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Gender Differences: The Chess Delusion

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Abstract

The last decades have witnessed a heated debate about the nature of gender differences. Chess, as the typical domain of excellence, has been used extensively to empirically test whether males demonstrate an undisputable superiority. A common finding is that average male ratings are superior to the average female ratings. While some authors have taken this superiority as evidence of males' superior intelligence, other have argued that it stems from statistical sample biases. In the present article the Elo ratings of 140,367 active players provided by the International Chess Federation were used to investigate the profiles of male and female chess experts. The commonly found advantage in general rating for males is replicated. But, the analysis of performance as function of both gender and age reveals the counterintuitive facts that females tend to equal males in both average rating and proportion of experts when both genders reach peak performance. This fact brings into question the usual view of clear male superiority and calls for further research into the chess play of females.

Keywords

Chess, gender differences, expertise

Introduction

World chess champion Robert J. Fischer had expressed a controversial view, describing women in chess as "weak...compared to men" (Ginzburg, 1962). A similar view has been expressed by UK grandmaster Nigel Short, who claimed that the superiority of men over women in chess is simply "hardwired" (Ellis-Petersen, 2015), causing a media outrage. That males are superior to females in some specific intellectual domains is also a view held by many scholars (Irwing & Lynn, 2005). Research on chess ratings has indeed documented the substantial difference in playing strengths between male and female players (Howard, 2005, 2014). The observed differences have been invoked to provide support for claims of innate male superiority in chess (Frydman & Lynn, 1992; Howard, 2005, 2014). On the other hand, as the proportion of males engaging in competitive chess radically dwarfs that of females, rating superiority might only reflect differences in participation rates. Such opposing claims have ignited a hot debate in the psychology community, which continues to invite argument (Bilalic et al., 2009; Blanch et al., 2015; Charness & Gerchak, 1996; Howard, 2005, 2014; Knapp, 2010). The present paper offers a third avenue. The finding that males are superior in chess is resting on a robust string of articles, but it stems from a one-dimensional view of skill: the Elo rating. Many a conclusion has been drawn from large datasets without taking into consideration that males and females develop at different rates. The main factor affecting skill acquisition and decline, that is age, has been so far neglected. The present study aims at remedying this gap. By using the Elo rating of a large, cross-sectional and cross-cultural sample of active players, the present

study tests whether males outplay females at all time points in the lifetime.

Differences in the performances and achievements of males and females have been highlighted in various academic domains (Ceci & Williams, 2010; Heim, 1970; Huffman & Torres, 2002). A similar phenomenon is seen in chess rating scores. For instance, an investigation into chess data taken from the 2004 International Chess Federation rating list reveals that male expert chess players have a higher and more variable performance mean than expert female players (Howard, 2005). The superiority of males over females in this skill has been a robust finding throughout the literature (Allen, 1974; Kerns & Berenbaum, 1991; Masters & Sanders, 1993). Hence, even if a study failed to find a link between intelligence and skill on a small sample of elite players (Bilalic et al., 2007), differences in chess ratings have been taken as reflecting intellectual superiority of males (Howard, 2005, 2014).

Taking a wholly different stance on the matter is the claim that chess performance differences are largely a statistical consequence of the fact that the number of male players is highly disproportionate to that of females (Bilalic et al., 2009; Chabris & Glickman, 2006). To help grasp fully the dearth of female players in chess, it is sufficient to examine their participation; Women have constituted from 9.7% of players (Chabris & Glickman, 2006), to as little as 6.3% (Bilalic et al., 2009). Investigations into the effect of participation rates on the gender of elite scorers suggest that female inferiority in performance can be largely accounted for by their massive underrepresentation in number (Charness & Gerchak, 1996). An analysis on USCF data concludes that the larger number of boys entering chess at early levels adequately accounts for the later number of top male competitors (Chabris & Glickman, 2006). In line with this sample size argument, Bilalic et al. (2009) calculated that the expected difference in performance due to an unequal gender ratio in a sample of players accounts for 96% of the actual difference between scores. This last claim, however, has been refuted by Knapp (2010), who showed that participation rates accounted for only two thirds of the difference. The statistical argument, leaving at best one third of the variance unexplained is thus not sufficient to account fully for the difference between female and male scores. Knapp's initial demonstration on the German sample of players has been replicated by Blanch (2016) on a sample on 24 countries. In spite of huge variations across countries, Blanch's study does not bring conclusive evidence in favor of the idea that the gender gap is due to participation rate. With much variance left unexplained, it is worth exploring the other factors that contribute to the complex skill that is expert chess playing.

