J. biosoc. Sci. (2005) **37**, 371–380

doi:10.1017/S0021932004006868

ARE GENDER DIFFERENCES IN HIGH ACHIEVEMENT DISAPPEARING? A TEST IN ONE INTELLECTUAL DOMAIN

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Summary. Males traditionally predominate at upper achievement levels. One general view holds that this is due only to various social factors such as the 'glass ceiling' and lack of female role models. Another view holds that it occurs partly because of innate ability differences, with more males being at upper ability levels. In the last few decades, women have become more achievement focused and competitive and have gained many more opportunities to achieve. The present study examined one intellectual domain, international chess, to quantify its gender differences in achievement and to see if these have been diminishing with the societal changes. Chess is a good test domain because it is a meritocracy, it has objective performance measures, and longitudinal data of a whole population are available. Performance ratings overall and in the top 10, 50 and 100 players of each sex show large gender differences and little convergence over the past three decades, although a few females have become high achievers. The distribution of performance ratings on the January 2004 list shows a higher male mean and evidence for more male variation, just as with traits such as height. Career patterns of players first on the list between 1985 and 1989 show that top males and females entered the list at about the same age but females tend to play fewer games and have shorter careers. In this domain at least, the male predominance is large and has remained roughly constant despite societal changes.

Introduction

Males typically predominate at upper levels of intellectual achievement, gaining more Nobel prizes, full professorships, science citation counts and first class honours degrees (Heim, 1970; Deary *et al.*, 2003). Almost all recognized geniuses are male.

A key question is why. This question has much theoretical and practical interest but is controversial (Nyborg, 2003). There are various possible explanations, which fall into two general categories. In one category are various views that the male predominance reflects not ability differences between the sexes (e.g. in general intelligence, creativity and so on) but effects of social factors. One argument goes that different gender socialization experiences result in different interests and motivation patterns (e.g. Reis, 1991; Lupart & Barva, 1998; Ayalon, 2003). Proposed factors include female 'fear of success' (e.g. Fried-Buchalter, 1997), less female interest in competition and careers, lack of female role models, pressure for greater investment in child-rearing, media messages, and a female wish for a balanced life (e.g. Rogers, 1999; Wilgosh, 2001). Indeed, some male high achievers have an intense interest in a narrow domain to the exclusion of almost all else (Simonton, 1988; Jensen, 1996). Achievements are more likely to follow if most waking hours are spent at an activity. Another social factor relates to opportunity (e.g. the 'glass ceiling'). Women may get fewer chances to become high achievers (Huffman & Torres, 2002); e.g. to go very far in formal education, still true in some nations. In most domains, gatekeepers control resources needed for high achievement and may run an 'old boy's network' favouring males. In science, for instance, gatekeepers distribute graduate school places, jobs, research grants, and journal and laboratory space.

In the second general category is the evolutionary psychology view that males predominate at least partly because of some innate differences. These may relate to ability advantages or non-ability characteristics, such as greater male competitiveness. Kanazawa (2003) recently proposed testosterone-induced competition for mates as a factor, suggesting that when men marry, their productivity in various fields greatly diminishes. Ability explanations come in several varieties. One version holds that the sexes have equal means on general intelligence, but males are more variable at both ends of the spectrum. More males are likely to be high on the key traits needed to achieve. Indeed, studies suggest greater male variation in such traits as height and intelligence. For instance, Deary *et al.* (2003), with data from almost all Scottish children born in 1921, found similar male and female IQ means but a more variable male distribution. (However, Feingold (1994) argues that the variability difference may not be universal across cultures.) Another version holds that the male mean is slightly higher on key abilities. For instance, males on average tend to be better at visuospatial ability and are over-represented at the extremes of mathematics performance (Benbow *et al.*, 2000), while females tend to be better at various aspects of verbal ability (Halpern & LaMay, 2000). Some researchers argue that the average male IQ score is slightly higher (e.g. Lynn, 1999; Lynn & Po Wah, 2003), which partly may account for higher achievement. This view still is controversial (Jensen, 1998).

