

Sex Differences in Intelligence: Reply to Comments

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Invitations to comment on the target paper IQ were sent to all those who were cited as asserting that there is no sex difference in intelligence, but few chose to do so. I thank all those who accepted the invitation and reply to their comments below.

David Becker and Heiner Rindermann have added results from studies in Germany and Brazil supporting my theory on cognitive sex differences and their development. They also show that there are associations between hormonal transitions during adolescence, especially in women, and increasing sex differences in cognitive abilities, particularly spatial ability, during adolescence. They suggest that these maturation-related changes are best explained from an evolutionary perspective, as cognitive and ecological specializations of the sexes, with the additional benefit of increasing group fitness due to differentiation of social gender roles. In addition, they argue that historical and cultural changes have first reduced male-favoring gender gaps in education and in many cases reversed them. Together with changes in the job market, this has affected sex differences in STEM-related abilities and modifies formerly stable sex differences.

Roberto Colom makes four principal points. First, he agrees that men obtain higher average scores on “intelligence in general” defined as the IQ obtained on the Wechsler and numerous other tests. Second, he argues that there is no sex difference in g as shown in his own study. Note, however, that he used the method of correlated vectors to assess sex differences in g , that there is considerable disagreement about whether this is an appropriate method for measuring g , and that Wicherts (2017, p. 35) provides an extensive critique of the method concluding that it is “deeply flawed”. Further, most studies have shown that there is a male advantage in g , as noted in the target article. I think this should be regarded as an open question until consensus on the correct method for measuring g been reached.

Third, he argues that the solution to the brain size-intelligence paradox is that

the greater average brain size of men is devoted to the computationally demanding task of visuo-spatial processing, on which men excel, and that the male advantage on the Progressive Matrices may be attributable to its visuo-spatial component. He is right that the Standard Progressive Matrices has a visuo-spatial component as shown by Lynn, Allik and Irwing (2004), but this is not the case for the Advanced Progressive Matrices which Waschl et al. (2016) have shown is unidimensional with no visuo-spatial component and yet males score higher on this. Furthermore, males obtained higher scores on abstract reasoning in the DAT, given in Table 1 of the target article, on which 18 year old males scored 2.4 IQ points higher in the US, 3.7 points higher in the UK, and 5.4 points higher in Spain, giving an average of 3.8 IQ points and very close to my estimated male advantage of 4 IQ points among adults. In addition, males also have large advantages on general knowledge and working memory.

Fourth, he summarizes his own neuroimaging studies confirming that men have larger brains but showing that this extra volume is associated with better scores on a highly demanding spatial test, not with *g*, and also supporting his greater female neural efficiency hypothesis stating that women have greater neural efficiency in requiring less neural material for achieving the same cognitive ability as men. These are important contributions to the debate on this issue and raise the interesting question of why women should have evolved greater neural efficiency than men. Note, however, that in his paper presenting the greater female neural efficiency hypothesis he writes that “the evidence regarding sex is largely confusing. Haier and Benbow (1995) failed to find positive evidence for the neural efficiency hypothesis” (Colom et al. 2013).

Edward Dutton has summarized the relevance to sex differences in achievement of Baron-Cohen’s concept of the ‘male brain’ with its higher “systemizing ability” consisting of the analysis of the variables in a system, working out its rules, and creating systems to make sense of novel situations, and the ‘female brain’ with its greater “empathizing ability” consisting of the identification of other people’s emotions and thoughts and working out the best way to respond to them so that they feel happy. He finds that the extreme male brain is high functioning autism and that this (when combined with the high IQ that is also more common in men) is associated with genius. The ‘male brain’ is partly determined by a high level of testosterone. It is independent of intelligence and thus makes an independent contribution to the greater numbers of men among high achievers.

Heitor Fernandes considers the implication of the developmental theory that there should be more men among high achievers by examining the numbers of men and women among top players in the cognitively demanding games of Poker,

Backgammon and Mahjong. He shows that men greatly outnumber women among the top players of the three games. His contribution provides further evidence that men have a higher average IQ than that of women, a greater standard deviation and/or are more competitive.

