02	.01	

Table 4.2 gives results for studies of 13 to 18–19 year-olds showing negligible sex differences in 13 and 14 year-olds, a small male advantage of

.12*d* in 15-year-olds and .13*d* in 16-year-olds and larger male advantages of .27*d* in 17 and .18*d* in 18–19 year-olds.

Table 4.2. Sex differences (*ds*) for the Standard and Advanced Progressive Matrices in general population samples aged 13–19 years. Minus signs denote higher means obtained by females.

Country	N: M	N: F	13	14	15	16	17	18–19	Reference
Britain	1,625	1,625	0	.10	.09	.	.	.	Raven, 1981
Poland	2,008	1,998	-.03	-.08	-.09	.	.	.	Jaworowska & Szustrowa, 1991
UAE	2,601	1,895	-.03	-.08	-.04	.	.	.	Khaleefa & Lynn, 2008a
Yemen*	1,076	938	.41	.	.	.	.	.	Bakhiet et al., 2015
Sudan	3,810	3,916	.16	.17	.10	.15	.66	.20	Bakhiet et al., 2015
Romania	621	662	0	.08	.15	15	.11	.	Iliescu et al., 2016
Oman	1,046	1,044	.27	.25	0	.80	.62	0.9	Abdelrasheed et al., 2021
Iceland	270	279	-.21	-	-.68	.	.	.	Pind et al., 2003
Croatia	240	229	-.44	-.02	.55	.55	1.56	.	Žebec et al., 2016
Sudan	2,553	2,636	-.39	-.22	-.05	-.16	.27	.14	Husain al., 2019
Taiwan	16,322	15,412	-	.08	.	.	.13	.	Chen et al., 2010
New Zealand	1,526	1,605	.01	.06	-.18	.04	.	.	Reid & Gilmore, 198
Kuwait	3,278	3,251	.06	-.14	.01	.	.	.	Abdel-Khalek & Lynn, 2006
Australia	1,948	2,120	.01	-0.1	-.04	.19	.	.	De Lemos, 1989
Saudi Arabia	1,613	1,596	-.33	-.25	-.28	0	-.05	.24	Batterjee, 2011
Libya	900	900	.07	.03	.32	.32	.31	.	Al-Shahomee & Lynn, 2010
Sudan	2,082	2,070	-.06	-.27	-.23	-.39	-.32	-.26	Khaleefa et al., 2008
Argentina	840	840	.11	.62	.46	.	.	.90	Rimoldi et al., 1947
Iran	2,206	2,355	.20	.13	.12	.22	.03	.01	Baraheni, 1974
New Zealand	375	433	-.43	.	.19	.	.	.	Reid & Gilmore, 1989

Nigeria*	5,583	5,581	.18	.22	.24	.21	.36	.45	Hur et al., 2017
Cyprus	2,003	1,828	-.03	-.02	.06	.01	.29	.	Spandoudis & Lynn, 2016
Taiwan*	2,363	2,241	.10	.	.	.16	-	.	Lynn & Chen, 2011
Italy	1,218	1,218	.17	.08	.04	-.05	.05	.	Tesi & Young, 1962
Israel	370	383	-.21	-.02	.30	.32	.14	.	Nathan & Schnabl, 1976
Spain**	1,621	1,650	.02	.03	-.14	.03	.29	.	Albade Paz & Monoz Cantero, 1993
Cuba	640	878	0.10	.06	17	-	.	.	Alonso, 1974
Estonia	1,250	1,441	-	-	-	-	.08	.04	Allik et al., 2003
Morocco	723	454	-.49	-.54	-.10	1.0	.98	-	Shaibi et al., 2014
India	185	185	-.07	-	-	-	-	-	Sinha, 1968
Argentina	462	469	0	-	.01	-	-.04	.02	Flynn. 2012
Tanzania-A	413	314	.	.15	.30	.11	-	-	Klingelhoffer, 1967
Tanzania-B	1,804	836	.14	.12	.21	.38	.06	-.07	Klingelhoffer, 1967
Hawaii	503	525	.	.15	-.05	.10	.05	.10	Wilson et al, 1975
USA	80	80	-.04	.	.	.	.	.	Natalicio, 1968
Brazil	80	80	.26	.	.	.	.	.	Natalicio, 1968
Sri Lanka*	153	167	.47	.	.	.	.	.	Omanbayev et al., 2018
Latin America	1,867	1,938	.13	.	.	.	.	.	Florez-Mendoza, 2018
Libya	550	550	.07	.03	.32	.31	.31	.12	Al-Shahomee et al., 2019
Libya	360	360	.32	.15	.12	.02	.31	.23	Al-Shahomee et al., 2019
Syria	1,739	1,750	.06	-	.06	-.45	-.27	.23	Khaleefa & Lynn., 2008b
India	1,025	1,019	.	.13	.38	.79	.42	.	Rao, 1975
England	239	229	.	-	.14	.	.	.	Conrad, 1979
S. Africa-Wh	490	566	.	-.03	.	.	.	.	Lynn, 2002
S. Africa-Col	386	381	.	.19	.	.	.	.	Lynn, 2002

S. Africa-Ind	530	533	.	.25	.	.	.	.	Lynn, 2002
Hong Kong**	903	594	.	.42	.36	.16	.38	.	Lynn & Tse Chan, 2003
Singapore**	229	230	.	.	.12	.	.	.	Lim, 1994
Egypt**	1,001	1,205	.	.	.09	.49	.61	.35	Abdelrasheed et al., 2019
S. Africa-B	554	539	.	.	.31	.	.	.	Lynn, 2002
Italy	303	303	.	.	.	.13	.	.	Young et al., 1962
Croatia*	174	263	.	.	.	.15	.	.	Matesic, 2000
Spain**	1,147	1,565	.	.	.	.13	.10	.16	Raven, 1996
Britain*	114	149	.	.	.	-.03	.	.	Savage McGlynn, 2012
Argentina**	53	112	.	.	.	.	.69	.	Cortada de Kohan, 1998
England*	48	49	.	.	.	.	.43	.	Mackintosh & Bennett, 2005
England**	125	117	.	.	.	.	.22	.	Plaisted et al., 2010
Israel	90	90	.	.	.	.	.32	.	Weiser et al., 2000
Israel	274,372	276,968	.	.	.	.	.09	.	Flynn, 1998
Yemen**	503	524	.	.	.	.	.06	-	Bakhiet & Lynn, 2016
Spain	303	301	.					.28	Colom & Garcia-Lopez, 2002
Belgium**	214	64	.	.	.	.	.	.36	Florquin, 1964.
Estonia	544	784	.	.	.	.	-	.33	Dutton & Lynn, 2016
Median	-	-	.06	.06	.12	.13	.27	.18	-

*Progressive Matrices Plus; **Advanced Progressive Matrices

Table 4.3 gives results for studies of 20–80 year-olds showing higher male scores in 32 of the 33 samples. Only Argentina showed a non-significantly higher IQ by females (Flynn, 2012). The median of the 33 studies of 20–80 year-olds is a male advantage of .30*d* (4.5 IQ points). These results provide further support for the developmental theory.

Table 4.3. Sex differences (*ds*) for the Standard and Advanced Progressive Matrices in general population samples aged 20–80 years. Minus signs

denote higher means obtained by females.

Country	N:M	N:F	d	Reference	Country	N:M	N:F	d	Reference
Britain	300	240	.29	Heron & Chown, 1967	Spain	101	157	.15	Diaz et al., 2010.
Hungary	250	250	.17	Szegedi, 1974	Sudan	115	125	.12	Khaleefa et al., 2010
Israel	100	100	.31	Guttman, 1974.	N. Zealand	143	187	.22	Fletcher & Hattie, 2011
Hawaii	939	971	.37	Wilson et al., 1975	Argentina	374	390	-.02	Flynn, 2012
Taiwan	225	225	1.33	Adair & Pollitt, 1985	Libya	300	300	.37	Al-Shahomee, 2012
Belgium	850	979	.31	Deltour, 1993	Libya	260	260	.36	Al-Shahomee & Lynn, 2012
Belgium	101	174	.38	Deltour, 1993	Brazil**	454	534	.10	Flores-Mendoza et al., 2013
USA	63	80	.16	Sitkei & Michael, 1996	Brazil**	161	386	.65	Braga et al., 2014
Belgium **	564	802	.21	Dufouil et al., 1997	Serbia	62	74	.27	Čvorović & Lynn, 2014
Brazil	1,921	741	.28	Campos, 1999	Romania*	618	823	.18	Iliescu et al., 2016
USA**	92	114	.31	Salthouse, 2001	Australia**	128	327	.30	Waschl et al, 2016
Scotland	210	217	.11	Deary et al., 2004	Brazil**	381	216	.43	Flores-Mendoza et al., 2016
Scotland	230	313	.29	Deary et al., 2004	USA***	393	503	.21	Van der Linden et al., 2017
Guatemala	683	786	.52	Martorell et al., 2005	Poland**	218	218	.12	Gignac & Zajenkowski, 2019
Brazil**	104	265	.49	Rossetti et al., 2009	USA***	346	399	.05	Du Pont et al., 2020
Pakistan	997	1,019	.04	Ahmad et al., 2008	Portugal	250	272	.34	Queiro-Garcia et al., 2021
Morocco	92	110	.38	Sellami et al., 2010	Median			.30	

*Progressive Matrices Plus; **Advanced Progressive Matrices; *** Advanced Progressive Matrices Short Form

Chapter 5

The Wechsler Tests

The Wechsler tests provide some of the best data with which to evaluate the equalitarian theory and the developmental theory of sex differences in intelligence because they measure a wide range of verbal, spatial, perceptual, reasoning and memory abilities that are averaged to provide the Full Scale IQ as a measure of general intelligence. Advocates of the equalitarian theory have contended that males and females obtain the same Full Scale IQ on these tests. Thus, it has been asserted by Halpern (2000, p. 91) that the WAIS Full Scale IQ “does not show sex differences”. This assertion was repeated by Anderson (2004, p. 829): “The evidence that there is no sex difference in general ability is overwhelming. This is true whether general ability is defined as an IQ score calculated from an omnibus test of intellectual abilities such as the various Wechsler tests, or whether it is defined as a score on a single test of general intelligence, such as the Raven’s Matrices”. The same assertion was made by Haier, Jung, Head & Alkire (2004, p. 1): “Comparisons of general intelligence assessed with standard measures like the WAIS show essentially no differences between men and women”. In the fourth edition of her textbook on sex differences in intelligence, Halpern (2012, p. 115) states that on the standardisation sample of the American WAIS-IV “[t]he overall IQ score does not show sex differences”. We consider now how far the evidence supports these assertions that there is no sex difference in intelligence measured by the Wechsler tests.

The WPPSI

The Wechsler Preschool and Primary Scale of Intelligence (WPPSI) was constructed in the United States in the mid-1960s by Wechsler (1967) and was designed for children aged between 4 and 7 years. It consists of six verbal sub-tests designated information, vocabulary, arithmetic, similarities, comprehension and sentences, of which the first five are averaged to give the Verbal IQ, and five performance sub-tests designated animal house, picture completion, mazes, geometric design and block design that are averaged to give the Performance IQ. The Verbal IQ and Performance IQ are averaged to give the Full Scale IQ. Subsequent standardisations of the WPPSI are designated the WPPSI-R, WPPSI-III and WPPSI-IV and have six performance sub-tests designated object assembly, geometric design, block design, matrix reasoning, picture completion and animal pegs, of which the first five are averaged to give the Performance IQ.

Studies of the sex differences on the WPPSI, WPPSI-R and WPPSI-IV giving the Verbal IQ and Verbal subtests are summarized in Table 5.1. The data for the United States and Japan are for standardisation samples. The median sex differences are given in the bottom row and are negligible for the Verbal IQ (-.01*d*), Information (.08*d*), Vocabulary (.04*d*), Arithmetic (.08*d*) and Comprehension (.03*d*) but there is a female advantage for Similarities (-.12*d*) and male advantage for Sentences (.16*d*).

Table 5.1. Sex differences on the WPPSI, WPPSI-R and WPPSI-IV Verbal IQ and verbal subtests: Information (IN), Vocabulary (VO), Arithmetic (AR), Similarities (SI), Comprehension (CO) and Sentences (SE); (*d*s; positive signs denote boys score higher)

Country	Test: N	Verb IQ	IN	VO	AR	SI	CO	SE	Reference
Canada	WPPSI: 109	-.07	-.03	.03	-.23	.08	.01	-	Miller & Vernon, 1996
China	WPPSI: 1331	.16	.36	-.12	.03	-.11	-.09	.35	Liu & Lynn, 2011
England	WPPSI: 60	.48	.53	.54	.09	.09	.30	-	Brittain, 1969
England	WPPSI: 150	.10	.11	.12	.08	-.01	.06	-	Yule et al, 1969

Japan	WPPSI: 599	-.01	-.06	-.06	.05	-.02	.03	-.15	Hattori, 2000
Taiwan	WPPSI-R: 900	-.06	-.07	-.05	-.14	-.14	-.14	-.14	Chen & Lynn, 2021a
Taiwan	WPPSI-IV: 924	0.05	.17	.31	-	.04	.21	-	Chen & Lynn, 2021b
USA	WPPSI: 1199	-.02	.05	.05	..09	-.10	.01	..16	Kaiser & Reynolds, 1985
USA	WPPSI-R: 1700	-.04	-	-	-	-	-	-	Sellers et al., 2002
Median	-	-.01	.08	.04	.08	-.12	.03	.16	

Studies of the sex differences on the WPPSI, the WPPSI-R and the WPPSI-IV, giving the Full Scale IQ, the Performance IQ and the performance subtests, are summarized in Table 5.2. The WPPSI-IV is not scored to give a performance IQ but this is calculated as the average of the four performance sub-tests object assembly, picture completion, matrix reasoning and block design. The median sex differences are given in the bottom row and are negligible for the Full Scale IQ (.05*d*), Performance IQ (.09*d*), Animal House (Object Assembly in Taiwan) (.04*d*) and Picture Completion (.04*d*), but boys obtained significantly higher median scores on Matrix Reasoning (.23*d*), Geometric Design (.18*d*) and Block Design (.15*d*). These male advantages are likely attributable to these being tests of spatial ability for which other studies have found boys perform better at this young age e.g., at the age of 6 years by Buczylowska, Ronniger, Melzer & Petermann (2019) in Germany and the Netherlands. With this exception, the other results show that there is no significant sex difference on the WPPSIs at the age of 4 to 7 years.