No doubt many above such social factors operate, but in industrial nations in the last few decades their effect has diminished as the role of women has seen a sea change. Attitudes have changed and affirmative action policies now allow women to go much further. Many women now want and get careers and delay or avoid marriage and childbearing. Birth rates have dropped greatly. Female opportunity has greatly improved, and women take formerly male roles such as fighter pilot. Females in some nations now outperform males on average in the education system and take more university places (Freeman, 2003). In sports such as tennis, women now seem just as motivated and competitive as males. If there really are no innate general intelligence differences, even at the extremes, female and male achievement should be converging. There should be more female geniuses and more female higher achievers. Is this happening? In some domains, anecdotally at least, it is. Gender gaps still exist but more women have moved into top positions in academia, government and industry. However, males still predominate overall in most domains, possibly still due to old boy's networks and other such factors. Adequately testing the evolutionary psychology view, that the achievement differences at least partly are due to ability differences, requires a domain with very special characteristics. First, it should be a complete meritocracy with no influence of gatekeepers, in which talent of either gender can rise readily. There should be objective performance measures which can be tracked over decades. The task should remain the same and should be purely intellectual, male physical advantages (e.g. Aitken, 1999) holding no sway.

International chess comes close to meeting these criteria. First, it is a meritocracy. Most tournaments are open to all and unpopular and/or unconnected talent can rise. Second, it has objective performance measures. A numerical performance rating scale, described in detail below, gauges skill at a particular time. Third, the task has remained essentially the same over decades so longitudinal comparisons make sense. Fourth, data are available for a whole population, all international chess players, over the last three decades or so. These data also may suggest clues in career patterns as to causes of differences. Finally, chess is a purely intellectual task and chess skill correlates with IQ and visuospatial ability (Horgan & Morgan, 1990; Frydman & Lynn, 1992). Indeed, chess performance often has been studied in cognitive psychology (e.g. Charness, 1992; Chabris & Hearst, 2003), Newell (1973) proposing it as a 'drosophila' for the field. Researchers have used chess data to study phenomena such as the Flynn effect (Howard, 1999, 2001) and expertise development (Charness *et al.*, 1996).

However, chess is not a perfect test domain. One disadvantage is that female participation rates are much lower (e.g. Charness & Gerchak, 1996), although the absolute number of female players has grown immensely since 1975: from about 250 to over 3600. Fewer females seem interested in chess, though that in itself may be significant, as with science. Good test domains of equal interest to the genders are scarce. Second, play depends partly on a minimum level of visuospatial ability, in which males on average have an advantage, though some say a shrinking one (Feingold, 1988). Waters *et al.* (2002) did report little relation between chess skill and a measure of visual memory, the Shape Memory Test. However, as they do note, the ability to manipulate visual images, unfortunately not gauged in their study, may be more important.

Anecdotally at least, there has been some convergence in chess at top levels. For example, there are more female grandmasters. Judit Polgar, born in 1976 and the strongest-ever female player, regularly wins tournaments against top male competition and several times has made the top ten players list. She once held the record for youngest-ever grandmaster. But, the extent of gender differences and their trends over time have never been quantified.

The present study had three aims. One was to quantify the sex difference in this domain. A second was to test for possible convergence over the last few decades. A third was to scan ratings data for explanations of any differences.