Mingrui Wang extends Fernandes' comment showing that there are more men than women among the top players in the cognitively demanding games of Poker, Backgammon and Mahjong by showing that this is also the case with the cognitively demanding and complex game of Go that is played in East Asian countries. He reports that men are 86.74 percent of top professional Go players and women are 13.26 per cent in China, Japan, Korea and Taiwan, and that in China men are 93.44 percent of the top dan rank 9 professional Go players and women are 6.56 per cent. His contribution provides further evidence that men have a higher average IQ than that of women, a greater standard deviation and are more competitive.

These contributions reporting that there are more men than women among the top players in cognitively demanding games were made with regard to Chess by Howard (2014), who noted that it has been shown that ability in Chess requires a high IQ citing Frydman and Lynn (1992) and confirmed by Burgoyne et al. (2016). Howard reported that in 2012 there were 1324 men and 26 women Chess grandmasters and over the years 1975 to 2014 there was a male advantage of about one standard deviation in the performance of the top 10 and top 50 of all international players. He concluded that higher male ability is the most plausible explanation for the greater number of men among top Chess players: "Males score higher on average in visuospatial abilities and many more males score at the upper IQ extreme" and that the male predominance in Chess is "probably partly innate" (p. 219-20). He was right that the much greater number of men with high IQs is part of the explanation for their much greater number of among top Chess players.

However, his suggestion that higher male visuospatial ability contributes to the male predominance among top Chess players is not supported by the meta-analysis of the relation between intelligence and ability in Chess that concluded that ability in Chess is positively correlated with fluid intelligence at .24, with numerical ability at .35, with verbal ability at .19, and with visuospatial ability at .13 (Burgoyne et al., 2016). This study showing only a very low correlation of .13 between ability in Chess and visuospatial ability suggests that the male predominance in top level Chess is more attributable to their greater fluid intelligence ($r = .24$) and numerical ability ($r = .35$). Howard's conclusion that there are many more men than women in top level Chess has been confirmed in 24 countries by Blanch (2016), who shows that this cannot be explained by the

higher participation rates of men.

Two other cognitively demanding games are Bridge and Scrabble. Success in Bridge requires the integration of information from a number of sources to reach the best decisions. This information includes the value of the cards held by the player, the likely values of the cards held by the player's partner and by each of the two opponents that can be inferred from the bidding. The good player evaluates this information to make the best decisions from a number of alternatives during the bidding and the play. As Charness (1979) writes in his analysis of the cognitive demands of Bridge, "the skilful bridge player frequently uses the bidding and sequence of plays to infer the distribution and identity of cards in the unseen hands." In addition, a good working memory is required to do well because during the play information that has been inferred from the bidding and from the cards already played has to be put into storage while attention is given to ongoing problems, and then retrieved from storage when needed. It has been shown by Kyllonen and Christal (1990) and by Colom, Chuderski and Santarnecchi (2016) that working memory is an important component of intelligence. The best Bridge players in the world are the 84 living Open World Grand Masters. Only one of these is a woman.

Scrabble is another cognitively demanding game involving combining letters to make words. It has been shown by Toma, Halpern and Berger (2014) that top scrabble experts have "extraordinarily high levels of visuospatial and verbal working memory capacities" and score 1.23*d* higher than elite college students who scored at the 93rd percentile of the quantitative SAT. There have been 38 winners of the American National Scrabble Championships 1978-2016 and 16 winners and runners-up of the Canadian National Scrabble Championships 1996-2013. All of these have been men.