Table 5.2. Sex differences on the WPPSI, WPPSI-R and WPPSI-IV Full Scale IQ, Performance IQ, and Performance subtests; Animal House (AH), Object Assembly (OA), Picture Completion (PC), Matrix Reasoning (MR), Geometric Design (GD) and Block Design (BD); (*d*s; positive signs denote boys score higher)

Country	**Test: N**	**FS IQ**	**PE IQ**	**AH OA**	**PC**	**MA**	**GD**	**BD**	**Reference**
Canada	WPPSI: 109	-.03	-01	-.03	-.07	-.17	.25	-.01	Miller & Vernon, 1996
China	WPPSI: 1331	.14	.11	.04	.11	.35	-.04	.09	Liu & Lynn, 2011

England	WPPSI: 60	.37	.22	.04	.07.	.47	.47	.40	Brittain, 1969
England	WPPSI: 150	.14	.14	-.02	.00	.40	.25.	.23	Yule et al, 1969
Japan	WPPSI: 599	.06	.11	.36	.21	.33	-.05	.22	Hattori, 2000
Taiwan	WPPSI-R: 900	-.06	.02	.12	-.09	-.09	-.05	.17	Chen & Lynn, 2001a
Taiwan	WPPSI-IV: 924	.05	.09	.11	.07	.10	-	.10	Chen & Lynn, 2001b
USA	WPPSI: 1199	-.06	-.01	.31	.01	.23	-.18	-.12	Kaiser & Reynolds, 1985
USA	WPPSI-R: 1700	-.04	-.01	-	-	-	-	-	Sellers et al., 2002
Median	-	.05	.09	.04	.04	.23	.18	.15	

The WISC

The Wechsler Intelligence Scale for Children (WISC) was constructed in the United States in the mid-1940s by Wechsler (1949) and was designed for children aged between 6 and 16 years. It consists of six verbal sub-tests designated information, vocabulary, arithmetic, similarities, comprehension and digit span, the first five of which are averaged to give the Verbal IQ, and six performance sub-tests designated picture completion, picture arrangement, object assembly, coding, block design and mazes, the first five of which are averaged to give the Performance IQ. The Verbal IQ and Performance IQ are averaged to give the Full Scale IQ. Subsequent standardisations of the WISC have been published in the United States and are designated the WISC-R, WISC-III and WISC-IV. The results of sex differences on the WISC Full Scale IQ, Performance IQ and Performance subtests are summarized in Table 5.3.

Table 5.3. Sex differences on the WISC Full Scale IQ, Performance IQ and Performance subtests; (*d*s; positive signs denote boys score higher)

Country	Test: N	FS IQ	PE IQ	PA	PC	BD	OA	CO	MA	Reference
Bahrain	WISC-III: 1018	.03	.04	.06	.01	.16	.08	-.03	.27	Bakhiet & Lynn, 2015
Belgium	WISC-R: 761	.12	.10	.20	.04	.13	.16	-.53	.17	Van der Sluis et al., 2008
China	WISC-R: 2330	.28	.21	-	-	-	-	-	-	Dai & Lynn, 1994
China	WISC-R: 788	.25	.28	.19	.19	.19	.35	-.41	-	Liu & Lynn, 2015
China	WISC-R: 1744	.12	-	-	-	-	-	-	-	Li et al., 2016
Germany	WISC-IV: 1650	.06	-	-	.07	..22	-	-	-	Goldbeck et al., 2010
Greece	WISC: 260	.15	.10	.41	.24	.10	.21	-.47	-	Haritas-Fatouros, 1963
Greece	WISC: 403	.21	.27	-	-	-	-	-	-	Fatouros, 1972
Greece	WISC-R: 300	.61	.49	.24	.44	.21	.29	-.50	-	Alexopoulos, 1979
Iran	WISC-R: 1400	.04	-	-	-	-	-	-	-	Shahim, 1990

Israel: Jews	WISC-R: 211	.32	.19	-	-	-	-	-	-	Leiblich, 1985
Israel: Arabs	WISC-R: 631	.41	.43	-	-	-	-	-	-	Leiblich, 1985
Israel	WISC-R: 1100	.15	.01	-	-	-	-	-	-	Cahan, 2005
Libya	WISC-R: 870	.10	.42	.07	.06	.29	.27	.00	-	Al-Shahomee et al., 2016
Mauritius	WISC-R: 1250	.38	.43	-	-	-	-	-	-	Lynn, Raine et al., 2005
Netherlands	WISC-R: 2027	.14	.08	-	.14	.12	.17	-.36	-	Born & Lynn, 1994
Netherlands	WISC-R: 737	.25	.00	.18	.15	.07	.00	-.53	.15	Van der Sluis et al., 2008
N. Zealand	WISC-R: 897	.04	.00	-	.07	.19	.23	-.53	-	Lynn et al., 2005
Romania	WISC-R: 100	.70	.62	-	-	-	-	-	-	Dumitrascu, 1999
Scotland	WISC: 437	.07	.02	-.03	.16	.11	.06	-.18	-	Scottish Council, 1967
Scotland	WISC-R: 1400	.18	.01	-	.19	.16	.21	-.55	-	Lynn & Mulhern, 1991
Sudan	WISC-III: 1214	.23	.13	.15	.15	.19	.16	-.24	.09	Bakhiet et al., 2017
Taiwan	WISC-III: 1100	.21	15	.09	.17	.23	.21	-.53	.16	Chen et al., 2016
UK	WISC: 240	.34	.28	-	-	-	-	-	-	Jones, 1962
USA	WISC: 2200	.11	.07	-	-	-	-	-	-	Seashore et al., 1960
USA: whites	WISC: 397	-.02	-.14	-	-	-	-	-	-	Goffeney et al., 1971
USA: blacks	WISC: 229	-.04	-.07	-	-	-	-	-	-	Goffeney et al., 1971
USA: whites	WISC: 163	.15	-.05	-	-	-	-	-	-	Miele., 1979
USA: blacks	WISC: 101	-.08	-.10	-	-	-	-	-	-	Miele., 1979
USA	WISC-R: 2200	.12	.01	.11	.15	.15	.18	-.53	-	Jensen & Reynolds, 1983
USA: whites	WISC: 1123	.07	-	-	-	-	-	-	-	Jensen & Johnson, 1994
USA: blacks	WISC: 813	-.04	-	-	-	-	-	-	-	Jensen & Johnson, 1994
USA	WISC-R: 100	.53	-	-	-	-	-	-	-	Rushton, 1997
USA	WISC-R: 852	.29	-	-	-	-	-	-	-	Knopik & Defries, 1998
USA	WISC-III: 2000	.11	.07	.09	.17	.23	.21	-.53	.16	Wechsler, 1992
USA	WISC-III: 2200	.21	.25	.28	.20	.25	.36	-.23	.34	Psychological Corp, 2006

Median		.12	.10	.10	.15	.16	.21	-.47	.16	

Sex differences in the Verbal IQ in the WISCs and in the verbal subtests are summarized in Table 5.4.

Table 5.4. Sex differences in the Verbal IQ in the WISCs and the verbal subtests: Information (IN), Digit Span (DS), Vocabulary (VO), Arithmetic (AR), Comprehension (CO) and Similarities (SI); *d*s; positive signs denote boys score higher.

Country	**Test: N**	**Verb IQ**	**IN**	**DS**	**VO**	**AR**	**CO**	**SI**	**Reference**
Bahrain	WISC-III: 1018	-.10	-.08	-.18	-.06	.12	-.03	-.28	Bakhiet & Lynn, 2015
Belgium	WISC-R: 761	.16	.37	-.12	.07	.19	.07	-.05	Van der Sluis et al., 2008
China	WISC-R: 2330	.30	-	-	-	-	-	-	Dai & Lynn, 1994
China	WISC-R: 788	.16	.44	-	-.03	.10	.00	.01	Liu & Lynn, 2015
Germany	WISC-IV: 1650	.19	-	-	.25	-	.10	.16	Goldbeck et al., 2010
Greece	WISC: 403	.19	-	-	-	-	-	-	Fatouros, 1972
Greece	WISC-R: 300	.45	.65	-	.28	.65	.48	.17	Alexopoulos, 1979
Israel: Jews	WISC-R: 211	.29	-	-	-	-	-	-	Leiblich, 1985
Israel: Arabs	WISC-R: 631	.43	-	-	-	-	-	-	Leiblich, 1985
Israel	WISC-R: 1100	.20	.35	.01	.04	.23	.11	.03	Cahan, 2005
Italy	WISC-IV: 2200	-.03	-	.00	.10	-	.03	.10	Pezzuti & Orsini, 2016
Libya	WISC-R: 870	-.02	-.03	-.02	-.01	.16	-.02	-.16	Al-Shahomee et al., 2016
Mauritius	WISC-R: 1250	.07	-	.06	-	-	-	.13	Lynn, Raine et al., 2005
Netherlands	WISC-R: 2027	.16	.30	-	.14	.09	-	.08	Born & Lynn, 1994
Netherlands	WISC-R: 737	.26	.52	-.03	.27	.31	.17	.05	Van der Sluis et al., 2008
N. Zealand	WISC-R: 897	.06	.18	-	.13	-.04	-	-.06	Lynn et al., 2005
Romania	WISC-R: 100	.70	-	-	-	-	-	-	Dumitrascu, 1999

Scotland	WISC: 437	.12	.19	-	.15	.08	.13	.03	Scottish Council, 1967
Scotland	WISC-R: 1400	.18	.39	-	.28	.12	-	.08	Lynn & Mulhern, 1991
Sudan	WISC-III: 1214	.26	.27	-.08	.27	.19	.09	.07	Bakhiet et al., 2017
Taiwan	WISC-III: 1100	.13	.18	-.07	.15	.18	.07	.00	Chen et al., 2016
Taiwan	WISC-IV: 968	-.02	.13	.07	.08	.21	-.05	.04	Chen & Lynn, 2020a
Taiwan	WISC-V: 1034	.06	.31	.00	.08	.26	-.01	.06	Chen & Lynn, 2020b
UK	WISC: 240	.29	-	-	-	-	-	-	Jones, 1962
USA	WISC: 2200	.17	-	-	-	-	-	-	Seashore et al., 1960
USA: whites	WISC: 370	.00	-	-	-	-	-	-	Goffeney et al., 1971
USA: blacks	WISC: 229	.00	-	-	-	-	-	-	Goffeney et al., 1971
USA: whites	WISC: 163	..14	-	-	-	-	-	-	Miele., 1979
USA: blacks	WISC: 101	-.06	-	-	-	-	-	-	Miele., 1979
USA	WISC-R: 2200	.19	.37	-.05	.14	.06	.09	.07	Jensen & Reynolds, 1983
USA	WISC-R: 852	.29	-	-	-	-	-	-	Knopik & Defries, 1998
USA	WISC-III: 2000	.13	.24	-.05	.07	.10	.03	.09	Wechsler, 1992
USA	WISC-III: 2200	.16	.25	-.07	.08	.14	.03	.10	Psychological Corp, 2006
Median		.16	.30	-.05	.10	.15	.07	.05	

The studies of the WISCs for children aged between 6 and 16 years summarized in Table 5.3 give Full Scale IQs for 36 samples. In 32 of these studies, boys obtained higher Full Scale IQs than girls with a median advantage of .12*d*. Table 5.3 also gives Performance IQs for 29 samples with a median male advantage of .10*d*. Table 5.4 gives Verbal IQs for 33 samples with a median male advantage of .16*d*.

The WAIS

The Wechsler-Bellevue Intelligence Scale (WBIS) was constructed in the United States in the mid-1940s by Wechsler (1946) and was designed for those aged 16 years into old age. There have been four revisions, designated the WAIS (Wechsler Adult Intelligence Scale), the WAIS-R, the WAIS-III and the WAIS-IV. The WAIS and the WAIS-R consist of six verbal subtests designated information, vocabulary, arithmetic, similarities, comprehension and digit span, which are averaged to give the Verbal IQ, and five performance subtests designated picture completion, picture arrangement, object assembly, block design and digit symbol (coding in WAIS-R), which are averaged to give the Performance IQ. The Verbal IQ and Performance IQ are averaged to give the Full Scale IQ. The results of 42 studies of sex differences on the WAIS Full Scale IQ and Performance subtests are summarized in Table 5.5.