The international rating list

The first FIDE (the international chess federation) list is dated December 1970 and was based on international games in the previous two years or so. Lists came out

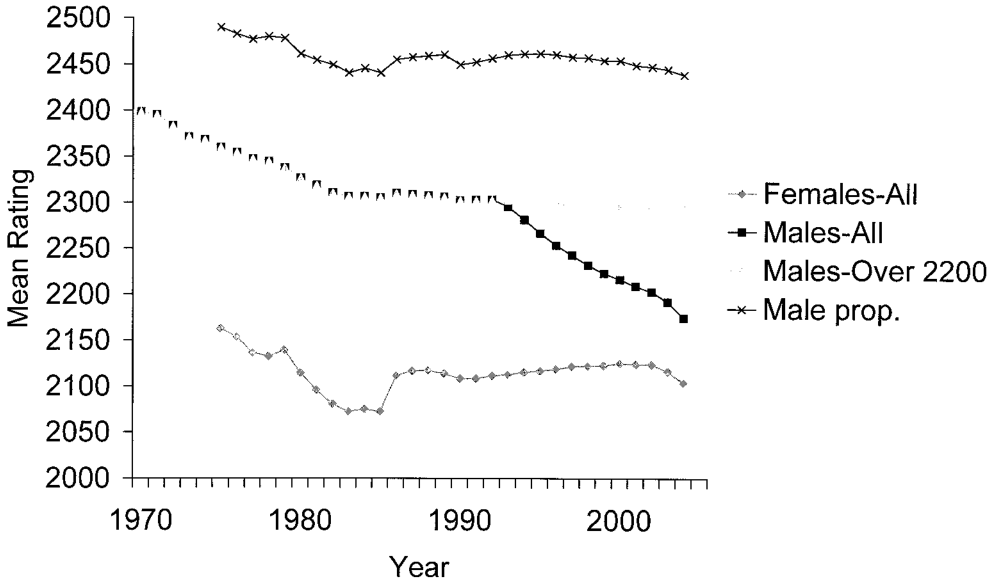

Fig. 1. Mean ratings of all players in the first list each year since 1970. 'Male prop.' refers to the exact same proportion of male players as females in each list.

annually until 1978, twice a year until 2000, thrice in 2000, and thereafter four times a year. Each list gives a player's current performance rating on a scale from about 1800 to about 2900, with a standard deviation of around 100–130 points. The rating may change with each game according to result and relative strength of the opponent. Wins against higher rated opponents raise it and losses to lower rated ones decrease it. Eventually, the rating reflects a player's skill at a given time. Pre-1975 lists have fewer than five female players but in 1975 a separate women's list was issued and then later lists were combined. FIDE added 100 points to all female ratings in 1987, evidently to bring them more into line with male ratings, and 100 points were added to all pre-1987 female ratings in the studies below. Rules to get and stay on the list have changed. Males once needed a minimum rating of 2200, but this was dropped in 1993. Numbers of games played in each rating period are recorded only from July 1985. Like almost all real-world data, the FIDE rating data are a bit messy and all values below should be seen as approximations.

FIDE also awards various performance-based master titles. The most prestigious are the international master (IM) and grandmaster (GM) titles. Their award normally requires a minimum rating and performance norms in several tournaments. The IM title usually is taken before the GM title, the latter being much harder to gain.

Study 1: Has convergence occurred?

This study quantifies the sex difference in performance and determines whether the sexes have converged over the past few decades. Figure 1 presents mean ratings in the first list each year for all males and females. Because the male participation rate is