By analyzing the data from 8 tournaments, Blanch et al. (2015), after replicating the findings from Knapp (2010), uncovered the hidden finding that age, alone and in interaction with practice, affects males and females differently. The data represented a small sample of females, localized geographically and thus with limited generalizability. But the finding that gender and age interact opens the way for further investigation into the specific role played by age in human development and decline. To become expert, chess players should start at an early age. An estimate from Gobet and Campitelli (2007) suggests 12 years old as the ideal starting age. It is thus a long path to travel for the players until they reach their peak performance which has been estimated to be either 39 years old (Vaci et al., 2015) or 43.8 years old (Roring & Charness, 2007). On such an extended learning period a multiplicity of factors contribute to expertise acquisition. Research with children indicates that in the early years, visuospatial skills (Frydman & Lynn, 1992), intelligence (Bilalic et al., 2007; Horgan & Morgan, 1990), and sensation seeking (Joireman et al., 2002) play a role in the development of chess players. Later on, the verbal component of chess thinking increases in importance (Pfau & Murphy, 1988). Being differentially skilled in visuospatial and verbal processing, males and females should display different learning curves from the onset. At the opposite end of the age spectrum, studies on aging have documented that very specific

cognitive competencies are gradually deteriorating. A series of studies conducted by Charness in the early 80s showed that recall and search of problem space, but not problem solving, are affected by aging (Charness, 1981a, 1981b, 1981c). Later, it was demonstrated that memory functioning is altered, with knowledge activation processes (Jastrzembski et al., 2006), and speed of information transfer (Moxley & Charness, 2013) being significantly slowed down. One of the few questions that has been investigated in relation to decline in skill is whether experts decline at a slower rate than non-experts. This hypothesis. that nature is kinder to the gifted, has found some supportive evidence (Blum & Jarvik, 1974). Yet, it is possible that the slower rate of decline is due to the higher amount of practice that experts exhibit (Vaci et al., 2015). Evidently the decline in performance is slower in chess as compared to fields of expertise marked by a more physical component (Fair, 2007). Across the lifespan, productivity, measured as the weighted sum of wins and draws divided by the number of played games, expectedly changes across the life span (Bertoni et al., 2015). All these studies have helped identify the factors that play a role in expertise acquisition and through it inform on the potential sources of gender differences. However, none investigated whether male superiority in chess holds true across the life span. The present article will remedy this gap by comparing male and female players ratings over the life span.

In addition to the theoretical complexity of the matter, the study of gender differences faces a series of empirical challenges. Even if skill in chess is accurately estimated through the Elo scale (Elo, 1978), which makes Elo ratings the scientists' favored tool to examine gender differences (Bilalic et al., 2009; Blanch et al., 2015; Breznik & Law, 2016; Howard, 2014), the analysis of gender differences is rendered difficult by four factors. The first factor is sample size. Because of this issue, many studies on expertise suffer from limited statistical power, and studies in chess expertise are no exception to this problem with studies having as few as three participants (Simmons et al., 2013). A second factor is that many studies have analyzed the ratings of a geographically restricted area; for example, Bilalic et al.'s (2009) study was conducted on a German sample, and Chabris and Glickman's (Chabris & Glickman, 2006) on a U.S. sample. Cultural variations influence how players approach the game at a strategic level (Chassy & Gobet, 2015) and crucially affect the two genders differently (Blanch, 2016). A third factor is the inconsistency across studies in the rating systems used to assess the differences between males and females. National chess federations have Elo rating systems that are specific to the country, making comparisons across countries difficult. The last factor to be controlled is that databases of Elo ratings might not contain accurate data. Indeed, many databases keep listing players years after they have stopped being active in competition, thus creating the false impression of there being more experts. All these issues taken together introduce a huge bias in the results. To inform the debate on male and female chess players a study should cover the widest geographical area possible, use a reliable and consistent rating system, and list players whose rating reflects their level of performance.

A series of hypotheses are derived from the above. First, in line with previous findings, male players ratings will on average be superior to female players on the whole sample of players. Second, in line with the previous prediction, male expert players (rating ≥ 2000) play better than female expert players (rating ≥ 2000 Elo). Third, it is predicted that the proportion of males in the sample is superior to the proportion of females. Finally, as male and females display different cognitive and emotional dispositions, it is predicted that male superiority is not constant across time.

Methods

Data Source

The data used were the official ratings provided by the International Chess Federation published in October 2019 (http://ratings.fide.com/archive.phtml). The

advantages of using the ratings from the International Chess Federation is that these ratings are comparable across countries and that they cover all players who are taking part in official competition on the planet (Chassy & Gobet, 2015). Each recording contains the player's name, country of registration, gender, titles (*e.g.*, IGM, IM), Elo rating, games played over the last chess period, year of birth, and activity. The data have been trimmed to ensure anonymity so that only the variables of interest—gender, skill, and birthdates—were left. The database specifies gender as male or female, and birthdate is limited to the year of birth. Age was computed from the birthdates as the difference between 2019 and the birthdate provided in the official record. The database comprised a total of 347,660 records. Keeping only the records allowing identification of both age and gender provides a database of registered players comprising 338,892 records, retaining 97.47% of all the players registered worldwide.