Table 5.5. Sex differences on the WAIS Full Scale IQ and Performance subtests; (*d*s; positive signs denote males score higher)

Country	Test: N	FS IQ	PE IQ	PA	PC	BD	OA	DS CO	Reference
Brazil	WAIS-III: 3494	.07	-	-	-	-	-	-	Victora et al., 2015
Canada	WAIS-III: 1104	.11	-	-	-	-	-	-	Longman et al., 2007
Chile	WAIS-IV: 887	.20	.22	.18	.25	.33	.39	-.05	Diaz & Lynn, 2016
China	WAIS-R: 1406	.24	.16	.11	.31	.02	.36	-.28	Dai et al., 1991
China	WAIS-R: 1979	.33	.36	-	-	-	-	-	Lynn & Dai, 1993
China	WAIS-R: 120	.43	.44	-	-	-	-	-	Yao et al., 2004
China	WAIS-111: 888	.29	.24	.18	.29	.33	.27	.03	Chen & Lynn, 2020c

China	WAIS IV: 311	.62	.60	-	-	-	-	-	Gao et al., 2015
Canada	WAIS 111: 1104	.11	.03	-	-	-	-	_	Longman et al., 2007
Denmark	WAIS: 62	.21	-	-	-	-	-	-	Nyborg, 2005
Germany	WAIS-IV: 1425	.21	-	-	-	-	-	-	Daseking et al., 2017
Italy	WAIS-R: 1168	.45	.35	.24	.35	.36	.33	.32	Tommasi et al., 2015
Japan	WAIS-R: 1402	.22	.10	.01	.19	.10	.20	.15	Hattori & Lynn, 1997
Netherlands	WAIS: 2100	.27	-	-	-	-	-	-	Stinissen, 1977
Netherlands	WAIS 111: 522	.24	-.07	-	.23	.26	-	-.19	Van der Sluis et al, 2006
Romania	WAIS: 100	.44	.52	-	-	-	-	-	Dumitrascu, 1999
Romania: Roma	WAIS: 100	.44	.42	-	-	-	-	-	Dumitrascu, 1999
Russia	WAIS: 296	.13	.06	.14	.27	.30	.10	-	Grigoriev et al, 2016
Russia	WAIS: 1800	.22	.15	-	-	-	-	-	Grigoriev et al, 2016
Scotland	WAIS-R: 200	.39	.28	.19	.24	.47	.32	-.38	Lynn, 1998
South Korea	WAIS-IV: 1228	.31	-	-	-	.17	-	-.38	Lynn & Hur, 2016
Spain	WAIS 111: 1369	.24	.16	.19	.12	.34	.16	.17	Colom et al., 2002
Sudan	WAIS-R: 330	.31	.18	-	-	-	-	-	Sulman et al, 2018
Sudan	WAIS-R: 319	.21	.31	-	-	-	-	-	Sulman et al, 2018
Taiwan	WAIS 111: 888	.29	.24	.18	.29	.33	.27	.03	Chen & Lynn, 2021a

Taiwan	WAIS 1V: 1105	.35	.16	-	.15	.41	-	-.07	Chen & Lynn, 2018
USA	W-Bell: 235	.59	.35	-	-	-	-	-	Strange & Palmer, 1953
USA	W-Bell: 153	.20	-.35	-	-	-	-	-	Norman, 1953
USA	W-Bell: 392	.29	.22	-	-	-	-	-	Goolishian & Foster, 1954
USA	WAIS: 1700	.10	.10	.00	.20	.11	.07	-.30	Matarazzo, 1972
USA	WAIS: 279	.40	.26	-	-	-	-	-	Boor, 1975
USA	WAIS: 588	.17	-	-	-	-	-	-	Horn et al., 1979
USA	WAIS: 521	.13	-	-	-	-	-	-	Turner & Willerman, 1977
USA	WAIS: 649	.09	-.08	-	-	-	-	-	Doppelt & Wallace, 1955
USA	WAIS: 649	.09	-.08	-	-	-	-	-	Doppelt & Wallace, 1955
USA	WAIS: 100	.33	.25	.41	.20	.67	.34	-.80	Shaw, 1965
USA	WAIS-R: 230	.27	.23	-	-	-	-	-	Arceneaux et al., 1996
USA	WAIS-R: 206	.28	.01	.05	.05	.32	.11	-.60	Ilai & Willerman, 1989
USA	WAIS-R: 1880	.15	.10	.14	.16	.10	.25	-.27	Matarazzo et al., 1986
USA	WAIS-III: 2450	.18	.03	.22	.08	.27	.04	-.46	Irwing, 2912
USA	WAIS IV: 2200	.15	.02	-	.16	.29	-	-.39	Piffer, 2016
USA	WAIS 111: 850	.04	-.05	-	-	-	-	-	Du Pont et al., 2020
Median		.24	.16	.18	.20	.29	.27	-.30	

The results of 42 studies of sex differences on the Verbal IQ (VIQ) and the verbal sub-tests are summarized in Table 5.6. Information (IN), Digit Span (DS), Vocabulary (VO), Arithmetic (AR), Comprehension (CO) and Similarities (SI).

Table 5.6. Sex differences on the WAIS Verbal IQ (VIQ) and the verbal sub-tests (*d*s; positive signs denote males score higher)

Country	**Test: N**	**Verb IQ**	**IN**	**DS**	**VO**	**AR**	**CO**	**SI**	**Reference**
Canada	WAIS 111: 1104	.16	-	-	-	-	-	-	Longman et al., 2007
Chile	WAIS IV: 887	.14	.34	.16	.02	.30	.02	.01	Diaz & Lynn, 2016
China	WAIS-R: 1406	.28	.51	.07	.11	.32	.19	.08	Dai et al., 1991
China	WAIS-R: 1979	.36	-	-	-	-	-	-	Lynn & Dai, 1993
China	WAIS-R: 120	.42	-	-	-	-	-	-	Yao et al., 2004
China	WAIS IV: 311	.61	.80	.34	.24	.53	.48	.27	Gao et al., 2015
Finland*	WAIS-III: 407	.07	-	-	-	-	-	-	Finland Psych. Corp., 2006
Germany*	WAIS-1V: 137	.08	-	-	-	-	-	-	Lebach et al., 2015
Germany	WAIS-1V: 1425	.20	.42	.11	.12	.48	.02	.06	Daseking et al., 2017
Hungary	WAIS-IV: 1110	.12	-	-	-	-	-	-	Rózsa et al., 2010
Italy	WAIS-R: 1168	.43	.58	.23	.15	.61	.27	.15	Tommasi et al., 2015
Italy	WAIS-R: 2708	.30	.39	.28	.06	.57	.21	.01	Pezzuti et al., 2020
Italy	WAIS-IV: 2174	.08	.29	.18	-.04	.47	.14	-.03	Pezzuti et al., 2020
Japan	WAIS-R: 1402	.28	.27	.09	.35	.26	.22	.09	Hattori & Lynn, 1997
Netherlands	WAIS: 2100	.29	-	-	-	-	-	-	Stinissen, 1977
Netherlands	WAIS III: 522	..44	.66	-	.07	.42	-	.18	Van der Sluis et al., 2006
Romania	WAIS: 100	.25	-	-	-	-	-	-	Dumitrascu, 1999
Romania: Roma	WAIS: 100	.37	-	-	-	-	-	-	Dumitrascu, 1999

Russia	WAIS: 296	.15	-	-	-	-	-	-	Grigoriev et al, 2016
Russia	WAIS: 1800	.42	.22	-.01	.03	.47	-.14	.08	Grigoriev et al, 2016
Scotland	WAIS-R: 200	.43	.65	-.04	.18	.61	.35	.23	Lynn, 1998
South Korea	WAIS IV: 1228	.31	.61	.31	-.01	.48	-	.26	Lynn & Hur, 2016
Spain	WAIS-III: 1369	.28	.42	.28	.13	.58	.16	.11	Colom et al., 2002
Sudan	WAIS-R: 330	.39	-	-	-	-	-	-	Sulman et al, 2018
Sudan	WAIS-R: 319	.10	-	-	-	-	-	-	Sulman et al, 2018
Taiwan	WAIS-111: 888	.30	.46	.05	.31	.25	.22	.21	Chen & Lynn, 2021
Taiwan	WAIS-IV: 1105	.33	.51	.29	.20	-	.35	.31	Chen & Lynn, 2018
USA	WBIS: 235	.63	-	-	-	-	-	-	Strange & Palmer, 1953
USA	WBIS: 153	.52	-	-	-	-	-	-	Norman, 1953
USA	WBIS: 392	.34	-	-	-	-	-	-	Goolishian & Foster, 1954
USA	WAIS: 2200	.20	-	-	-	-	-	-	Seashore et al.., 1950
USA	WAIS: 1700	.10	.18	.00	-.12	.32	.11	-.02	Matarazzo, 1972
USA	WAIS: 279	.14	-	-	-	-	-	-	Boor, 1975
USA	WAIS: 588	.21	-	-	-	-	-	-	Horn et al., 1979
USA	WAIS: 649	.20	-	-	-	-	-	-	Doppelt & Wallace, 1955
USA	WAIS: 100	.13	.44	-.67	.09	-.92	.15	-.04	Shaw, 1965
USA	WAIS-R: 230	.25	-	-	-	-	-	-	Arceneaux et al., 1996
USA	WAIS-R: 206	.37	.67	.16	.19	.14	.17	.08	Ilai & Willerman, 1989
USA	WAIS-R: 1880	.15	.28	-..19	.05	.33	.09	.01	Kaufman et al., 1988
USA	WAIS III: 2450	.22	.43	.07	.04	.40	.28	.09	Irwing, 2012
USA	WAIS IV: 2200	.19	.45	.08	.05	.32	.14	.11	Piffer, 2016
USA	WAIS-III: 850	.04	-	-	-	-	-	-	Du Pont et al., 2020
Median		.25	.44	..09	..09	.40	.19	.08	

The results of the studies given in the preceding six tables are summarised in Table 5.7. These show that there is no significant sex difference in 4- to 6-year-olds in the WPPSI, a small male advantage in 6- to 16-year-olds of .12*d* (1.8 IQ points) in the the WISC and a larger male advantage in adults of .24*d* (3.6 IQ points) in the WAIS. The 3.6 IQ points male advantage in adults is a dis-confirmation of the assertions by Halpern (2000, p. 91), Anderson (2004, p. 829) and Haier et al. (2004, p. 1) that there is no sex difference on the WAIS Full Scale IQ. In addition, Halpern's (2012, p. 115) assertion that in the standardisation sample of the American WAIS IV "the overall IQ score does not show sex differences" is incorrect. Contrary to this assertion, Piffer's (2016) study showed that men obtained a statistically significant higher Full Scale IQ than women of 2.25 IQ points.

Table 5.7. Sex differences in the WPPSI, the WISC and the WAIS; (*d*s; positive signs denote males score higher)

Test	**Age**	**Full Scale IQ**	**Verbal IQ**	**Perf IQ**
WPPSI	4 to 6	.05	-.01	.09
WISC	6 to 16	.12	.16	.01
WAIS	Adults	.24	.25	.16

The median male advantage of 3.8 IQ points on the WAIS Full Scale IQ is only slightly lower than the male advantage of 4 IQ points among adults that I estimated in my first paper on this issue (Lynn, 1994). It should be noted that this male advantage is present despite the efforts by the test developers to construct tests on which males and females obtain the same IQs. Thus, "[f]rom the very beginning test developers of the best known intelligence scales (Binet, Terman and Wechsler) took great care to counterbalance or eliminate from their final scale any items or sub-tests which empirically were found to result in a higher score for one sex over the other" (Matarazzo, 1972, p. 352); and "[t]est developers have consistently tried to avoid gender bias during the test development phase" (Kaufman & Lichtenberger, 2002, p. 98). The constructors of the Wechsler tests have reduced the true male advantage by excluding measures of spatial perception and mental rotation on which males obtain higher IQs than females by 9.6 and 10.9 IQ points, respectively (Voyer, Voyer & Bryden, 1995) and on which 18-year-old males have an advantage of .72*d* (10.2 IQ points) (Hedges & Newell, 1995). This has been noted by Eysenck (1995, p. 128) who concluded: “Allowing for the fact that Wechsler made every effort to equalize IQ between the sexes... we may perhaps say that an IQ difference of four points would be a conservative estimate of the true difference”. It is considered that this is correct and thus the results in this chapter confirm the developmental theory of sex differences in intelligence that there is little difference in young children and adolescents but in adults males obtain higher average IQs than females by 4–5 IQ points.

Chapter 6

Other Tests of General Intelligence

Sex differences in 43 studies of general population samples aged 16 years and above using other tests of general intelligence are summarized in Table 6.1. College student samples are not given because generally more females than males attend college so males are more highly selected. In all but one of these studies males obtained higher IQs than females, the single exception being the Lubinski & Humphries (1990) study of 16-year-olds showing a negligible female advantage of .02*d*.

There is a wide range of results from the male advantage of .07*d* to .77*d* with a median of .23*d*. Note also that the male advantage of .15*d* among 17-year-olds reported in 1922 and of .13*d* for 15–18 year-olds reported in 1942 given in rows 1 and 2 are smaller than the male advantages of .14*d* and .25*d* given in the two most recent studies dis-confirming the claims made by Feingold (1988), Flynn (2012) and Mackintosh (2011) that a male advantage in former years had disappeared by the twenty-first century. The tests are identified in the Appendix.

In addition, Deary (2020, p. 44) has commented on sex differences in intelligence in a representative sample of 12,686 American 18-year-olds assessed by the Armed Forces Vocational Aptitude Battery and the Armed Forces Qualification Test. He reports that "[t]here were significant but very small advantages in the mean scores for males in the general intelligence estimate for males from both (tests) ... the difference was less than a fifteenth of a standard deviation". From this he concludes that there are no sex differences in intelligence in adults. An alternative reading of the data is that the higher mean scores of 18-year-old males and the significantly higher mean scores of males than of females at the ages of 22 and 23 on the AFQT (Wilder & Powell, 1989, p. 6) is a further confirmation of the studies showing that in adults males have a higher average IQ than that of females summarised in Table 6.1.