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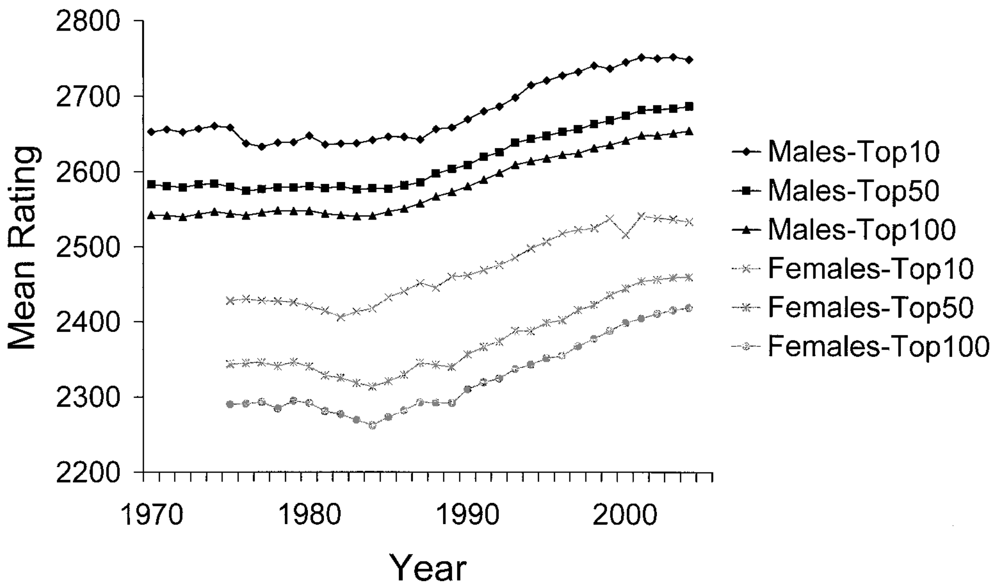

Fig. 2. Mean ratings of the top 10, 50 and 100 male and female players in the first list each year over the last three decades.

higher, also given is the figure for the top males in the same proportion of females ('Male prop.'). For instance, if a list had 1000 females, then Male prop. is the value for the top 1000 males on that list. In addition, because before 1993, males who fell below 2200 were dropped from the list, also presented are the average ratings of all males over 2200 on each list. Because the data are of a whole population, no inferential statistical analyses were performed.

The figure at first suggests some convergence. The mean rating for all males has continually dropped, but this largely seems due to the increasing proportion of males and number of players and the weakened criterion for males to stay on the list. There is little evidence of convergence for Male prop. and for males rated over 2200.

Figure 2 presents the mean ratings of the top 10, 50 and 100 males and females in each year. Only the first *n* ratings are used. Thus, if say five players are tied in tenth place with a rating of 2500, only one 2500 rating value is used in computations. The figure shows a clear male predominance at each level, of more than a standard deviation. Though average ratings have inflated from the late 1980s, the sex difference roughly is constant at all levels.

Study 2: The ratings distribution

Study 1 suggests large gender differences and little convergence. Is the distribution of chess skill like that of such traits as height and IQ, with higher male variation and equal means or a higher mean for males? The study determined this by examining the ratings distributions on the January 2004 list, which has 50,450 players.

https://doi.org/10.1017/S0021932004006868 Published online by Cambridge University Press