As indicated above, players can remain registered without being active which implies that they keep aging without playing official games. Their ratings are not updated and thus are no longer reflective of their skills. Only the players who continue being active in competition have their ratings updated and thus only these players have ratings that reflect their skills. The International Chess Federation allows the identification of the players who have stopped practicing and thus whose ratings skew the data. Players who have not a recoded game for at least 12 consecutive months are considered inactive, and their rating is marked as such. Based on Elo's rating system (Elo, 1978) players were assigned the status of expert when their rating was equal or superior to 2000 Elo and the status of club players when their rating was strictly inferior to 2000 Elo. To comply with statistical requirements of having 50 data points per condition (Brysbaert, 2019; Simmons et al., 2013), the only ages kept were those for which both samples are at least equal to 50 records. The final database of active players contained the data of 140,367 active players who ranged in age from 8 to 59 years. In line with the objective of having ratings reflecting level, each of these players had their rating updated within the previous 12 months.

Statistical Analysis

For the sake of comparability with previous studies, the analyses are first carried out on the sample of registered players. But active players will constitute the core of the analysis of the present study as this sample addresses all the methodological issues raised in the above: they constitute a large, cross-cultural sample for which the ratings are calculated with the same equations in all countries and are updated due to recent official practice. In addition to the statistics carried out on ratings, the methodology of rank comparison introduced by Knapp (2010) was also used to estimate the gender gap both in the whole sample and then as a function of age. The methodological approach comprises two different statistical procedures.

The first procedure consists in comparing whether the distribution of the female rank in the combined list of males and females matches an equiprobable sampling with no replacement; in such case the distribution would follow a negative hypergeometric law (Knapp, 2010). In line with the procedure used by Blanch et al. (2015), the factual distributions of ranks were compared in this article against the theoretical rank distribution at $p = .05$, $p = .50$ and $p = .95$.

The second procedure consists in comparing the Elo rating between males and females of the same rank in the factual and theoretical distributions to evaluate the amount of Elo rating that is attributable to the differential participation rate (Blanch, 2016; Blanch et al., 2015; Knapp, 2010). Both statistical procedures were used to evaluate female skills as compared to male.

Results

Registered Players

The mean rating of registered players is 1667.25 Elo (SD = 348.15 Elo) for a mean age of 36.91 years old (SD = 20.05 yr.). The database comprises 89.40% of males (n_m = 302,986), and 10.60% females (n_f = 35,906). With a worldwide distribution of 101 male for 100 females (Factbook, 2019), an equivalent

sampling of the chess players population would predict a distribution of 170,089 males for 168,603 females. The difference between the theoretical and the observed count is significant, $\chi^2(N = 338{,}892) = 207{,}841.149$, $p < .01$); indicating that chess players are predominantly males.

Table 1 reports the descriptive statistics on Elo ratings for males and females. The mean male rating is significantly superior: $t(338{,}890) = 88.21$, $p < .01$, $d = .50$, to the mean female rating. The same significant difference is found within experts, $t(66{,}510) = 19.28$, $p < .01$, $d = .34$ where male experts have a higher rating than female experts. Furthermore, the proportion of experts in the male population, 20.62%, is significantly higher $\chi^2(N = 66{,}512) = 50{,}734.11$, $p < .01$. than the proportion of experts in the female population 11.27%. Female players being significantly younger than male players, $t(54159.617) = 165.200$, $p < .01$, $d = .80$.; a difference that holds true for expert players too, $t(4762.146) = 32.05$, $p < .01$, $d = .49$.

Table 1. Descriptive statistics of ratings for each gender (Elo) in the whole database

			Males	Females
Database	Elo rating	Mean	1685.20	1515.72
		SD	344.91	338.36
	Age	Mean	38.34	24.47
		SD	20.12	14.38
Experts	Elo rating	Mean	2156.19	2118.03
		SD	123.24	100.62
	Age	Mean	45.20	37.72
		SD	16.35	14.25

Note. *SD* stands for standard deviation.

Active Players

The analyses conducted on the active players ($N = 140{,}367$) mirror the main results reported in the above. Active players are 29.43 years old on average ($SD = 15.77$ yr.) with a mean rating of 1667.72 Elo ($SD = 365.07$ Elo). The database is composed of a majority of males (123,829; 88%) over females (16,538; 12%), $\chi^2(n = 140{,}367) = 80{,}946.92$, $p < .01$).

Table 2. Descriptive statistics of active players for each gender (Elo)

			Males	Females
Database	Elo rating	Mean	1650.90	1454.13
		SD	362.67	334.96
	Age	Mean	30.71	19.85
		SD	15.85	11.15
Experts	Elo rating	Mean	2175.44	2153.86
		SD	141.81	123.24
	Age	Mean	37.06	29.40
		SD	13.21	11.12

Note. *SD* stands for standard deviation.