Table 6.1. Sex differences in general intelligence (*ds*; positive signs denote males score higher)

Test	Country	N	Age	d	Reference
IUIS	USA	5748	17	.15	Book, 1922
SB	USA	419	15–18	.13	McNemar, 1942
AH4	Britain	4243	50–69	.22	Rabbitt et al., 1995
AH4	Britain	900	50	.08	Deary et al., 2001
BAT	Britain	8193	30	.09	Dykiert et al., 2009
Verbal	Britain	14469	16	12	Lynn & Kanazawa, 2011
AH4	Iran	3120	17–18	.29	Mehryar et al, 1972
AH4	Greece	1176	16–18	.25	Alexopoulos, 1976
NZ IQ Test	New Zealand	329	18–70	0.45	Hattie & Fletcher, 2008
AH5	N. Ireland	1436	17	.32	McEwan et al., 1986
IST	Germany	227	17	.30	Amelang & Steinmayr, 2006
IST	Germany	207	34	.40	Amelang & Steinmayr, 2006
IST	Germany	977	17	.77	Steinmayr et al., 2015
IST	Germany	236	17	.71	Steinmayr & Kessels, 2017
IST	Germany	124	33	.72	Steinmayr & Kessels, 2017
IST	Austria	449	21	.41	Pietschnig et al., 2011
Dureman	Norway	3064	18–65	.53	Nystrom, 1983
DRTB	Portugal	6280	16–18	.29	Almeida, 1989
DAT	Britain	653	17–18	.12	Lynn, 1992
DAT	Ireland	2600	18	.17	Lynn, 1996
DAT	Spain	703	16–18	.21	Colom & Lynn, 2004
MAB-11	Romania	4417	16–74	.07	Iliescu et al., 2016
GAMA	Romania	4772	16–81	.03	Iliescu et al., 2016
Tiki-T	Indonesia	936	18–24	.16	Drenth et al., 1977

SAT	Israel	1778	24	.23	Zeidner, 1986
SAT	Sweden	31342	18	.38	Stage, 1988
JAT	S.Africa: Blacks	1093	16	.35	Owen & Lynn, 1993
JAT	S.Africa: Indians	1062	16	.26	Owen & Lynn, 1993
JAT	S.Africa: Whites	1056	16	.29	Owen & Lynn, 1993
RIT	Portugal	1519	16	.17	Lemos et al., 2013
Test QI	France	222000	21–70	.25	Société Anxa, 2004
KAIT	USA	1146	17–94	.22	Kaufman et al. 1995
KBIT	USA	2022	4–90	.16	Kaufman & Wang, 1992
WJ I	USA	441	19–79	.15	Camarata & Woodcock, 2006
AFQ	USA	269968	21	.26	Carretta, 1997
DAT	USA	692	16–17	.13	Keith et al., 2011
PMA	USA	4850	25–81	0.08	Shaie, 2002
CogAT	USA	50735	17	.14	Lakin, 2013
CET	USA	1394	16–20	.14	Roalf et al., 2014
HCP	USA	896	29	.25	Van der Linden et al., 2017
Talent	USA	96000	16	-.02	Lubinski & Humphries, 1990
WMT	Sweden	8257	41	.25	Madison et al., 2016
VNR	UK	5216	44–77	.18	Ritchie et al., 2017

We have seen that males have a higher average intelligence than females in adults of 4.5 IQ points on the Progressive Matrices (Chapter 4), 4.0 IQ points on the Wechsler Tests (Chapter 5) and 3.45 IQ points on the other intelligence tests (this Chapter). The average of these is 4.0 IQ points and is proposed as the best estimate of the male advantage in intelligence.

Chapter 7

Reaction Times

In addition to their higher average IQs, males have an intelligence advantage consisting of faster reaction times than those of females. It has been shown in numerous studies that fast reaction times are positively associated with intelligence. In the early 1930s, Beck (1933) reviewed 39 studies reporting this positive association with correlations of around 0.30. A correlation of 0.32 was reported by Jensen (1987), correlations of 0.31 for simple reaction times and 0.49 for four choice reaction times were reported by Deary, Der & Ford (2001) and correlations between of 0.35 and 0.56 were reported by Nissan, Liewald & Deary (2013).This positive association has been widely interpreted as attributable to the possession of a more efficient nervous system for processing information in individuals with higher IQs (e.g., Anderson, 1992; Neuberger, 1997; Jensen, 1998, 2006).

It has also been shown in numerous studies that males have faster reaction times than those of females. This has been reported for 6- to 8-year-olds by Lock & Berger (1990) and in a meta-analysis of 72 effect sizes derived from 21 studies (N=15,003) of simple reaction times over a 73-year period that concluded that there is an effect size favouring men of 0.17*d* (Silverman, 2006). A more recent meta-analysis by Archer (2019) of simple reaction times gives an effect size favouring men of 0.35*d* These results have been confirmed in further studies by Der & Deary (2006), by Pesta, Bertsch, Poznanski & Bommer (2008) who report a male advantage of .26*d*, by Roivainen (2011) in a review of the literature showing that males have faster reaction times than females for both auditory and visual stimuli, and in further studies reporting that men obtain significantly faster times than women of .10*d* for auditory reaction time by Madison, Mosing, Verweig, Pedersen & Ullen (2016), of .21*d* by Ritchie, Cox, Shen et al. (2018) and in 9-year-olds in China by Li, Liu, Zhang, Wang, Wang & Shi (2017).

It has been shown by Reed & Jensen (1992) that nerve conduction velocity time is associated with intelligence with a correlation of .37. This result was confirmed by Reed, Vernon & Johnson (2004), who also reported that males have a significantly 4 percent faster nerve conduction velocity time than females. They suggest that this male advantage is attributable to the greater myelination and axon size of males and the faster increase in white matter in the male brain during adolescence, shown by Giedd, Blumenthal, Jeffries et al. (1999) and confirmed by De Bellis, Keshavan, Beers et al. (2001).

To calculate the magnitude of the male IQ advantage given by their faster reaction times, I take the male-female difference in reaction times of 0.35*d* from Archer's (2019) meta-analysis and the correlation between reaction times and intelligence of 0.40 as the average reported by Deary, Der & Ford (2001). These figures would give adult males a higher average IQ of 2.1 IQ points (0.35 multiplied by 0.40 = .14*d* = 2.1 IQ points).

Chapter 8

Sex Differences in *g*

Spearman (1923) asserted that there is no sex difference in *g*, the common factor that accounts for about half the variance in intelligence assessed in tests like the Wechslers, e.g., Colom et al. (2002). Table 8.1 summarises 44 studies that have addressed the question of whether there is a sex difference in *g*. It will be seen that the results are inconsistent with 32 studies reporting a higher *g* in males than in females, 10 studies reporting a higher *g* in females than in males, and one study reporting no difference in *g* between males and females. Row 1 gives the results of the first of these studies carried out by Jensen & Reynolds (1983), based on the American WISC-R standardisation sample of whites. They carried out a Schmid-Leiman principal factor analysis to obtain factor scores on *g* and on independent second stratum factors of verbal, performance and memory abilities (the first two of these correspond approximately to Carroll's second stratum factors 2C and 2V; the third is more problematical and appears to be approximately Carroll's first stratum Perceptual Speed factor). The sex differences on the factor scores were calculated and showed that males obtained a higher mean score on *g* of .161*d* and on the verbal and performance factors of .175*d* and .144*d*, while females obtained a higher mean score on the memory factor of .256*d*.

Jensen returned to this problem in his book *The g Factor* (1998, p. 538). Here he argued that his use of *g* factor scores in his first study was not the best method for analysing sex differences in *g* because "*g* factor scores are not a pure measure of the *g* factor … it is somewhat contaminated by including small bits of other factors and test specificity measured by the various sub-tests". To overcome this problem, he proposed the method of correlated vectors (CV), described as follows: "the sex difference in *g* is calculated by including the sex difference on each of the sub-tests of a battery in terms of a point-biserial correlation and including these correlations with the full matrix of inter-correlations for factor analysis; the results of the analysis will reveal the factor loading of sex on each of the factors that emerge from the analysis, including *g*" (Jensen, 1998, p. 538).

His results for the WISC-R standardisation sample are shown in Table 10. It will be seen that this method produced a similar but slightly greater male advantage of .189*d*, as compared with the male advantage of .161*d* obtained from the principal factor method shown in row 1.

Jensen (1998, p. 538) used the same method to analyse four further data sets. His results are summarized in rows 3–6. The results were that males obtained a higher *g* of .366*d* on the ASVAB (Armed Services Vocational Aptitudes Battery) and of .12*d* on the American standardisation sample of the WAIS; females obtained a higher *g* of .527*d* on the GATB (General Aptitude Test Battery); while there was no sex difference (.002*d*) on the BAS (British Ability Scales). These results are highly inconsistent and Jensen (1998, p. 40) concluded that "the sex difference in psychometric *g* is either totally non-existent or is of uncertain direction and of inconsequential magnitude".

This conclusion cannot be accepted. The major inconsistency in these results is the large female advantage of .527*d* on the GATB. This is attributable, as Jensen points out (p. 543), to the presence in the battery of five perceptual motor tests on which females perform well. When these are removed and the analysis is carried out on the three cognitive tests of verbal, numerical and spatial abilities, the sex difference becomes .021*d* (a negligible difference in favour of males). This shows that the sex difference in *g* obtained by the method of correlated vectors depends on the nature of the tests from which the *g* factor is extracted and that the method of correlated vectors is flawed as a technique for measuring *g* independent of the nature of the tests in the battery from which it is extracted. A number of criticisms of this method have been made by Dolan & Hamaker (2001), Lubke et al. (2003), Nyborg (2003) and Ashton & Lee (2005). These have argued that the method of correlated vectors is invalid on a number of grounds, including (1) the correlations calculated using the method are dependent on the combination of sub-tests used to measure *g*; (2) the correlations between the sex and non-*g* sources of variance in the battery of tests; Ashton and Lee (2005) demonstrate that, due to these sources of contamination, the method of correlated vectors can yield a correlation of zero even when a variable has a strong relation with *g*, leading to the erroneous conclusion of no sex difference in *g*; (3) the method of correlated vectors lacks power even in large samples, because the degrees of freedom equal the number of sub-tests minus 1. Thus, the degrees of freedom were 4 and 5 in the two studies in the Colom et al. (2000) study, and 13 in the Colom et al. (2002) study, producing non-significant sex differences in *g*, even though the differences are appreciable. This conclusion is elaborated by Nyborg (2003, p. 206), who also discusses the principal axis (PA) and principal components (PC) methods of measuring *g* and considers both unsatisfactory. He prefers hierarchical oblique factor analysis (Schmid-Leiman transformation) (HOFA) on which he reported a male advantage on *g* of .27*d* in a sample of 16-year-olds.

Meisenberg (2009) has confirmed my developmental theory by examining the data of the Armed Services Vocational Aptitude Battery in the NLSY79. He shows that there was no significant sex difference on *g* among 15-year-olds among either blacks or whites. Among whites a significant male advantage of 4 IQ points was present among 16-year-olds, and this increased to an advantage of 6.1 points among 21–23 year-olds. For blacks there was a male advantage of 1 IQ point at age 16 that increased to an advantage of 1.5 points at age 21–23.

In more recent studies, the preferred method for measuring differences in *g* has been the multi-group confirmatory factor model with mean structures (MGCFA) as described and used by Irwing (2012). Table 8.1 gives five studies using this method for samples aged 16 and above showing a zero sex difference in row 17 and male advantages of .12*d*, .11*d*, .29*d* and .30*d* in rows 17, 22, 23 and 29. These give an average of .16*d* equivalent to 2.4 IQ points. This figure is proposed as the best available estimate of the sex difference in *g* for adults. This estimate is contrary to Jensen's (1998, p. 540) conclusion that "the sex difference in psychometric *g* is either totally non-existent or is of uncertain direction and of inconsequential magnitude; the generally observed sex difference in variability of tests scores is attributable to factors other than *g*;" and also contrary to the conclusion reached by Colom et al. (2000, p. 65) that there is "a negligible sex difference in *g*".

Evidence confirming that there is male advantage in *g* is shown in the last two rows in Table 8.1, which summarise the meta-analyses of sex differences in the mental arithmetic sub-test in a number of Wechsler samples, interpreted as a measure of working memory capacity and *g*, as proposed by Kyllonen & Christal (1990), Colom, Abad, Quiroga, Shih &

Flores-Mendoza (2008) and Chuderski (2013). The results show a male average of .11*d* among children aged 4–16 and of 47*d* among adults.

The last question to be considered is how far the adult male advantage in intelligence is an advantage in *g*. We concluded at the end of Chapter 6 that the adult male advantage in intelligence is 4 IQ points. This figure is higher than the male advantage of 2.4 IQ points given above for *g*. It is therefore concluded that the adult male advantage in intelligence is attributable to both *g* and other abilities.