These studies showing that there are much greater numbers of men than of women among the top players of these cognitively demanding games calls into question the "glass ceiling" that has frequently been proposed as the reason that women are under-represented in senior positions in corporations and the professions. It is a notorious fact that there are many more men than women at the top of all professions and among the very rich. Wai (2014) has reported that there is a male-female ratio of 9.4:1 among the world's billionaires. Nyborg (2015, p. 51) gives data for a number of countries showing that about 20 percent of senior positions in academia and business are women. More recently, the European Commission reported that in 2016 there was an average of 23 percent of women on the boards of large companies in the 27 nations of the European Union, ranging from 5 percent in Malta to 37 percent in France. The reason for the high percentage in France is a legal requirement for 40 percent of female

directors by 2017. In Britain, only 20 percent of university vice-chancellors in 2015 were women (Nath, 2017), and in the Netherlands only 18 percent of university full professors in 2016 were women (THE, 2017). In the United States, among those with an advanced degree women earn 74% as much as men (American Association of University Women, 2016).

The concept of the glass ceiling to explain the under-representation of women in senior positions in corporations and the professions was popularized by Gay Bryant (1984), who wrote that there are many women middle managers but “a lot of women are hitting a “glass ceiling” and finding they can rise no further.” In 1991 the United States Congress was so concerned about this disparity that it created the Federal Glass Ceiling Commission to investigate the problem and defined the glass ceiling as “the unseen, yet unbreakable barrier that keeps minorities and women from rising to the upper rungs of the corporate ladder”. In 2016 the Dutch Network of Women Professors asserted that the small number (18 percent) of women among university professors in the Netherlands showed that “There is a ruthlessly thick glass ceiling between job levels” (THE, 2017). Janet Hyde (2007, p.142) has written that “Women in science report significant discrimination.” Rainbow Murray (2016, p. 6), a professor of politics at Queen Mary University of London, has written that “Men often form networks with other men and recruit in their own image while overlooking women.” Oyvind Martinsen (2017, p. 30) of the BI Norwegian Business School has written of “the glass ceiling that has long existed within universities and business schools”.

While the glass ceiling might explain the under-representation of women in corporations and in medicine, the law, the universities and in other institutions that are largely run by men, it is doubtful whether it can explain the smaller numbers of successful women in fields where men are not able to discriminate against women. These include awards for outstanding intellectual achievement. Table 1 shows sex differences for the Nobel Prize, the highest award for intellectual achievement in physics, chemistry, physiology and medicine, and literature, and for the Wolf, Fields and Abel awards for mathematics. This gives the numbers of men and women who have received these awards up to 2016. The right hand column gives the percentages of the prize winners who were women.

There are four points of interest in the results. First, in discussing the much greater numbers of men that have won the Nobel Prize, Jausovec and Pahor (2017, p. 81) write: “Can all of these be attributed to sociocultural influences and the glass ceiling effect? Probably not. The first female prize for physics was awarded to Marie Curie Sklodowska in 1903 and the second to Maria Goeppert Mayer in 1963. One can speculate that in 1903 and even in 1963 there was much more gender inequality and male chauvinism than at the present time.” This is a

good point. No women have won the Nobel Prize for physics in the last 53 years showing that greater gender equality has not increased the small numbers of women prize winners. Second, women have had greater success in literature than in the sciences. This would be expected because women's verbal abilities are about the same as those of men but they have still only won 12.84 percent of the prizes. There is no glass ceiling to prevent women writing good novels for which nearly all the literature prizes are given. This shows that there must be other factors in addition to the IQ and the glass ceiling responsible for the small number of women getting the literature prize. Third, there are many more men than women recipients of the three awards for mathematics. There is no glass ceiling to prevent women from obtaining these awards. Fourth, the number of men prize winners is greater than would be predicted from their 4 point higher IQ showing that there must be other factors contributing to the preponderance of men.

Table 1. *Men and women awards for Nobel Prizes and mathematics prizes.*

Prize	Subject	Men	Women	% Women
Nobel	Physics	203	2	0.98
Nobel	Chemistry	171	4	2.28
Nobel	Physiology	199	12	5.69
Nobel	Literature	95	14	12.84
Wolf	Mathematics	57	0	0
Fields	Mathematics	61	1	1.61
Mathematics	Mathematics	16	0	0

Furthermore, there is no glass ceiling to prevent women doing as well as men in Chess, Poker, Backgammon, Mahjong, Bridge and Scrabble. The much greater numbers of men than of women among the top players of these cognitively demanding games is further evidence that the existence of an invisible glass ceiling preventing women from rising to the top does not stand up to critical examination. The concept of the invisible glass ceiling calls for William of Ockham's (1281-1347) razor: "Hypothetical entities should not be unnecessarily multiplied."