Table 2 reports the descriptive statistics for the active players. The mean male ratings is significantly superior, $t(22{,}048.055) = 70.25$, $p < .01$, $d = .56$ (corrected for inhomogeneity of variances), to the mean female rating. The same difference is found within experts, where male experts have a higher mean rating than female experts, $t(24984) = 5.50$, $p < .01$, $d = .16$. Furthermore, the proportion of experts in the male population, (19%, $n = 23{,}623$), is significantly higher $\chi^2(n = 29{,}002) = 23{,}387.756$, $p < .01$. than the proportion of experts within the female population, (8%, $n = 1{,}363$).

In addition, as indicated in the top pane of Figure 1, it is found that the actual distribution of female ranks in the combined list is well apart from the distribution of female rank in case of sampling without replacement. The factual distribution departs from the theoretical distribution at such an early stage and for such a magnitude that the two dashed curves delimiting the $p = .05$ and $p = .95$ probabilities are barely distinguishable from the median probability. This result strengthens the analysis on Elo indicating a marked superiority of males. The difference in Elo rating, indicated in the bottom panel of Figure 1 is also supportive of a marked difference between males and females, with 73% of variance in rating difference accounted for by the ranking on average, leaving 27% of variance unexplained.

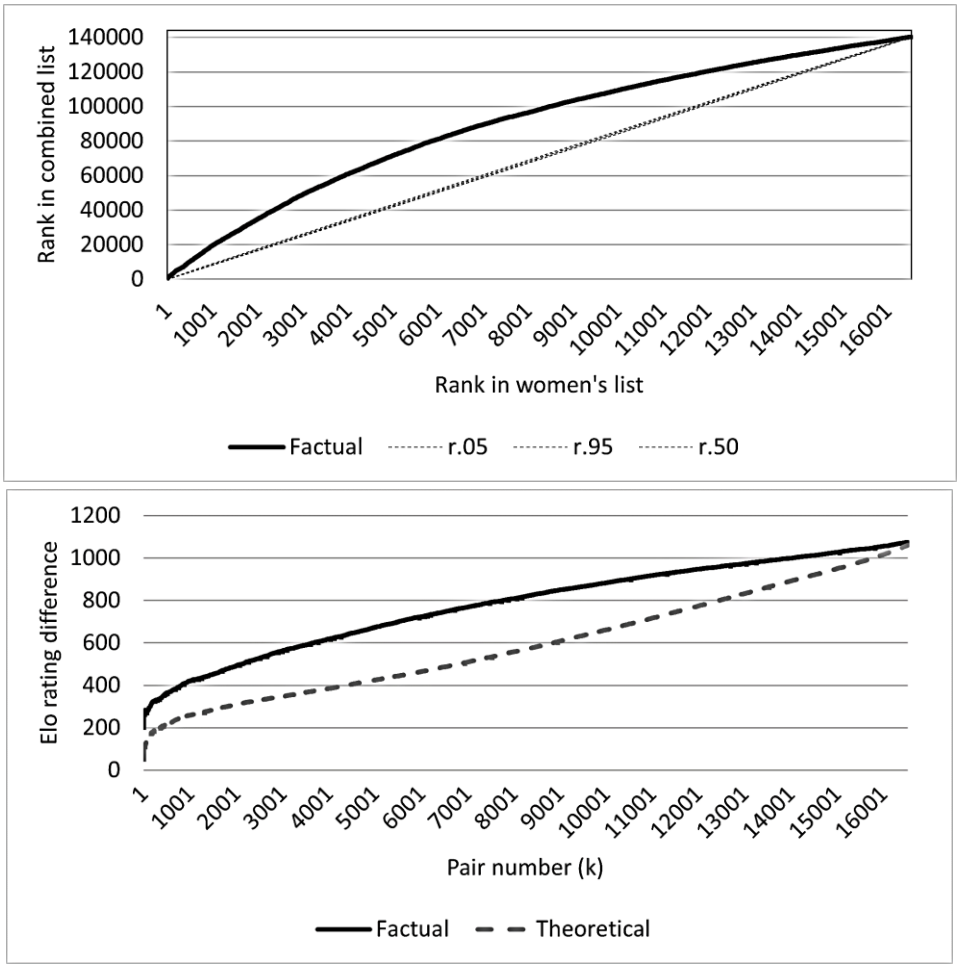

Figure 1. Top pane: Predicted (dash) and factual (line) rank of the women in the combined list. Bottom pane: Predicted (dash) and factual (line) Elo difference between males and females of the same pair number.

By showing that males are more numerous and better rated the results replicate and extend previous findings in the field but the data mask a subtler reality. As reported in Table 2, female players are significantly younger than male players, $t(140{,}365) = 85.36$, $p < .01$, $d = .80$. This difference also holds true for female experts who are significantly younger than male experts, $t(24984) = 20.99$, $p < .01$, $d = .63$. A correlate of the age distribution is that females get increasingly underrepresented as illustrated in Figure 2.