Table 8.1. Studies of sex differences in *g* (*d*s, positive signs denote *g* higher in males)

	Country	**Age**	**N**	**Test**	**Method**	**g**	**Reference**
1	USA	6–16	1,868	WISC-R	PF	.161	Jensen & Reynolds, 1983
2	USA	6–16	1,868	WISC-R	CV	.189	Jensen, 1998
3	USA	14–17	-	BAS	CV	-.002	Jensen, 1998
4	USA	18–23	-	ASVAB	CV	.366	Jensen, 1998
5	USA	25–34	-	WAIS	CV	.012	Jensen, 1998
6	USA	18	-	GATB	CV	-.527	Jensen, 1998
7	USA	18–95	6,832	Various	PC	-.03	Salthouse, 2004
8	USA	18	2,584	AFQT	CFS	.06	Deary et al., 2006
9	USA	17–18	102,516	SAT	CV	.24	Jackson & Rushton, 2006
10	USA	19–79	441	WJ 111	PC	.01	Camarata & Woodcock, 2006
11	USA	18–79	436	Various	MIMIC	.14	Johnson & Bouchard, 2007
12	USA	16	2,100	KABC	MIMIC	-.15	Reynolds et al., 2008
13	USA	17–18	275	KABC	MIMIC	-.12	Reynolds et al., 2008
14	USA	16–59	6,970	W-J III	MIMIC	-.17	Keith et al., 2008
15	USA: blacks	21–23	771	ASVAB	PC	.10	Meisenberg, 2009
16	USA: whites	21–23	2,512	ASVAB	PC	.41	Meisenberg, 2009

17	USA	16–89	2,450	WAIS-III	MGCFA	.20	Irwing, 2012
18	USA: blacks	16–17	472	ASVAB	PC	-.30	Nyborg, 2015
19	USA: hisp.	16–17	327	ASVAB	PC	.04	Nyborg, 2015
20	USA: whites	16–17	913	ASVAB	PC	.24	Nyborg, 2015
21	USA	22–37	896	HCP	CV	.25	Van der Linden et al., 2017
22	Austria	42	620	GEOV	MGCFA	.12	Arendasy & Sommer, 2012
23	Austria	41	597	GEOV	MGCFA	.11	Arendasy & Sommer, 2012
14	Brazil	13–58	4,771	BPR5	CFA	.23	Flores-Mendoza et al., 2013
25	Denmark	11	52	Various	HOFA	.18	Nyborg, 2005
26	Denmark	16	52	Various	HOFA	.27	Nyborg, 2005
27	Germany	18–21	187,110	TMS	PC	.50	Stumpf & Jackson, 1994
28	Germany	33	651	IST	PC	.25	Amthauer et al, 2001
29	Estonia	18	1,201	Various	PC	.65	Allik et al., 1999
30	Italy	65–84	1,168	WAIS-R	MGCFA	0	Saggino et al., 2014
31	Mauritius	11	1,258	WISC-R	CV	.46	Lynn et al., 2005
32	Netherlands	Adult	519	WAIS-III	MGCFA	.30	van der Sluis et al., 2006
33	Portugal	13	1,714	RTB	MGCFA	.13	Lemos et al., 2013
34	Portugal	16	1,519	RTB	MGCFA	.29	Lemos et al., 2013
35	Scotland	11	70,000	CAT	PA	-.01	Deary et al., 2007
36	Spain	13	678	Various	PF	-.19	Aluja-Fabregat et al., 2000
37	Spain	13	887	Various	PF	-.15	Aluja-Fabregat et al., 2000
38	Spain	23	6,879	Various	CV	.08	Colom et al., 2000
39	Spain	23	3,596	Various	CV	.05	Colom et al., 2000
40	Spain	16–94	1,369	WAIS-III	CV	.16	Colom et al., 2002
41	Spain	16–34	588	WAIS-III	MGCMSA	.03	Dolan et al., 2006

42	Various	Child	16,943	Wechslers	MA	.11	Lynn & Irwing, 2008
43	Various	Adult	13,659	Wechslers	MA	.47	Lynn & Irwing, 2008
44	UK	22	4,751	Pathfinder	PC	0.31	Malanchini et al., 2021

A description of the tests is given in the Appendix.

CV: correlated vectors; HFA: hierarchical factor analysis; HOFA: hierarchical oblique factor analysis (Schmid-Leiman transformation); PA: principal axis; PC: principal components; MIMIC: multiple indicator-multiple cause; MGCFA: multi-group confirmatory factor model with mean structures; MG-CMSA: multi group-covariance and mean structures analysis; CFS: confirmatory factor analysis; MA: meta-analysis.

Chapter 9

The Evolution of Sex Differences in Intelligence

In previous chapters, the developmental theory of sex difference in intelligence has been established showing that in infants aged between 1 and 4 years, girls have higher average intelligence than boys, between the ages of 6 and 15 years there is virtually no difference in intelligence between males and females, while at the age of 16 years males begin to have higher average intelligence than females increasing an advantage of 4 IQ points in adults. In this chapter we consider the likely evolutionary explanation of these sex differences.

The explanation of the higher intelligence of girls than of boys in infancy is that girls mature earlier than boys, as shown by Lenroot, Gogtay, Greenstein et al. (2007) in a longitudinal investigation of sex differences in brain development using magnetic resonance imaging (MRI) of 387 subjects aged 3 to 27 years, showing that cerebral volume peaked at age 10.5 in females and 14.5 in males. The likely evolutionary explanation of earlier maturation of girls is that it is advantageous for them to begin reproducing in early puberty when they are sufficiently mature to have babies and look after them. Between the ages of 6 and 15 years, the greater brain size of boys compensates for their later maturation resulting in virtually no difference in average intelligence between males and females during these ages.

The likely evolutionary explanation of the higher intelligence of males from the age of 16 years is that in all mammalian group-living species, males compete for territory or high status in dominance hierarchies to secure access to females and reproduction as documented in detail by Wynne-Edwards (1962) and Wilson (1975). During the evolution of the hominids, greater intelligence would have contributed to success in this male competition by enabling males with greater intelligence to form useful alliances, display leadership qualities in hunting and warfare, and to dominate other males with lesser intelligence. The continued maturation and increasing intelligence of males in later adolescence and into adulthood from the age of 16 years would have enabled males to acquire the experience and skills required to work their way up the dominance hierarchies and obtain sufficient status to secure access to females. In contrast, females do not need to acquire these skills. The advantage of intelligence is present in contemporary societies where it is a significant determinant of rank indexed by socio-economic status as documented in the United States by Jencks (1972), who showed they are correlated at 0.46, and in Britain by Nettle (2003) and Saunders (2012, 2019).

A further probable evolutionary explanation for the higher average intelligence of men than of women lies in sexual selection, the process by which females tend to favour males with high intelligence and accept them as mates because they consider them likely to be good providers for themselves and their children. This theory was first advanced and described as sexual selection by Charles Darwin (1871) to explain why in most species males are bigger and stronger than females. Darwin argued that males have to compete with each other for mates, and females tend to accept those who are bigger and stronger and, in humans, more intelligent, with the result that "man has ultimately become superior to woman". This thesis has been elaborated by Geoffrey Miller (2000) who writes: "Male nightingales sing more and male peacocks display more impressive visual ornaments. Male humans sing more and talk more in public gatherings, and produce more paintings and architecture... Men write more books. Men give more lectures. Men ask more questions after lectures. Men dominate mixed-sex committee discussions". He argues that these are strategies successfully used by intelligent males to attract females.

The higher average intelligence of males than of females is greater in Europeans than in sub-Saharan Africans. This was shown by Jensen & Johnson (1994) who reported that among 7-year-old whites boys had a 1.1 higher WISC IQ than girls, but among blacks girls had a 0.6 higher IQ than boys. This difference was confirmed by Meisenberg (2009) who reported that among 20- and 21-year-olds the white male advantage was .356*d* but the black male advantage was only .10*d*. The difference was further confirmed by Nyborg (2015) who reported a female advantage of .30*d* on g in black 16–17 year-olds and a male advantage of .24*d* in whites. The same difference was reported for mathematical problem-solving ability, given as

.23*d* for blacks and .41*d* for whites in the meta-analysis by Hyde, Fennema & Lamon (1990). Consistent with these results, Rushton (1992) reported that the male-female difference in brain size is greater in whites than in blacks. He reported that for enlisted military personnel the male-female difference in brain size was 204 cc. in whites and 189 cc. in blacks and for officers it was 210 cc. in whites and 197 cc. in blacks.

The likely evolutionary explanation for the greater advantage of males over females in intelligence in Europeans than in sub-Saharan Africans is that in the tropical and sub-tropical evolutionary environment of sub-Saharan Africa, black males had only a weak need for greater intelligence than females because plant and insect foods were available throughout the year and females could collect these for themselves and their children without the support of males. The effect of this was that males were only under weak selection pressure to evolve the higher intelligence required to hunt for animal foods. When early humans migrated into Europe, they found that plant and insect foods were not available in the winter and spring and males had to hunt large animals to obtain food for themselves and their females and children. Hunting large animals is more cognitively demanding than gathering plant and insect foods, so European males came under selection pressure to evolve higher intelligence than females. In confirmation of this explanation, it has been shown by Humphreys, Lin & Fleishman (1976) that white males have significantly greater hunting ability than have white females, compared with that of black males and females.

If this theory is correct, the male intelligence advantage should be greater in North East Asians than in Europeans because North East Asians experienced a harsher and more cognitively demanding environment. This expectation is confirmed by the sex differences in the Wechsler Full IQs in the 45 adult samples given in Tables 5.4 and 5.5. Eight of these samples were North East Asians (four from China, two from Taiwan, one from Japan and one from South Korea) in whom the median male advantage was .31*d*. The other thirty-seven were Europeans in whom the median male advantage was .21*d*.

Chapter 10

Specific Abilities: Male Advantages

Hitherto, intelligence has been considered as a single entity and sex differences have been reviewed as assessed by the Progressive Matrices (Chapter 4), the Wechslers (Chapter 5), other intelligence tests (Chapter 6), reaction times (Chapter 7) and Spearman's g (Chapter 8). In Chapter 9 we considered the evolution of sex differences in intelligence. In this chapter we summarise the male advantages in specific abilities and in the next chapter we summarise the female advantages in specific abilities. In these chapters we also consider the possible evolutionary explanations of the sex differences in the specific abilities.

10a. Abstract (non-verbal) Reasoning

Sex differences in abstract (non-verbal) reasoning vary with age, generally showing little difference among primary school children and young adolescents and a male advantage beginning at about the age of 16 years and increasing into adulthood. This age trend is shown in Table 2.1 for the DAT (Differential Aptitude Test) for which there were little sex differences in 14-year-olds (zero in the US, .06*d* in the UK and .14*d* in Spain) and an increasing male advantage up to age 18 to .16*d* in the US, .25*d* in the UK and .36*d* in Spain. It was shown in Chapter 4 (Table 4.1) that these age differences are also present in the Progressive Matrices, in which there is virtually no difference from the age of 6 through 14 years but that males obtain higher means from the age of 16 through to adults reaching an advantage of .29*d*, equivalent to 4.35 IQ points. The likely evolutionary explanation of these sex differences are the same as those for intelligence discussed in Chapter 9.

10b. Verbal Reasoning

Sex differences in verbal reasoning generally show no sex difference among primary school children and young adolescents and a male advantage beginning at about the age of 16 years and increasing into adulthood. Sex differences in verbal reasoning are available in the Similarities and Comprehension subtests in the Wechsler tests. The Similarities subtest poses questions like “In what way are work and play alike?” and “In what way are an enemy and a friend alike?” The test measures verbal reasoning assessed as the ability to understand analogies. The Comprehension subtest of the Wechslers poses questions like “If you were lost in a forest in the daytime, how would you go about finding your way out?” and “What does the saying *Still waters run deep* mean?*”* The test measures verbal reasoning assessed as the ability to understand verbal problems and proverbs.

Studies of the sex differences in these of 4- to 6-year-olds in the WPPSI and WPPSI-R are summarized in Table 10.1, showing that girls obtained a higher median score on Similarities (.12*d*) but boys obtained a higher median score on Comprehension (.03*d*). The average of these is a small female advantage of .075*d*, suggesting that girls have a slightly higher ability than boys at the age of 5.5 years.

Table 10.1. Sex differences in the Similarities (Si) and Comprehension (Co) subtests of the WPPSI and WPPSI-R; *d*s; positive signs denote males score higher.

Country	**Test: N**	**Si**	**Co**	**Reference**
Canada	WPPSI: 109	.08	.01	Miller & Vernon, 1996
China	WPPSI: 1331	-.11	-.09	Liu & Lynn, 2011
England	WPPSI: 60	.09	.30	Brittain, 1969
England	WPPSI: 150	1	.06	Yule et al, 1969
Japan	WPPSI: 599	-.02	.03	Hattori, 2000
Taiwan	WPPSI-R: 900	-.14	-.14	Chen & Lynn, 2021a

Taiwan	WPPSI-R: 924	.04	.21	Chen & Lynn, 2021b
USA	WPPSI: 1199	-.10	.01	Kaiser & Reynolds, 1985
Median	-	-.12	.03	

Sex differences in the Similarities and Comprehension subtests in the Wechsler tests are available for 6- to 16-year-olds in the WISCs (Wechsler Intelligence Scale for Children) and are summarized in Table 10.2, showing that boys obtained a higher median score on both Similarities (.07*d*) and on Comprehension (.05*d*), suggesting that there is a small male advantage at the age of 6 to 16 years.

Table 10.2. Sex differences in the Similarities (Si) and Comprehension (Co) subtests in the WISCs; *d*s; positive signs denote males score higher.

Country	**Test: N**	**Si**	**Co**	**Reference**
Bahrain	WISC-III: 1018	-.28	-.03	Bakhiet & Lynn, 2015
Belgium	WISC-R: 761	-.05	.07	Van der Sluis et al., 2008
China	WISC-R: 788	.01	.00	Liu & Lynn, 2015
Germany	WISC-IV: 1650	.16	.10	Goldbeck et al., 2010
Greece	WISC-R: 300	.17	.48	Alexopoulos, 1979
Israel	WISC-R: 1100	.03	.11	Cahan, 2005
Italy	WISC-IV: 2200	.10	.03	Pezzuti & Orsini, 2016
Libya	WISC-R: 870	-.16	-.02	Al-Shahomee et al., 2016
Mauritius	WISC-R: 1250	.13	-	Lynn, Raine et al., 2005
Netherlands	WISC-R: 2027	.08	-	Born & Lynn, 1994
Netherlands	WISC-R: 737	.05	.17	Van der Sluis et al., 2008
N. Zealand	WISC-R: 897	-.06	-	Lynn et al., 2005
Scotland	WISC: 437	.03	.13	Scottish Council, 1967
Scotland	WISC-R: 1400	.08	-	Lynn & Mulhern, 1991

Sudan	WISC-III: 1214	.07	.09	Bakhiet et al., 2017
Taiwan	WISC-III: 1100	.00	.07	Chen et al., 2016
Taiwan	WISC-IV: 968	.04	-.05	Chen & Lynn, 2020a
Taiwan	WISC-V: 1034	.06	-.01	Chen & Lynn, 2020b
USA	WISC-R: 2200	.07	.09	Jensen & Reynolds, 1983
USA	WISC-III: 2000	.09	.03	Wechsler, 1992
USA	WISC-III: 2200	.10	.03	Psychological Corp, 2006
Median		.07	.05	

Sex differences in the Similarities and Comprehension subtests in the Wechsler tests are also available for adults in the WAISs (Wechsler Adult Intelligence Scale) and are summarized in Table 10.3, showing that males obtained higher median scores than females on both Similarities (.08*d*) and on Comprehension (.16*d*), showing that there is a male advantage in adults.