Jim Flynn has made two principal points. First, he argues that there is no sex difference in IQ in the current generation of women in developed nations and where samples appear to be large and representative. He contends that women have a fluid intelligence of 100.5 assessed from Raven's data for general population samples for modern nations. To assess this contention, the results of

sex differences (d s) for the Standard and Advanced Progressive Matrices in general population samples for ten modern nations published since the Lynn and Irwing (2004) meta-analysis are given in Table 2 and show that it is only in the sample from Argentina that women scored higher than men. The mean male advantage of the ten studies is $.206d$, equivalent to 3.1 IQ points.

Table 2. *Studies of sex differences (d s) for the Standard and Advanced Progressive Matrices in general population samples aged 20-89 years. Minus signs denote higher means obtained by females.*

Location	N ♂	N ♀	d	Reference
Scotland	210	217	0.11	Deary et al., 2004
Scotland	230	313	0.29	Deary et al., 2004
Brazil**	104	265	0.48	Rosseti et al., 2009
New Zealand	143	187	0.22	Fletcher & Hattie, 2011
Argentina	374	390	-0.02	Flynn, 2012
Brazil**	454	534	0.10	Flores-Mendoza et al., 2013
Serbia	62	74	0.27	Čvorović & Lynn, 2014
Romania*	618	823	0.18	Iliescu et al., 2016
Australia**	128	327	0.30	Waschi et al., 2016
USA***	393	503	0.21	van der Linden et al., 2017

* Progressive Matrices Plus; **Advanced Progressive Matrices; ***Penn PM, a short version of the Progressive Matrices.

Second, Flynn argues that differences in achievement between men and women have more to do with character than with intellect. Women tend to be less violent and combative than men and are more sensitive to other human beings. This difference is widely accepted and has been elaborated in the comment by Dutton showing that women have higher empathy that has recently been confirmed by Pietschnig and Gittler (2017). I agree that this difference is important and contributes to the over-representation of men in top jobs.

Adrian Furnham makes important points on some of the personality differences that contribute to the greater success of males than of females in many areas of life. These are that males are more self-confident shown in his numerous studies of their higher self-estimated intelligence. Males are more competitive and are greater risk-takers. I agree with his conclusion that “if males are more desirous to succeed (achievement orientation), willing to put in the effort, and risk a great deal in the process, it is not surprising that they have a greater success rate in many fields.”

Gerhard Meisenberg has confirmed my developmental theory by examining the data of the Armed Services Vocational Aptitude Battery in the NLSY79. He shows that the score increases between age 15 and age 23 were greater in males than in females, supporting an essential element of the theory. He shows also that neither the sex differences themselves nor their developmental changes are related in any consistent way to the *g* loadings of the subtests and therefore that sex differences should not be conceptualized as differences in *g*.

Helmuth Nyborg provides further evidence for sex differences in intelligence among 12-17 year olds measured as *g*-factor scores derived from the ASVAB subtests. He shows in whites, Hispanics and blacks males obtain higher IQs than females at age 17. In his white sample shown in his Figure 2 pre-pubertal boys hold a slight lead in intelligence development and this becomes statistically significant around age 15. The likely explanation for the earlier appearance of this higher male *g* is the presence of tests of mechanical comprehension and electronics information in the ASVAB, as he points out. His data are generally supportive of the developmental theory.