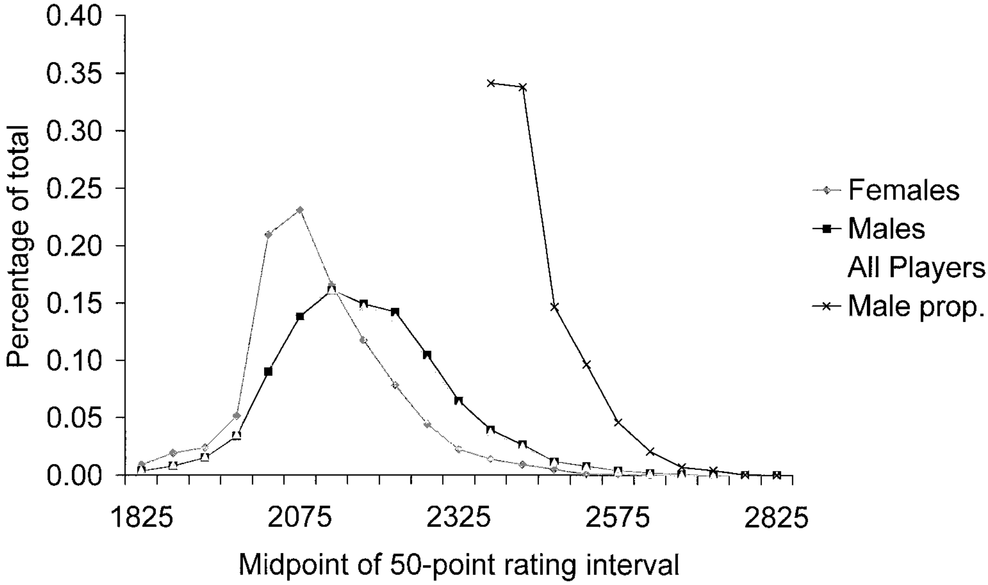

Fig. 3. The distributions of ratings in 50-point intervals on the January 2004 list. 'Male prop.' refers to the same proportion of male players as females in the list.

Table 1. Rating distributions and title statistics of the January 2004 list

	All females	All males	Male prop.	All players
Number of players	3646	46,804	3640*	50,450
Mean rating	2104·166	2174·609	2438·684	2169·518
Standard deviation	109·059	127·579	67·381	127·641
Median	2089·5	2166	2419	2160
Mode	2005	2205	2370	2205
Kurtosis	1·272	0·488	2·225	0·49
Skewness	0·629	0·392	1·444	0·412
Percentage with IM title (includes GM title holders)	1·042	5·151	70·494	4·836
Percentage with GM title	0·247	1·869	23·324	1·752

*Title counts for Male prop. are based on 3640 players (those rated above 2363) because too many players were rated 2363 to include.

Figure 3 presents the distributions of ratings, in 50-point intervals, starting with the interval 1800–1849. Values are percentages of totals. Table 1 presents some of the distributions' parameters. The distributions mirror those of traits with a genetic component. The overall male mean is higher and males are more variable, the standard deviation for males being much higher. The difference between the female distribution and that of the same proportion of top males is large, with a male mean

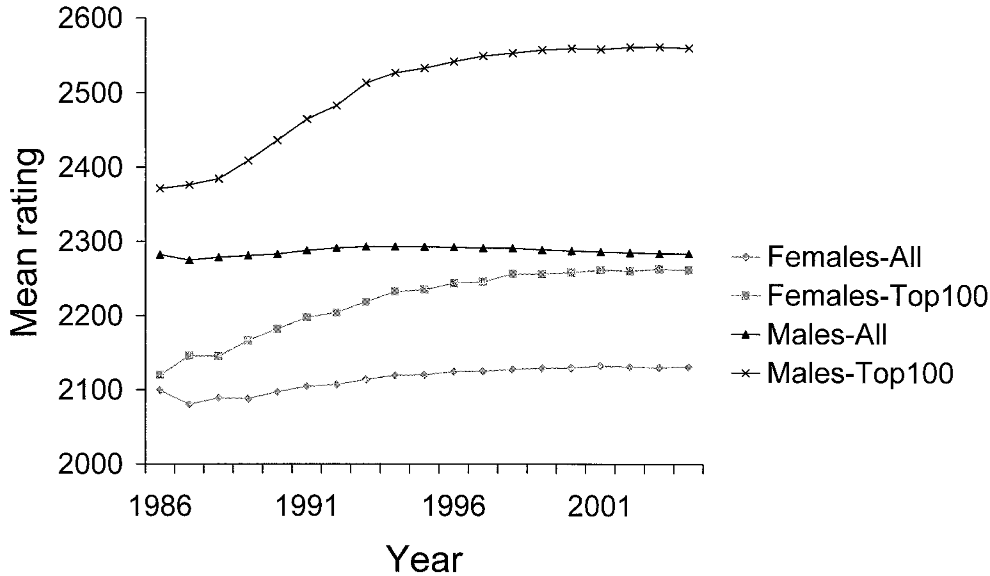

Fig. 4. Rating profiles of all males and females who first came on the list between July 1985 and July 1989.

over two standard deviations higher. Males also disproportionately hold IM and GM titles.

However, another interpretation is that males are not more variable as with IQ, just that males on average are stronger. The higher male standard deviation is due to the predominance of males at the top.