Table 10.3. Sex differences in the Similarities (Si) and Comprehension (Co) subtests in the WAISs; *d*s; positive signs denote males score higher.

Country	**Test: N**	**Si**	**Co**	**Reference**
Chile	WAIS IV: 887	.01	.02	Diaz & Lynn, 2016
China	WAIS-R: 1406	.08	.19	Dai et al., 1991
China	WAIS IV: 311	.27	.48	Gao et al., 2015
Germany	WAIS-1V: 1425	.06	.02	Daseking et al., 2017
Italy	WAIS-R: 1168	.15	.27	Tommasi et al., 2015
Japan	WAIS-R: 1402	.09	.22	Hattori & Lynn, 1997
Russia	WAIS: 1800	.08	-.14	Grigoriev et al, 2016
Scotland	WAIS-R: 200	.23	.35	Lynn, 1998
South Korea	WAIS IV: 1228	.26	-	Lynn & Hur, 2016
Spain	WAIS-III: 1369	.11	.16	Colom et al., 2002

Taiwan	WAIS IV: 1105	.31	.35	Chen & Lynn, 2018
USA	WAIS-III: 2450	.09	.28	Irwing, 2012
USA	WAIS: 1700	-.02	.11	Matarazzo, 1972
USA	WAIS: 100	-.04	.15	Shaw, 1965
USA	WAIS-R: 206	.08	.17	Ilai & Willerman, 1989
USA	WAIS-R: 1880	.01	.09	Kaufman et al., 1988
USA	WAIS-IV: 2200	.11	.14	Piffer, 2016
Median		.08	.16	..

These results for sex differences in the Similarities and Comprehension subtests in the Wechsler tests given in Tables 10.1, 10.2 and 10.3 show a small female advantage among 4 to 6 on Similarities (.12*d)* and virtually no sex difference on Comprehension (.03*d*), a small male advantage among 6- to 16-year-olds on Similarities (.07*d*) and Comprehension (.05*d*) and a larger male advantage in adults on Similarities (.08*d)* and Comprehension (.16*d*). These results provide further support for the developmental theory.

More studies of sex differences in verbal reasoning in ages 12 through to adults showing that there is little difference among young adolescents and a small male advantage from the age of 16 years are given in Table 10.4. Row 1 shows negligible differences in the American standardisation sample of the DAT (Differential Aptitude Test) in 14- through 17-year-olds and a marginally higher male score of .07*d* in 18-year-olds. Row 2 shows a marginally higher male verbal reasoning ability of .047*d* in a sample of Norwegian adults on the Dureman-Salde test. Row 3 shows a male advantage in 14-year-olds of .15*d* increasing to an advantage of .25*d* in 18-year-olds in the British standardisation sample of the DAT. Row 4 shows that males obtained a higher verbal reasoning score of .17*d* in a Spanish sample of applicants to a Spanish university (n=3596, age 23). Row 5 shows a marginally higher male advantage of .06*d* in a study of verbal inductive reasoning in 4,850 American adults aged 25 to 81 (Schaie, 2005, p. 102). Row 6 shows that in the verbal reasoning test in the CogAT in an American sample, girls scored higher than boys at the ages of 9 through 15 but boys scored higher than girls at .12*d* at the age of 17. Row 7 shows a fractionally higher score of .06*d* by males than by females on the verbal SAT in the United States over the years 1972–2016 (Murray 2020, p. 48).

Table 10.4. Studies of sex differences in verbal reasoning (*d*s, positive signs denote higher scores in males)

	Country	12	13	14	15	16	17	18	Adults	Reference
1	USA	-	-	.01	-.03	.02	.02	.07	-	Bennett et al., 1974
2	Norway	-	-	-	-	-	-	-	.05	Nystrom, 1983
3	UK	-	-	.15	.04	.10	.28	.25	-	Lynn, 1992
4	Spain	-	-	-	-	-	-	-	.17	Colom et al., 2000
5	USA	-	-	-	-	-	-	-	.06	Schaie, 2005
6	USA	-.05	-.03	-	-.05	-	.12	-	-	Lakin, 2013
7	USA	-	-	-	-	-	-	-	.06	Murray, 2020
-	Median	-.05	-.03	.08	.01	.06	.12	.16	.06	-

Sex differences in verbal reasoning are also given in Hyde & Linn’s (1988) meta-analysis in which there is a male advantage of .16*d.* All these studies therefore give a small male advantage in verbal reasoning ability in adolescents from the age of 14 years. A related ability is the latent comprehension–knowledge (Gc) factor in the Woodcock–Johnson Tests of Cognitive Abilities III, in which there was a small male advantage of .07*d* in a sample of 6- through 59-year-olds (n=6970) reported by Keith, Reynolds, Patel & Ridley (2008). The likely evolutionary explanation of the greater verbal reasoning ability of males is the same as those for abstract reasoning ability discussed above.

10c. Numerical and Mathematical Ability

Sex differences in numerical and mathematical ability are similar to those in abstract and verbal reasoning in generally showing either no difference or a female advantage among primary school children and young adolescents and a male advantage beginning in mid-adolescence and increasing into adulthood. Moore & Smith (1987) reported sex differences in mathematics achievement of 11,914 American black, Hispanic and white 15- to 22-year-olds in which females obtained higher scores than males among 15-year-olds but males obtained higher scores than females at later ages. Similar age differences were given by Hyde, Fennema & Lamon (1990) in a meta-analysis of sex differences in numerical and mathematical ability in the United States that concluded there is a female advantage of .21*d* among 9–10 year-olds. This has been confirmed for 10-year-olds in Jordan by Al-Bursan, Kirkegaard, Fuerst, Bakhiet et al. (2018). At this age, numerical and mathematical ability is largely arithmetic. Contrary to these results, Loesche (2019) has reported a male advantage in arithmetical ability of .17*d* for “numbers and operations” and .22*d* for “patterns and structures” in a large sample of 149,465 German 9-year-olds.

Numerous studies have shown that from mid-adolescence into adulthood, males have an advantage in numerical and mathematical ability, including algebra and geometry, and that this advantage increases with age. In the United States, males have greater mathematical problem-solving ability given as .29*d* among high school students and .32*d* among college students in the meta-analysis by Hyde, Fennema & Lamon (1990). This result was confirmed by Hedges & Newell (1995) in a summary of six representative American adolescent samples in which there was a male advantage of .26*d*.

In the British standardisation sample of the DAT (Differential Aptitude Test), there was a male advantage in numerical ability in 14-year-olds of .24*d* that increased to .54*d* in 18-year-olds (Lynn, 1992). In a Spanish sample, a male advantage in 12-year-olds of .19*d* increased to .52*d* in 18-year-olds (Arribas-Agula et al., 2019). A study of 15-year-olds in Germany by Brunner, Krauss & Kunter (2008) confirmed that boys obtained higher average scores than girls in mathematics. They showed that boys had no advantage in *g* and that their advantage was attributable to a specific mathematical ability on which boys scored higher than girls by .94*d*. A study of mathematics in 15-year-olds in 41 countries assessed by PISA in 2004 provided further confirmation that in adolescence boys obtain higher average scores than girls in mathematics by .11*d* (Else-Quest, Hyde & Linn, 2010). In the PISA 2015 study of mathematics in 15-year-olds in 67 countries, there was a male advantage of .05*d* (Murray, 2020, p. 58).

A meta-analysis by Lindberg, Hyde, Petersen & Linn (2010) confirmed that there is no sex difference in math until high school, when boys obtained higher average scores than girls by .23*d* and had more variance at 1.07. Remarkably, these four ladies concluded that their results "provide strong evidence of gender similarity in mathematics performance".

A meta-analysis of the American NAEP (National Assessment of Educational Progress) mathematics test from 1990 to 2011 found male advantages of .07*d*, .04*d* and .10*d* at grades 4, 8 and 12, respectively (Reilly, Newmann & Andrews, 2015), for 2015 male advantages were .07*d*, .00*d* and .08*d* at grades 4, 8 and 12, respectively (Murray, 2020, p. 383) and for 2017 male advantages were .06*d*, .03*d* and .09*d* at grades 4, 8 and 12, respectively (Murray, 2020, p. 49).

A male advantage in mathematics of .10*d* in 13-year-olds in 19 sub-Saharan African countries has been reported by Dickerson, McIntosh & Valente (2015). This has been confirmed in a sample of 5,389 Nigerian public school students aged 11 to 19 years, in which there was a slight male superiority in mathematics of .06*d* (Lynn & Hur, 2021).

The male advantage in mathematics in normal populations entails substantially more males than females among the gifted. This has been shown by Benbow (1988) in a study of gifted 12- to 14-year-olds who took the SAT-Math. The male:female ratios were 2:1 for those with scores of at least 500, 4:1 for those with scores of at least 600, and 13:1 for those with scores of at least 700. These results have been confirmed by Wai, Hodges & Makel (2018), who have shown that in 2,053,265 academically talented students in the United States and 7,119 academically talented students in India who were in the top 5% of cognitive ability, males performed better than females in math.

These studies showing increasing male advantages in mathematics with age during adolescence are similar to those in abstract and verbal reasoning shown above in sections 10a and 10b and to the male advantage in non-verbal reasoning ability in the Progressive Matrices among general population samples of adults of *.29d* given in Table 4.3. The likely explanation for this increasing male advantage with age is that mathematics ability is largely a function of abstract and verbal reasoning ability and of spatial visualisation shown in numerous studies summarised and confirmed by Hawes, Caswell, Moss & Ansari (2018) and of a specific mathematical ability shown by Brunner, Krauss & Kunter (2008).

There have been some claims advanced by Ceci & Williams (2007) and by Miller & Halpern (2014) that the male advantage in mathematics has declined in recent years with an improvement in gender equality. This claim has been supported by Wai, Cacchio, Putallaz & Makel (2010) who show that in the early 1980s the sex ratio among those scoring at the 0.01% (top 1 in 10,000) favored boys by 13.5 to 1. By the mid-1990s, it had shrunk to 3.83 to 1 but it does not appear to have shrunk further since then. Wai et al. (2010) published the male-to-female SAT-M ratios from 1981 to 2010 and showed that they shrank from 2.61 to 1.54 among the top 1%. Thus, although males still predominated at the right tail in 2010, their dominance has been greatly reduced, suggesting the operation of environmental factors in addition to probable biological ones. Murray (2020, p. 50) has also reported a decline in the United States in the male advantage among gifted 12th graders on the Math SAT from .38*d* in 1977 to .25*d* in 2016.

Ceci (2018) has confirmed that the under-representation of women in eight mathematically intensive fields has narrowed over the past two decades. He reviewed evidence concerning sex differences in mathematical and spatial aptitude, biases in hiring, funding, publishing, remuneration, and promotion and concluded that the most important causes of under-representation appear to occur before women matriculate in college and are concerned with ability-related beliefs, stereotypes and preferences starting in early elementary school, which by the end of high school have reduced the size of the potential pool. By the time women reach graduate school, there is evidence that they are as successful as their male counterparts in being interviewed and hired for tenure-track positions, funded, and published. However, contrary to these results for the United States, Tao &

Michalopoulos (2018) have examined five waves of country-level PISA data for mathematics for 15-year-olds and concluded that there has been no reduction in the lower average scores obtained by girls in recent years.

10d. Mental Arithmetic

Mental arithmetic is measured in the Wechslers and a male advantage in this has been shown by Lynn & Irwing (2008) in a summary of 13 studies of children aged 4 to 16 in which the male advantage was .11*d* and 11 studies of adults with a male advantage of .47*d*. They argue that the higher male ability is largely a function of their higher general intelligence which increases with age. They argue that the arithmetic subtest assesses mental arithmetic which depends on working memory capacity, i.e., the ability to hold information in short-term memory while attending to another problem, that this is a measure of *g*, and that the higher score obtained by males is attributable to their higher *g*, which is estimated at .20*d* by Irwing (2012). The likely evolutionary explanation of the male advantage is the same as that for the male advantage g given in Chapter 8.

10e. Written Arithmetic

There is conflicting evidence on sex differences in written arithmetic which does not require working memory ability. In Hyde & Linn's (1988) meta-analysis, there was a negligible male advantage in arithmetic of .02*d* but Loesche (2019) reported a significant male advantage in written arithmetic assessed by "numbers and operations" (17*d*) and "patterns and structures" (.22*d*) in a large sample of 149,465 German 9-year-olds.

10f. Spatial Abilities

It has long been established that there is a large male advantage in spatial abilities. In a review of early studies, Tyler (1965, p. 144) concluded that "in spatial relationships, a consistent male superiority has been demonstrated". A subsequent meta-analysis of sex differences in spatial abilities by Linn and Petersen (1985) concluded that there are three spatial abilities and that the male advantage is largest in mental rotation, followed by spatial perception and smallest in visualisation and the average of the three abilities is .50*d* (7.5 IQ points). These male advantages have been confirmed in a later meta-analysis by Voyer, Voyer & Bryden (1995) who give the male advantage as largest in mental rotation (.66*d*) and smallest in visualisation (.23*d*), averaging .445*d*. These male advantages have been further confirmed for 40 countries by Silverman, Choi & Peters (2007) and more recently for Oman and Germany by Jansen, Zayed & Osmann (2016). In a recent review, Ceci (2018) writes: "The typical finding is that males are superior at 3D mental rotation, and the effect size is usually large (0.8). Systematic sex differences in other forms of spatial ability such as 2D rotation are not usually found, and sometimes female superiority is reported, for instance, women usually excel on tasks measuring spatial memory". However, this conclusion is not supported in a more recent meta-analysis by Archer (2019) who gives the male advantage as largest in mental rotation (.66*d*) followed by visualisation (.48*d*) and spatial visualisation (.23*d*) averaging .46*d*.