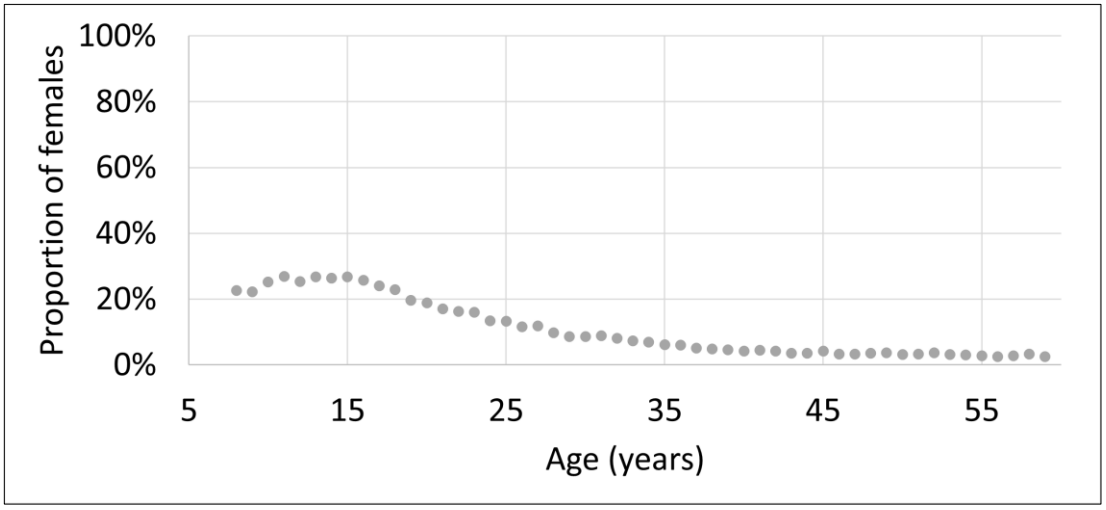

Figure 2. Proportion of females in the sample at each age.

Being younger, female players have less experience and thus it is not surprising that their average Elo is lower than the males. To be able to conclude about potential differences between the two genders, it is necessary to examine Elo difference as a function of age. An ANCOVA with gender as independent variable and age as covariate was caried out. The result indicates that both gender $F(1, 140364) = 1162.58$, $p < .01$, $\eta^2 = .01$ and age $F(1, 140364) = 26543.16$, $p < .01$, $\eta^2 = .16$ constitute significant factors but age has a much larger effect size. Figure 3 shows the mean Elo rating for each gender and each age. An ad-hoc test confirms this trend by showing that male and female mean ratings are not significantly different when females reach their peak, $t(1770) = -0.06$, $p = .95$.

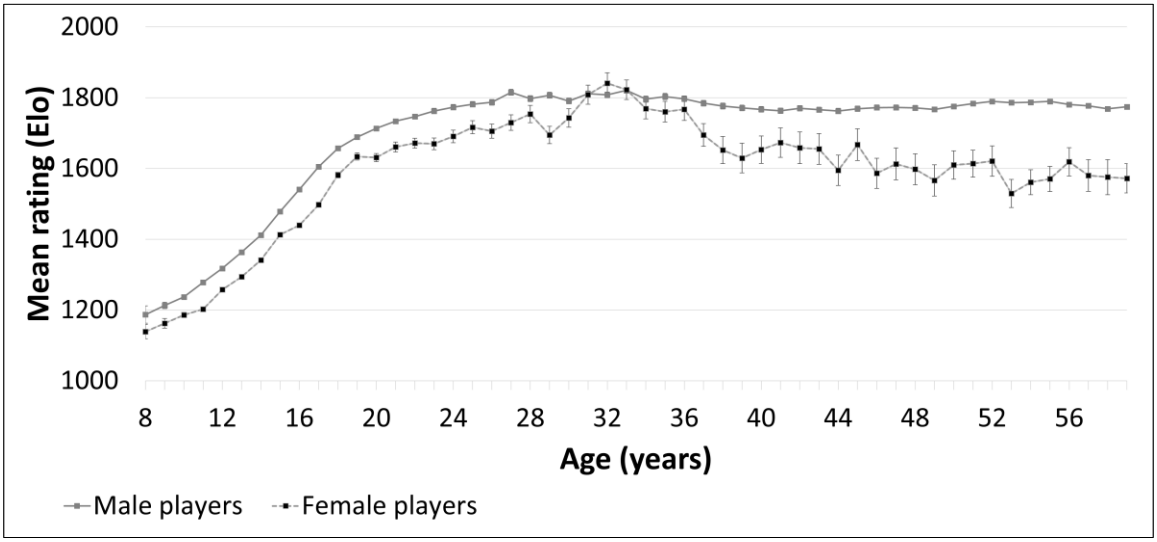

Figure 3. Mean Elo rating per gender and age. Error bars are standard error of the mean.