Study 3: Career patterns

The gender differences may be due to various chess-specific factors, such as less female inherent interest. However, the ratings data may hold clues about career patterns which could shed further light. Numbers of games in each rating period are recorded only from July 1985, but this gives enough of a forward span. All male and female players who entered the list from July 1985 to and including July 1989 were selected for further analysis. The sample consisted of 340 females and 3132 males. Data of the whole sample and the top 100 players of each gender in the sample, defined as those with the highest average rating from entry on the list until January 2004, were examined. How do their career paths compare?

Figure 4 presents ratings trajectories for each group. The gender differences at the top are stark. For the top 100, the male curve starts at a much higher level and rises more rapidly.

Table 2 presents further summary career data for each group. Data in the table are based on all lists each year. Again, the male achievement level is much higher. However, an interesting difference emerges with length of career and number of rated

https://doi.org/10.1017/S0021932004006868 Published online by Cambridge University Press

Table 2. Career data to January 2004 of all players first on the list between July 1985 and July 1989

	All females	All males	Top 100 females	Top 100 males
Number	340	3132	100	100
Percentage active past 1999	38·529	66·667	69	100
Median total career games	67·5	104	302·5	936·5
Median age first on list	19·431*	24·678*	17·443*	17·944*
Mean peak rating	2141·988	2329·428	2297·35	2595·32
Mean peak rank	5158·585	2595·359	4037·9	113·2
Percentage gaining IM title (includes GM title holders)	2·352	16·411	8	99
Percentage gaining GM title	0·883	5·013	3	92

*Not all birth dates were available: 97% for males in the top 100, 75% of females in the top 100, about 79% of all males and about 54% of all females.

games played. Even with the top 100, many more females were inactive after 1999 and males play many more games. This is particularly striking with the top 100; the male median number of games is more than three times greater.

Discussion

The present study looked at only one domain. However, data on a whole population were available and performance could be objectively quantified. The results are clear. A few women recently have done extremely well in chess but the male advantage is very large and has remained roughly constant over nearly three decades. This has occurred even though international chess is a meritocracy and there are female role models, such as Judit Polgar. The differences are not just due to different participation rates. Even proportionate to participation numbers they are quite striking.

Study 3 offers some clues on why the differences occur, with females playing fewer career games and becoming inactive sooner. This finding has several interpretations, which cannot be readily distinguished here. It may be due to the greater male tendency to become obsessed with a domain, and do little else. Skill at international chess requires many years of study and continual knowledge updating. Chess, even for top females, may be more a passing interest before moving on to something else. Indeed, different gender interest patterns are one reason for the disproportionate male representation in science (Lubinski *et al.*, 2001). Also, perhaps males just get much more practice. Finally, it may be due to an interaction with natural talent. Most competitors in a domain such as chess (or tennis or science) eventually come to the limits of their ability and realize they will get little further, and turn to other realms. Further studies might look at these possibilities.

The results are consistent with the evolutionary psychology view that males predominate at high achievement levels at least partly because of ability differences. Two explanations often proposed as causes of male predominance, the glass ceiling and lack of female role models, definitely can be excluded here. Differences in numbers at the top of the general intelligence distribution partly may be responsible. However, it is not clear if sex differences in visuospatial ability are important. If they were, this could even be evidence against Feingold's (1988) argument that spatial ability gender differences are diminishing. With chess, probably only a threshold level of visuospatial ability is needed, beyond which general intelligence is more important. The top ten females over the last few years have achieved very high ratings of over 2500 and many have gained the grandmaster title as well, which requires good visuospatial ability, but are still greatly outperformed by the top ten males. The gender difference is roughly constant at all levels, suggesting that other factors are responsible for the differences between the top ten males and females.

The present findings need replication in other domains. Other intellectual games might be examined, such as bridge and go. Bridge in particular may be of much interest, since the female participation rate is higher.

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