An effect of the male advantage in spatial ability reviewed by Bond (2020) is that men have better navigational abilities than do females, expressed in the ability to locate their position on a map and working out their position and orientation relative to boundaries and edges.

Some studies have reported that the male superiority in spatial ability is present in infants and young children. Moore & Johnson (2011) have reported that male superiority in mental rotation is present in 3-month-old infants. Several studies have found that the male advantage in spatial ability is present from the age of 6 years, e.g., Buczylowska, Ronniger, Melzer & Petermann (2019) in Germany and the Netherlands. This advantage increases with age as shown in the British standardisation sample of the DAT in which a male advantage of .19*d* in 14-year-olds increased to an advantage of .39*d* in 18-year-olds (Lynn, 1992). The increase in the male advantage with age from 9 to 23 years has been confirmed on a mental rotation task in a German sample by Geiser, Lehmann & Eid (2008).

Knickmeyer & Baron-Cohen (2006) have reported an association between prenatal testosterone and later spatial ability and concluded that the male superiority in spatial ability is attributable to male hormones. This hypothesis has been supported by Vuoksimaa et al. (2010) in a study of female twins with male co-twins. The female twins who were exposed to male hormones prenatally had greater spatial ability than those whose co-twin was female, indicating that the male hormone is responsible for their subsequent superior spatial ability.

In a review of all this evidence, Ceci (2018) writes that the meta-analyses make clear that sex differences in mental rotation are observed everywhere, usually with a large effect size and that "the debate is over the role of the environment in producing or exacerbating them, with some favouring a biological essentialist argument and others favouring the argument that the environment could be instrumental in producing or exaggerating these sex differences as, for example, when preschool boys are exposed to Lincoln Logs, erector sets, and LEGOs more than girls". There is also some suggestive evidence that sex differences are malleable given by Miller & Halpern (2014), although given the short-term nature of most of interventions (e.g., a 6-week exposure to playing dynamic video games), it is unsurprising that the sex gap has not been completely closed. As an example of a cultural factor that may influence spatial performance, some spatial tasks show a male advantage when they are framed as geometry problems but a female advantage when the same task is framed as an art problem. Huguet & Regner (2009) presented an abstract drawing to middle school students for 90 seconds and gave them 5 minutes to reproduce it from memory. The data formed a cross-over interaction, with females excelling when the drawing was portrayed as art and males excelling when it was portrayed as geometry.

It has frequently been proposed that the evolutionary explanation of the greater spatial abilities of males is that during the evolutionary environment hominids were hunter-gatherers in which males specialized in hunting animals and females specialized in gathering plant foods. This was shown in a study of 224 tribal societies by Murdock (1937). Hunting large animals required spatial abilities to enable males to throw stones and spears accurately at which males are better than females (Watson & Kimura, 1991), to plan and execute group-hunting strategies, such as driving potential prey into the loops of rivers which they had to swim across and could then be clubbed as they scrambled up the opposite bank, and to make weapons such as spears and bows and arrows with which to kill prey. Females had less need for spatial abilities because they specialized in gathering plant foods and so they did not evolve them so strongly (Lovejoy, 1981; Watson & Kimura, 1991; Geary, 1995, 1998; Buss, 1999; Silverman, Choi & Peters, 2007).

10g. Mechanical Reasoning Ability

The greater mechanical reasoning ability of males than of females in the United States assessed by the DAT (Differential Aptitude Test) was .89*d* for 14–18 year-olds (Lupkowski, 1987), .97*d* for 18-year-olds (Lynn, 1992), .83*d* for 15-year-olds in Project Talent and .72*d* for 18-year-olds in the NLSY by Hedges & Nowell (1995). The greater mechanical reasoning ability of males has also been reported as .815*d* for 17–18 year-olds in Spain (Colom & Lynn, 2004) and as .98*d* in a meta-analysis by Archer (2019). There is an age difference in mechanical reasoning ability in the British standardisation sample of the DAT in which a male advantage in 14-year-olds of .66*d* increased to an advantage of .97*d* in 18-year-olds (Lynn, 1992) and in a Spanish sample in which the male advantage increased from .42*d* in 12-year-olds to .67*d* in 18-year-olds (Arribas-Agula et al., 2019).

The increasing advantage of boys in mechanical reasoning ability during adolescence shown in the British and Spanish samples is similar to that in abstract and verbal reasoning given in Tables 10.1 to 10.4 and to that in spatial ability and is probably attributable to these being largely responsible for the higher male mechanical reasoning ability. In addition, Baron-Cohen's study (2003) has proposed that males are genetically predisposed to learn about objects and their mechanical interactions, whereas females are predisposed to learn about people and their emotional interactions.

The likely evolutionary explanation of the greater male advantage is that mechanical reasoning ability is required for making the tools and weapons that are needed for the male specialisation of hunting large animals and dismembering them after they had been killed. This would have required the highly skilled ability of striking flints to produce sharp cutting tools able to cut through the ligaments of large animals and cut them into pieces that could be carried back to camps to feed females and children.

10h. General Knowledge

Age differences in sex differences in general knowledge are available in the Information subtest of the Wechsler tests. In 8 studies of the WPPSI for 4- to 6-year-olds, there is a small median male advantage of .08*d*, given in Table 5.1. In 17 studies of the WISCs for 6 to 16 year-olds, males obtained a higher median score than females of .30*d*, given in Table 5.6. In 23 studies of the WAIS, males obtained a higher median score than females of .44*d*, given in Table 5.4. Lynn & Irwing (2002) show that this male advantage is not attributable to a bias in favour of males on these tests.

A large male advantage in adults in general knowledge of .68*d* is reported by Ackerman, Bowen, Beier & Kanfer (2001). This has been confirmed at .51*d* by Lynn, Irwing & Cammock (2002) in a study that identified 19 domains of general knowledge, six first order factors and one second order general factor. It was found that males obtained significantly higher means than females on the second order general factor of .51*d* and on four of the six first order factors identified as information about Current Affairs, Physical Health and Recreation, Arts and Science. Females obtained a significantly higher mean than males on the first order factor identified as Family. There was no sex difference on the remaining first order factor identified as Fashion.

Further studies showing a male advantage in general knowledge have been reported, including at .51*d* by Lynn, Irwing & Cammock (2002), Lynn, Wilberg & Margraf-Stiksrud (2004), Zarevski, Ivanec, Zarevski & Lynn (2007), Tran, Hofer & Voracek (2014) and Steinmayr, Bergold, Margraf-Stiksrud & Freund (2015). A male advantage in 15-year-olds in general historical knowledge in 26 nations has been reported by Wilberg & Lynn (1999). A likely evolutionary explanation of the male advantage in general knowledge is that much of general knowledge is concerned with activities of and conflicts between men, e.g., in history, the arts and politics, and males have more interest in these and hence more knowledge of them.

10i. Throwing Accuracy

Many studies have shown that men have better throwing accuracy at both stationary and moving targets than that of women (Watson & Kimura, 1991; Hall & Kimura, 1995; Watson & Kimura, 1989). This male advantage is also present in 4-year-old boys (Moreno-Briseño, Díaz, Campos-Romo & Fernandez-Ruiz, 2010) who show that the male advantage is independent of the greater male spatial ability. The likely evolutionary explanation of the male advantage is that the ability to throw stones and spears accurately was needed to hunt animals during the evolutionary environment when males specialized in hunting and females specialized in gathering plant foods for which throwing accuracy was not required.

Chapter 11

Specific Abilities: Female Advantages

11a. Verbal Ability

Females have higher average verbal ability than males in school students reported at .29*d* in a meta-analysis of American studies of more than 10 million students in grades 3 through 11, in which the female advantage increased in a linear pattern from grades 3 to 8 and then remained steady in high school (Petersen, 2018). The female advantage is also present in grammar and punctuation assessed in the Language Usage Test in the 14 to 18 year-old adolescent standardisation samples of the DAT (Differential Aptitude Test) of .43*d* in the United States, of .20*d* in 14-year-olds in Britain and .35*d* in 18-year-olds (Lynn, 1992). In a review of 24 large data sets (including several large representative samples of US students, working adults, and military personnel), Willingham & Cole (1997) reported that girls performed better than boys in the elementary school grades in language usage at fourth grade ($d > 0.2$) and at the end of high school, females performed better than males in language usage (*d* between 0.4 and 0.5). However, in adults, males have higher verbal ability than females at .25*d* assessed as the median of 42 studies of the WAIS verbal IQ, as given in Table 5.4 and consistent with the developmental theory.

11b. Verbal Fluency

Verbal fluency is the ability to produce a larger number of words in a given category (e.g., birds, dogs, etc.) in a short period of time. Kimura (1999) and Hyde (2014) have shown that females have higher verbal fluency than that of males. This female advantage has been confirmed by Colom, Juan-Espinoza, Abad & Garcia (2000) in a Spanish sample of applicants to a Spanish university (n=6879, age 23) in which females obtained a higher verbal fluency score of .15*d*; and further confirmed by Schaie (2005, p. 77) in a study of 4,850 American adults aged 25 to 81 in which females obtained a higher score than males of .17*d*, and again by Maylor, Reimers, Choi et al. (2007) who reported an adult female advantage of .18*d*. A recent longitudinal study of clinically normal adults found a female advantage in fluency tasks (e.g., name as many words as you can that begin with a selected letter or have a similar meaning to another word) and higher performance for males on some tests of visual-spatial abilities, with a steeper decline for men over time (McCarrey et al., 2016). However, higher verbal fluency in females has been confirmed by Kosmides, Vlahou, Panagiotaki & Kiosseoglou (2004) or by Waber, Skirrbek & Herlitz (2014), who have reported that in Northern Europe there is no sex difference and in Southern Europe males scored higher than females in verbal fluency. Despite the last two studies, most studies have reported a female advantage in verbal fluency. The likely evolutionary explanation for this is that women who produce a lot of words promote the acquisition of language in their children.

11c. Second Language Ability

Several studies have reported that females have higher average ability than males in second language ability. A female advantage of .17*d* has been reported among 13-year-olds in England (Burstall, Jamieson, Cohen & Hargreaves, 1974), of .64*d* among 12-year-olds in Ireland (Lynn & Wilson, 1993), .20*d* among 12-year-olds in Israel (Lewy & Chen, 1974), .27*d* among 12-year-olds in Sweden (Ljung, 1965), .19*d* among 14-year-olds in Lebanon (El Hassan, 2001), .50*d* among college students in the United States (Payne & Lynn, 2011) and of .32*d* as the median of 17 studies in a number of countries given by Lynn & Piffer (2011). In all these studies of school students who learned the second language at school, females did not perform better than males in first language ability, consistent with the results given in Chapter 9, showing that females are not better than males in verbal abilities.

The likely evolutionary explanation for the female advantage in second language ability is that normally in the great apes, including evolving hominids, females were exogamous. Thus, “[a]mong baboons, chimps and humans, males stay where they were born and females disperse” (Gamble, 1993, p. 115) and “[i]n the great apes, including humans, males tend to stay in their birth groups and females tend to reside in the birth group of their mate” (Geary, 1998, p. 296). These exchanges have the advantages that they strengthen alliances between neighbouring groups and reduce inbreeding and the numerous genetic disorders these cause, including an impairment of intelligence (Jensen, 1998).

When females joined a neighbouring group by exchange or capture, they would have had to integrate with their new group, and the better they integrated, the greater their chances of survival and that of their children. The neighbouring groups that females joined would sometimes have spoken a different language. For instance, in West Africa “[t]he tribes are traditionally at war with each other and speak mutually incomprehensible languages” (Dembrovitz, 1945, p. 70). And when the Caribs (the original inhabitants of the Caribbean) defeated neighbouring groups, “[t]hey used to kill the men of conquered peoples and take the women for wives, which resulted in the men and women speaking different languages” (Muller-Lyer, 1930, p. 120). When this occurred, the ability of females to acquire the new language would have facilitated acceptance by the new group. Humans are co-operating animals. Males typically hunt for meat and share it with females and children, and females help other females in a variety of tasks, such as child rearing, food sharing and caring for one another during illness. To benefit from these co-operative activities, females joining a new group would have evolved a stronger module (an innate ability designed for a specific purpose) for the acquisition of a foreign language. A female who joined a new group but was unable to acquire its language would have found it much more difficult to gain acceptance. Men, however, who remained in their own group would have had no need of the aptitude for the acquisition of a new language.

11d. Visual Memory and Memory for Object Location

Females have better average visual memory and memory for object location than that of males reported as .66*d* in a study by Eals & Silverman (1994) and confirmed at .58*d* by Barnfield (1999), at .33*d* by Maylor, Reimers, Choi et al. (2007) and at .31*d* in a meta-analysis by Archer (2019). The likely evolutionary explanation for this is that in the evolutionary environment, women specialized in foraging and gathering plant foods and this would have favored the development of accurate memory for their locations. In addition, Kimura (1999, p. 51) suggested that the female advantage may be attributable to their ability to detect small changes in the home environment because “[i]f a predator or vermin entered the home, noticing displacements of objects in domestic space could help in detection of the intruder, and so contribute to survival”.