To further the investigation on gender, age, and chess skill, the proportion of individuals that achieve expert status in each gender group was examined. Figure 4 reports the proportion of experts within genders. To establish whether the same proportion of males and females are expert in their groups, the proportion of experts between the two genders was compared independently at each age.

Results of the Chi^2 tests are presented in Figure 4. A significantly higher proportion of male experts is marked by a rhombus (◊). In contrast, a dash (-) marks the ages where the proportion of experts does not differ between the two genders. As Figure 4 indicates the difference between males and females is significant for the population below the age of 30 but vanishes in the fourth decade, when players are at their peak, showing that the proportion of female experts is the same as the proportion of male experts. The proportion of experts is higher in males than females for the whole population, but this fact is thus covering a more subtle reality.

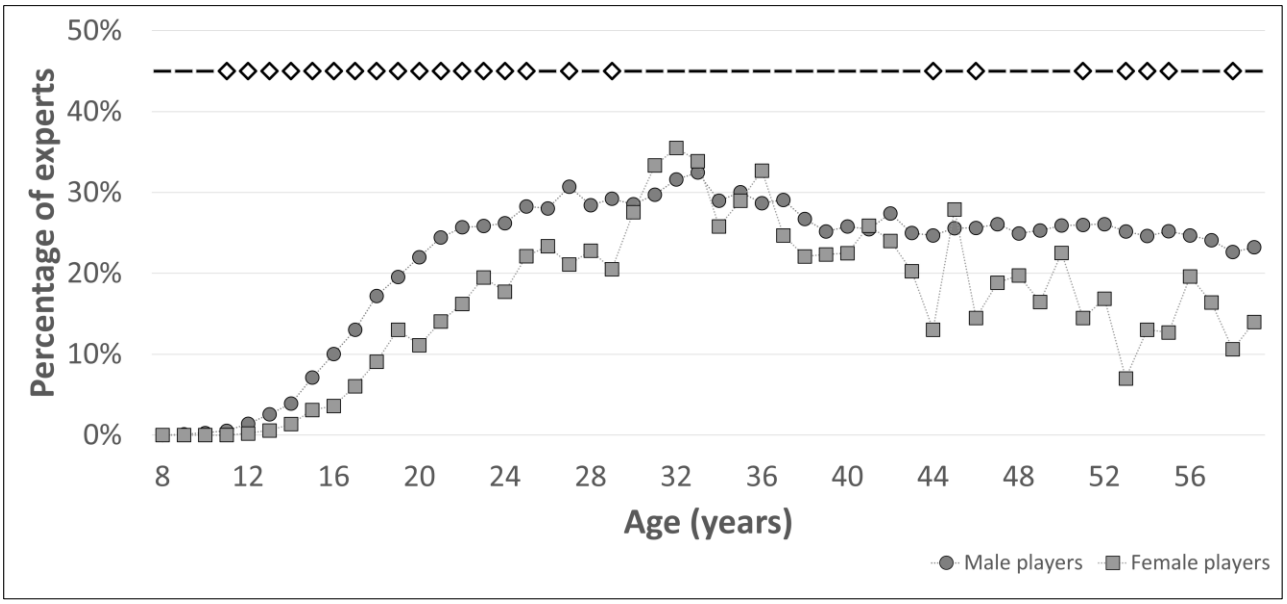

Figure 4. Proportion of experts within gender as a function age. (See text for details)

To examine the gender gap further, the rank distribution of females within the combined list of each decade was analyzed separately. Figure 5 shows the rankings and rating gaps between males and females for 5 different age groups: 0-19, 20-29, 30-39, 40-49, and 50-59. The data from players aged less than 10 were aggregated with the players belonging to the age bracket 10 to 19 as there were not enough data points to ensure statistical robustness. In all cases but the age group 30-39 women are well below the expected ranking as would be predicted by a negative hypergeometric distribution. The 30-39 age group displays two indicators of equality between the two genders. As the two panes indicate not only are the best women ranked in line with a hypergeometric distribution, but their ratings are similar to those of males, thus becoming undistinguishable in performance from male players of the same caliber.