His Figure 3 confirms previous studies that the IQ distribution is wider in males than in females in 17-year-old whites from the NLSY97 data. He estimates there should be about 20% females at an IQ of 145 leading to an expectation that this would be about the proportion of women heading large companies and that this is approximately the case in Denmark. This proportion of women has been shown in a number of other countries. For instance, the European Commission reported that in 2016 there was an average of 23 percent of women on the boards of large companies in the 27 nations of the European Union. In Britain, 20 percent of university vice-chancellors in 2015 were women (Nath, 2017) and in the Netherlands 18 percent of university full professors in 2016 were women (THE, 2017).

Davide Piffer discusses the contribution of the greater male variability of IQ to the greater number of men among high achievers and the explanation of this. He suggests this may be attributable to X-linked transmission of intelligence and/or to higher testosterone that could increase the expression of genes related to neurological development or cognition.

Invitations to comment on the target paper were sent to a number of women academics who are concerned about gender inequality. One of these was Clare Hemmings who has been Professor and Director of The Gender Institute at the London School of Economics since 1998. The Gender Institute was established in 1993 to teach courses and carry out research on issues associated with gender and gender inequality. In addition to the director, it has a staff of twelve including Professors Mary Evans, Diane Perrons, Wendy Single and Nail Kabeer. Clare

Hemmings did not reply to the invitation.

An invitation to comment was also sent to Emma Rees who is professor and director of the Institute of Gender Studies at the University of Chester. Her book *The Vagina: A Literary and Cultural History* has been widely acclaimed by feminists for its account of men's oppression of women. Lisa Downing, professor of French Discourses of Sexuality at the University of Birmingham, has written "At last! A book on the vagina that I feel privileged to endorse. This careful cultural and literary history explores the vagina primarily as a loaded cultural symbol. It critiques the numerous ways in which the female sexual organs have had deleterious meanings projected onto them by a patriarchal society. A magnificent achievement!" Another admirer is Sally Hunt, professor of Cultural and Gender Studies at the University of Sussex, who has written "this really wonderful book on the history of the vagina... The Vagina bedazzles". Emma Rees did not reply to the invitation to comment on the target paper.

Another to whom an invitation to comment was sent was Uta Frith, professor emerita of cognitive development at University College, London, and a Fellow of the Royal Society and of the British Academy. She is chair of the Royal Society diversity committee that was established in 2014 to examine why women were under-represented in receiving funding. In 2014, 10 women out of 116 applicants and 35 men out of 350 applicants received Royal Society University Research Fellowships. Frith is reported as saying that her committees regarded this disparity as "a wake-up call" and "there was a general feeling that something needed to be done... not just in this country but world-wide" (Else, 2016, p. 7). She did not reply to the invitation to comment on the target paper.

Others who did not reply to the invitation to comment on the target paper include Gina Rippon and Helen Haste. Gina Rippon is professor of cognitive neuroscience at Aston University and has written that gender differences are "extremely small and the distribution of measured variables almost always overlapping" and that "gender inequality remains a matter of global concern (Rippon, 2016, pp. 921-2). Helen Haste is emerita professor of psychology at the University of Bath and a visiting professor at the Harvard School of Education. She discusses gender issues in her book *The Gender Metaphor*, in which she writes that "gender oppression is pervasive".

The only one who replied to the invitation to comment was Baroness Susan Greenfield who graduated in psychology at the University of Oxford and is now the Oxford Professor of Pharmacology. She has expressed concern about gender inequality stating that "It does worry me that only 10% of science professors are women" (*The Times*, 2010, 15 April, p. 50). She expressed thanks for the invitation but regretted that she was too busy to send a comment.

Thus, the only reservations about the theme of the target paper came from Colom and Flynn. Colom contended that there is no sex difference in g but agreed that men have a higher average IQ defined as the aggregate of cognitive abilities measured by tests like the Wechsler. This leaves Jim Flynn as the sole defender of what has surely become a lost cause. As Helmut Nyborg concludes: “[I]t is no longer scientifically acceptable to continue to tell readers of general textbooks and specialized publications that there is NULL sex difference in general intelligence. To the contrary, there is a reproducible adult sex difference, and it has been demonstrated to have practical value.”

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