11e. Spelling Ability

Females have higher average spelling ability than that of males of .50*d* in the American and of .24*d* in the British standardisation samples of adolescents on the DAT (Differential Aptitude Test) (Lynn, 1992). The female advantage in the British standardisation sample increased from .09*d* in 14-year-olds to .39*d* in 18-year-olds (Lynn, 1992). Arribas-Agula, Abad, & Colom (2019) reported data for a Spanish sample giving a female advantage in spelling ability in all ages from 12 (.19*d)* through 18 (.11*d)* with no significant age trend. The greater female spelling ability is likely attributable to the female advantage in visual memory that enables them better to visualize the shape of words and hence their spelling.

11f. Perceptual and Processing Speed

Females have higher average ability in perceptual and processing speed assessed in tasks requiring "the ability to make rapid comparisons among a number of designs (letters, numbers or pictures)" (Kimura, 1999, p. 87) and the rapid encoding of abstract symbols (Estes, 1974). The female advantage in perceptual speed is shown in the 9 studies in the WISC-III, WISC-IV and WISC-V, given in Table 5.3.The female advantage in processing speed is shown in the 12 studies in the WAIS-111 and WAIS-1V with a median advantage of .12*d*, given in Table 5.5. The female advantage in perceptual speed is shown in the Clerical Speed and Accuracy Test in 14 to 18 year-old adolescents in the standardisation sample of the DAT (Differential Aptitude Test) of .48*d* in the United States (Lynn, 1992). In the British standardisation sample of the DAT (Differential Aptitude Test), the female advantage increased from .19*d* in 14-year-olds to .54*d* in 18-year-olds (Lynn, 1992). The female advantage is also present in the latent processing speed (Gs) factor in the Woodcock–Johnson Tests of Cognitive Abilities (Keith, Reynolds, Patel & Ridley, 2008). Maitland et al. (2000) reported a study of sex differences in processing speed across the adult life span in three age categories of younger (22–49), middle-aged (50–63) and older (64–87). They found that women in the younger and middle-aged groups performed better than men in processing speed, and across all age groups, women performed better than men on verbal recall.

11g. Reading Ability and Comprehension

Females have higher ability than males in reading ability and comprehension in a number of studies summarized by Halpern (2012, pp. 123f) and confirmed in America’s National Assessment of Educational Progress (Reilly, Neumann & Andrews, 2018) and in a meta-analysis of American studies at .19*d* by Petersen (2018). Higher female reading ability of .18*d* has also been found in a large sample of 149,465 German 9-year-olds by Loesche (2019). An expression of this advantage is that females have a lower prevalence of dyslexia than that of males (Arnett, Pennington, Peterson et al., 2017). The female advantage is probably a function of the greater female verbal ability given in section 11a.

11h. Episodic Memory

Episodic memory consists of remembering past experiences such as what one did yesterday. A female advantage in most episodic memory tasks has been reported by Herlitz & Yonker (2002) and by Asperholm, Hogman, Rafi & Herlitz (2019) in a meta-analysis of 617 studies conducted between 1973 and 2013 with 1,233,921 participants. They reported a female advantage for more verbal tasks, such as words, sentences and prose, and for materials that cannot easily be placed along the verbal-spatial continuum, such as faces, odour, taste and colour, and a male advantage in more spatial tasks, such as abstract images. It has not proved possible to find studies on whether there are sex differences in episodic memory at different ages that would confirm or dis-confirm the developmental theory. The female advantage is likely attributable to the greater female verbal ability given in section 11a.

11i. Writing Ability

Females have higher writing ability than males in the United States in a review of the literature by Hedges & Nowell (1995) and confirmed by Willingham & Cole (1997) in a review of 24 large data sets (including several large representative samples of US students, working adults and military personnel) that concluded that girls performed better than boys in elementary school grades in writing and reading at fourth grade ($d > 0.2$), and by the end of high school, females performed better than males in writing (between .5 *d* and .6*d)*. The female advantage was confirmed by Reynolds, Schreiber, Havjovsky et al. (2015) and again in the National Assessment of Educational Progress with an effect advantage of .55*d* among 17–18 year-olds (Reilly, Neumann & Andrews, 2018) and in a meta-analysis of American studies at .45*d* by Petersen (2018). These studies show that the female advantage in writing ability increases with age. The female advantage is likely attributable to the greater female verbal ability given in section 11a.

11j. Fine Motor Skills

A female advantage in fine motor skills in infants involving hand-eye coordination has been reported by Nagy, Kompagne, Orvos et al. (2007) and at older ages by Halpern (2012, p. 109). Kimura (1999, p. 37) suggested that the female advantage may be due to their better control of their fingers and in the ability to coordinate several movements into a unit, which also contributes to their advantage in perceptual and processing speed. There is no apparent evolutionary explanation for this female advantage.

11k. Immediate Memory

Hedges & Newell (1995, Table 2) in their meta-analysis give a female advantage of .25*d*. However, immediate memory is measured by the digit span test in WISC and the WAIS tests and in these there is a negligible female advantage of .05*d* in the WISCs given in Table 5.4 and a negligible male advantage of .09*d* in the WAISs given in Table 5.6.

11l. Vocabulary

It was stated by Kimura (1999, p. 91) that "[w]hen speaking first begins, girls on average articulate earlier and better than boys, and produce longer sentences. To the extent that they speak earlier, they also have larger working vocabularies at very young ages". This contention is confirmed in studies reviewed in Chapter 3 that showed that in 4- or 5-year-olds, females have larger vocabularies than those of males. The majority of studies show that this female advantage ceases by the age of 6 years. This was confirmed by Lynn & Cheng (2021) in a study showing that girls obtained statistically significantly higher means on vocabulary at the ages of 3 and 5 years but not among 14-year-olds, as shown in Table 6.2.

The evidence on this was reviewed more than half a century ago by Tyler (1965, p. 144), who concluded that "[o]n vocabulary, the sex groups have turned out not to differ significantly". This conclusion has been confirmed in a number of subsequent studies. Hyde & Linn's (1988) meta-analysis of 40 American studies gave a negligible female advantage of .02*d*. Hedges & Newell (1995, Table 2) in a subsequent meta-analysis gave a negligible male advantage of .02*d*. Salthouse (2004) gave a negligible male advantage of .03*d*, derived as the average of 33 studies of samples aged from 19 to 95 years, and more recently Hyde (2014) gave a negligible female advantage of .02*d*. All four of these results are effectively zero. This was confirmed in the American General Social Survey (2019) which gives a zero sex difference in the knowledge of 10 words in Wordsum. There was no sex difference in vocabulary in the United Kingdom in the standardisation samples of the Mill Hill Vocabulary Scale (mean age 12.5 years, *d*=.0; Raven, 2008a) and in a further sample on the Mill Hill Vocabulary Scale (mean age 10.5 years, *d*=.0; Raven, 2008b).

There have been some contrary results. A study of a sample of 5,389 Nigerian public school students aged 11 to 19 years on the British Mill Hill Vocabulary Scale reported that females obtained a significantly higher score than males of .11*d* (Lynn & Hur, 2021). There have also been some studies that have reported larger vocabulary scores in males than in females. A large male advantage of .26*d* was reported on the norms (n=210) for adults aged 25 to 88 years on the Boston Naming Test (Tombaugh & Hubley, 1997). This test consists of 60 pictures of objects that have to be named in decreasing order of word frequency from “bed” to “abacus”. A small male advantage has been reported in Belgium on the Boston Naming Test (n=371, mean age 9 years, *d*=.08; Storms, Saerens & De Deyn, 2004) and in England in a sample on the Mill Hill Vocabulary Scale (n= 2000, mean age 9 years, *d*=.10; Dunstan & Roberts, 1955). In the vocabulary subtest of the Wechslers, males obtained negligibly higher median scores than females of .04*d* in the WPPSIs given in Table 5.1, of .01*d* in the WISCs given in Table 5.4, and of .09*d* given in Table 5.6. The sex differences reported in these studies are inconsistent and suggest that there is virtually no sex difference in vocabulary except in infants among whom girls have a larger average vocabulary than that of boys. There is no apparent evolutionary explanation for this female advantage in vocabulary in infants. It is likely an effect of the earlier maturation of girls.

11m. Social Cognition and Emotional Intelligence

Social cognition is the ability to understand what other people are thinking and is a designated theory of mind. A female advantage in social cognition assessed by the ability to decode non-verbal cues was reported by Hall (1978) and by the ability to identify emotions by Thompson & Voyer (2014). Social cognition is associated with emotional intelligence, on which a meta-analysis by Joseph & Newman (2010) reported a female advantage of .47*d*. There is no apparent evolutionary explanation for this female advantage.

Chapter 12

Conclusions

We have reached a number of conclusions in this study. First, contrary to the numerous scholars who have asserted that there is no sex difference in intelligence, cited in Chapter 1, we have shown that this is only true for children and young adolescents aged between 6 and 15 years. Chapter 2 summarises the alternative developmental theory of sex difference in intelligence, stating that in infants aged between 1 and 4 years, girls have higher average intelligence than boys, while from the age of 16 years, males begin to have higher average intelligence than females, reaching an advantage of 4 to 5 IQ points in adults. Chapter 3 presents the studies showing that in infants aged between 1 and 4 years, girls have higher average intelligence than boys. Chapter 4 presents the studies showing that from the age of 16 years, males begin to have higher average intelligence than females, reaching an advantage of 4.5 IQ points in adults assessed by the Progressive Matrices. Chapter 5 presents the studies showing that in adults, males have higher average intelligence than females of 4 IQ points in the Wechsler Tests. Chapter 6 presents the studies showing that in adults, males have higher average intelligence than females of 3.45 IQ points in other intelligence tests. Chapter 7 presents the studies showing males have faster reaction times than those of females. Chapter 8 presents the studies showing males have higher Spearman's *g* than that of females.

Chapter 9 discusses the evolution of the higher average intelligence of males. Chapter 10 discusses the evolution of a number of specific abilities on which males are higher than females. Chapter 11 discusses the evolution of a number of specific abilities on which females are higher than males.

The implications of the conclusion that males begin to have a higher average IQ than that of females at the age of 16 years and this advantage increases to 4 IQ points in adults have been spelled out by Helmuth Nyborg (2017): "It is no longer scientifically acceptable to write in general textbooks and specialized publications that there is a NULL sex difference in general intelligence" and he adds that males have a wider distribution of intelligence than that of females, producing about 20 females and 80 males with IQs of 145 and above. Taken together, he suggests that these two male advantages could explain, at least in part, why “males throughout history have tended to dominate in politics, warfare, chess, musical composition, mathematics, science, business, and other areas requiring intellectual brilliance”.

Appendix

Description of the Tests Given in Table 6.1:

AH4 and AH5. These tests consist of two parts designated verbal-numerical and diagrammatic (consisting of spatial and non-verbal reasoning). These are summed to give a total representing general intelligence (Heim, 1968).

BAS. British Ability Scales. Two verbal and two non-verbal tests that are summed to give a total representing general intelligence.

BPR5. Brazil Cognitive Reasoning Battery. The average of five reasoning tests.

CET. The Conditional Exclusion Test. This consists of tests of a number of mental abilities. The data shown are for the Abstraction and Mental Flexibility test.

CogAT. Cognitive Abilities Test. Tests of verbal, quantitative and non-verbal reasoning that are averaged to give a measure of general intelligence.

DAT. The Differential Ability Test. Eight tests of verbal, reasoning, spatial, memory and perceptual speed averaged to give an IQ. Keith et al. (2011) aggregate these from the American standardisation sample into four ability factors identified as visual memory (Gv), free recall memory (Glr), working memory (Gsm) and perceptual speed (Gs) and give the average of these as a male advantage of .12*d*.

DRTB. Differential Reasoning Tasks Test. A Portuguese test of general intelligence.

Dureman-Salde. A Norwegian test of verbal, reasoning and spatial abilities averaged to give general intelligence. Male advantages are .047*d*, .77*d* and .77*d*, respectively.

GAMA. General Ability Measure for Adults. A non-verbal test of general intelligence.

HCP. Human Connectome Project. A number of tests that are averaged to give an IQ.

IST. Intelligenz-Struktur-Test. A German test of general intelligence measuring a number of abilities that are averaged to give an IQ.

JAT. Junior Aptitude Test. A South African test of general intelligence.

KABC. Kaufman Intelligence Test. A test of a number of abilities that are averaged to give a mental processing composite.

KAIT. Kaufman Adult Intelligence Test. A test of a number of abilities that are averaged to give crystallized and fluid IQs.

KBIT. Kaufman Brief Intelligence Test. A short form of the KAIT.

MAB-11. Multidimensional Aptitude Test. Verbal and non-verbal tests that are averaged to give general intelligence.

NZ IQ Test. A New Zealand test of verbal, reasoning and spatial abilities averaged to give general intelligence.

Pathfinder. Verbal, reasoning and spatial abilities averaged to give general intelligence.

PMA. Primary Mental Abilities. A number of abilities that are averaged to give general intelligence.

RIT. A Portuguese test of general intelligence.

SAT. Scholastic Aptitude Test (Sweden), consists of verbal, reasoning and spatial abilities averaged to give general intelligence. Male advantages are .04*d*, .54*d* and .56*d*, respectively. Note the marginally higher male verbal ability and much higher male spatial ability confirming the Wechsler results.

SAT. Scholastic Aptitude Test (American). An American test of verbal and mathematical abilities taken for entry to university.

SB. Stanford-Binet. A test of general intelligence.

Test de QI. A French test of general intelligence administered over the internet.

Tiki-T. An Indonesian test of verbal, reasoning and spatial abilities that are averaged to give general intelligence. Male advantages are .11*d* (verbal), .15*d* (reasoning) and .29*d* (spatial). Note that the sex differences on the three abilities are similar to those in Western countries with the greatest male advantage in spatial ability and the least in verbal ability.

VNR. A test of verbal and numerical reasoning averaged to general intelligence.

WJ 111. The Woodcock-Johnson Test. A test of a number of abilities, including fluid IQ.

WMT. The Weiner Matrizen Test. A matrix reasoning test similar to the Progressive Matrices.

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