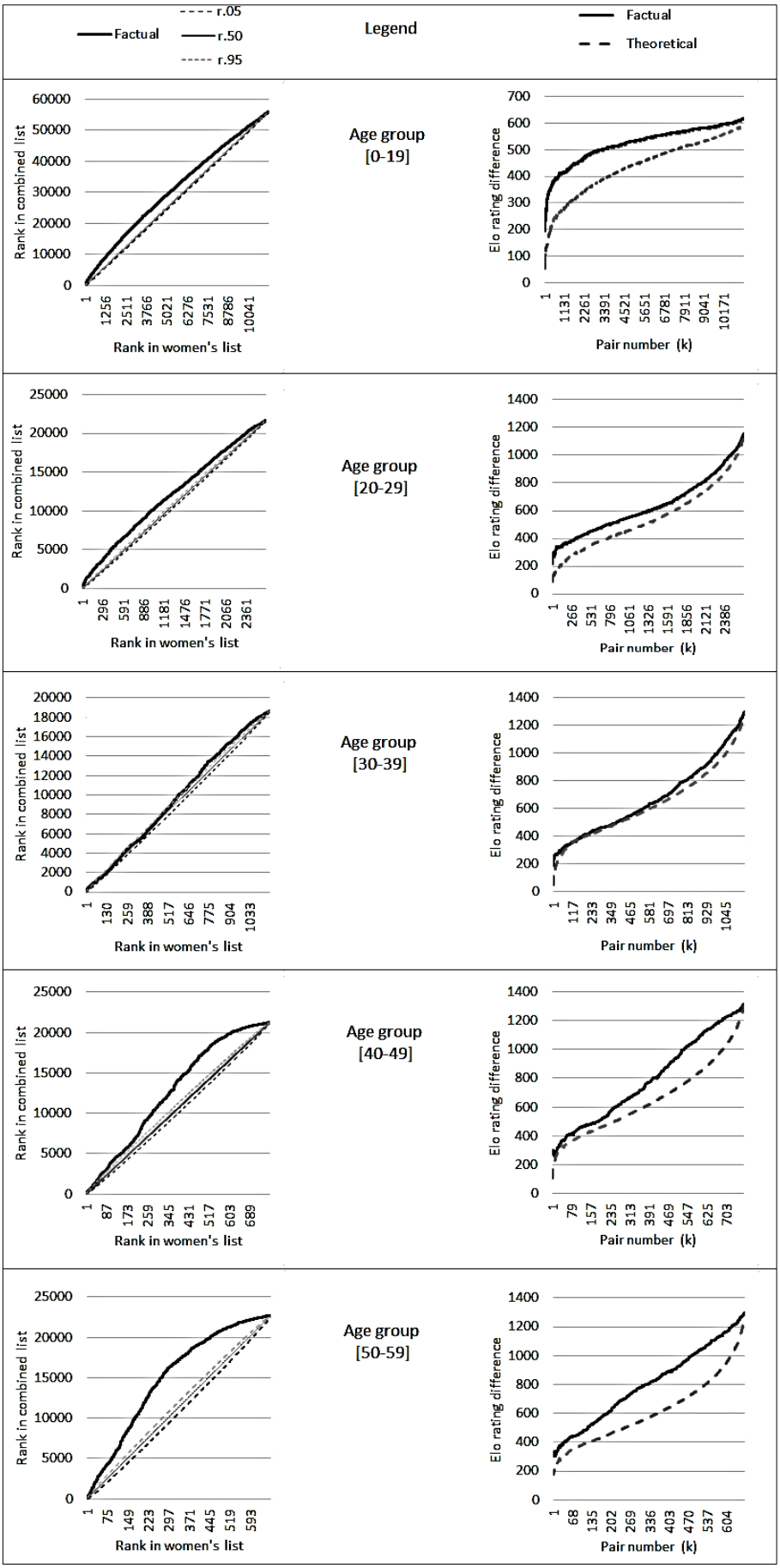

Figure 5. Rank ordering of females in the combined list and Elo differences for each of the age group.

Discussion

To test whether males are superior to females, chess rating and rankings have been compared over the life span. Each hypothesis has found supportive evidence. First, male players ratings were on average superior to female players ratings. Second, male expert players play better than female expert players. Third, the proportion of males in the sample is superior to the proportion of females. Beyond replicating these results, the study investigated how age modulated the average level of male and female players. These analyses revealed that the gender gap is cancelled for the best females in their thirties hence showing the male superiority is not systematic and hides a more complex reality.

The present analysis found that male chess players have a higher rating average than female players; a difference that has been consistently found in past studies (Bilalic et al., 2009; Chabris & Glickman, 2006; Howard, 2005, 2014). The difference of 197 Elo points is a large one if we consider that chess classes are defined by a 200 Elo point window (Elo, 1978). While Howard (Howard, 2005, 2014) suggested that such striking difference in chess ratings reflects innate differences in ability, other groups (Bilalic et al., 2009; Charness & Gerchak, 1996) argued that the stark differences in ratings are in fact largely attributable to vast differences in participation rates. The data analyzed in this paper have brought to light the fact that these interpretations of Elo ratings are under a methodological cloud. Female players were about 11 years younger on average than male players. Considering the age at which players peak in performance, previously found to be at about 43.8 years old (Roring & Charness, 2007), female players in our sample, aged 19.85 on average, have 24 years of improvement before they reach their peak. The massive age bias in the pool of players analyzed in previous studies has distorted reality, even more so as previous studies could include non-active players that would carry ratings that do not reflect the true playing skills of some players. Because of the age bias, comparing males' and females' ratings will necessarily lead to the conclusion of male dominance. By replicating previous results that indicate a male superiority in mean Elo ratings and in ranking positions, the present study seems to lend credence to the hypothesis of a systematic superiority of males over females in chess. But, a closer inspection of the gender gap per decade reveals a much more subtle reality.

The gender gap is significant when the players are less than 20 years old. The results show that female skill begins to flourish significantly in their twenties to peak in their thirties. The gap is thus progressively reduced up to the moment when there is no detectable difference between the two groups for the best players. This relative cancellation of the difference between the two genders is apparent when the players are in their thirties as indicated by both the analysis of Elo rating and rank ordering. A similar pattern is observed for experts. Intriguingly, not only is the difference in proportion of experts reduced during the 20s, but closer inspection here too indicates that the difference completely vanishes when the players reach their thirties. The gender gap reappears when the players are in their forties and is even more marked when the players are in their fifties. What the present study reveals is that the difference between males and females is partly an illusion which originates in the methodological approaches used insofar to examine the question of gender differences. The fact that the best females in their peak have a rating similar to males calls for challenging many of the explanations based solely on either intelligence or deliberate practice. Intelligence being a stable trait over the lifetime, there is no known mechanism that would compensate for a lower IQ while players are aging into their thirties. Regarding deliberate practice, it seems unlikely that players did not commit to the game in the first 20 years of practice and accumulate sufficient training in the second decade of play. The results also question the idea of the gender gap being due to the participation rate. A potential explanation for the observed trend is that the source for the usual finding of male superiority results from the differential rate of acquisition of the different components that

contribute to expertise. If this explanation holds true, then the gender gap in chess merely reflects that chess problem solving suits best the skills such as visuospatial processing that have evolved to favor males. Assuming the amount of practice is the same for males and females, scientists would be observing only differences that have been artificially created by cultural evolution (i.e., a game).

Before drawing general conclusions, it is important to bear in mind the methodological limits of the research reported in this paper. First, as the database provides only the year of birth, the ages used are accurate within one year. A player born on 31st December 1980 for example will be classed as 1980 and a player born one day later will be recorded as 1981. A margin of error of one year is not significant considering that the study spans about five decades of activity but could be of importance should future research address the first stages of expertise acquisition where much is acquired within the first years of practice. Second the results reported in the above are from a cross-sectional study instead of a longitudinal study. The cross-sectional study has allowed quantifying and comparing skills in males and females over 5 decades but it does not establish causality (Pearl, 2009). The problem is inherent to cross-sectional studies and can be overcome only by further experimental research. It is worth noting though that the key finding of the paper, that at a given age males and females have equal mean performance, cannot be denied even if the cause cannot be established. Future research should prioritize two points that stem from the previous limit on the ability to establish causality. A possibility is conducting a longitudinal, quasi-experimental study where the research team would monitor the cognitive development and decline of the players by applying a battery of cognitive and emotional tests on a regular basis. A third limit, unrelated to the two previous, also requires attention. While Roring and Charness (2007) found that players peak in their forties the present study has found, in line with Vaci et al. (Vaci et al., 2015), that they peak in their thirties. It is possible that the difference is due to the databases used. Roring and Charness (2007) used a database from Howard (2006) who acknowledged the limits of the database he developed. As the present results are based on a more recent database, that was trimmed of inactive players, there is reason to believe that players reach their peak well before they enter their fifth decade. Yet, further research is warranted in the field to understand how complex a skill as chess expertise develops over time. Such research will have an effect beyond chess expertise and demonstrate the length of time necessary to achieve one's best in intellectual performances that require cognitive skills and emotional control.

In conclusion, the explanations provided to account for gender differences in chess mirror the debate that rages in expertise between the scholars supporting an explanation exclusively based on nurture (Ericsson et al., 1993) and those who, in addition to nurture, attribute a role to nature (Burgoyne et al., 2016; Hambrick et al., 2014). Following the same division in theoretical orientations, scholars looking at the difference in performance between the two genders tend to attribute the differences either to innate traits (Howard, 2005, 2014) or to inequities in training conditions that create a statistical bias (Bilalic et al., 2009). The present paper has revealed that the relationship between skill and gender is much more complex than initially thought. None of the explanation provided so far can account for the complex pattern of female skills over the lifespan. The sole fact that females equate the performance of males at some point shows that the superiority of males is a circumstantial matter, that is the psychological reality that deserves further investigation.

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Author's Declarations

The author declares that there are no personal or financial conflicts of interest regarding the research in this article.

The author declares that the research reported in this article was conducted in accordance with the Ethical Principles of the *Journal of Expertise.*

The author declares that he is not able to make the dataset publicly available but is able to provide it upon request.

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