

Rise of human intelligence Comments on Howard (1999)

Fernand Gobet^{a,*}, Guillermo Campitelli^a, Andrew J. Waters^b

^a*ESRC Centre for Research in Development, Instruction, and Training, School of Psychology,
University of Nottingham, University Park, Nottingham NG7 2RD, UK*

^b*Transdisciplinary Tobacco Use Research Center, Georgetown University, Washington, DC 20007, USA*

Received 20 April 2001; received in revised form 24 September 2001; accepted 24 September 2001

Abstract

Based upon the evidence that the best chess players in the world are becoming increasingly represented by relatively young individuals, Howard [Intelligence 27 (1999) 235–250.] claimed that human intelligence is rising over generations. We suggest that this explanation has several difficulties and show that alternative explanations relating to changes in the chess environment, including increased access to chess knowledge, offer better explanations for the increased presence of young players at top-level chess. © 2002 Elsevier Science Inc. All rights reserved.

Keywords: Age; Chess; Expertise; Flynn's effect; Environment; Extreme-value distribution; Intelligence; IQ; Patent; Practice; SAT score; Visuospatial intelligence

1. Introduction

There is strong evidence that IQ test scores have steadily increased in industrialized countries for the last 75 years or more (e.g., Flynn, 1984, 1987). A number of explanations have been proposed, including better diet, more favourable educational opportunities and environmental conditions, and test sophistication (see Neisser, 1998, for review). However, the real meaning of this rise has been the subject of much controversy, with some authors suggesting that it reflects a true increase in intelligence (e.g., Lynn, 1990), while others denying that average intelligence is rising (e.g., Flynn, 1987; Neisser, 1997), citing counterevidence such as declining average SAT scores over the last decades or decrease in patent numbers in France and in the Netherlands.

* Corresponding author. Tel.: +44-115-951-5402; fax: +44-115-951-5324.

E-mail address: frg@psyc.nott.ac.uk (F. Gobet).

In order to settle this question using nontest, real-world data, Howard (1999) has reported interesting and useful data indicating that the best chess players in the world are becoming increasingly represented by relatively young individuals. He suggests that this reflects the fact that population intelligence is increasing over time; the more intelligent young players can outperform the less intelligent older players in high-level chess and thus dominate the domain. We agree that the young are tending to dominate top-level chess but disagree as to what is the most likely underlying cause for this phenomenon. In particular, we believe that Howard's conclusion that this increase is due to an increase of the population intelligence at large, while a possible explanation, does not account for the data better than other explanations that he rejects.

Here we argue that the rising intelligence hypothesis, while plausible, has some difficulties, and that the youth effect could be explained by the fact that younger players have greater access to chess-relevant knowledge and to better training techniques, which could be caused by a variety of social and cultural factors.

2. Difficulties with Howard's (1999) explanation

Howard (1999) takes the view that the young players are doing very well currently because they are more intelligent. To make this argument, he assumes that more intelligent individuals (as well as more chess-knowledgeable individuals) play better chess. Thus, he views chess skill as a kind of real-world behavioural marker for intelligence. Indeed, the fact that the young are now dominating chess is viewed by Howard as evidence that human intelligence is rising over generations.

A point that is not clear in Howard's (1999) account is why this increase in intelligence is not linear, which would be necessary to account for the sudden domination by young players, and why it seems to appear suddenly in the early eighties. No independent support is given for the presence of a (nonlinear) increase in intelligence over time such that currently young players are the beneficiaries of particularly high intelligence. Moreover, the other data used by Howard seem to go directly against this hypothesis: if anything, the SAT scores¹ suggest that population intelligence is going down, and the data about patents are inconclusive.²

¹ In order to explain the decrease in SAT scores, which Flynn (1987) takes as evidence against any rise of intelligence, Howard (1999, p. 246) notes that "[...] SAT is not a pure IQ test. Performance depends heavily on knowledge and skills acquired in the classroom and from print." Although we agree with this statement, we would like to suggest that the same explanation applies for chess skill (e.g., role of books in acquiring chess expertise).

² Fig. 5 of Howard (1999), depicting the total number of patents granted by the U.S. Patent Office since 1963, including patents from foreign countries, does show an increase. However, we disagree with Howard's analysis of his Fig. 6, showing the number of U.S. patents granted each year to U.S. sources per 100,000 of U.S. population, concluding that "patent numbers overall have risen since 1963" (p. 242). Fig. 6 of Howard does not show any increase, and eyeballing of the graph actually suggests a decrease. Howard argues by using beginning and ending points, essentially two arbitrary points, which is fully inappropriate for judging trends. Actually, a regression analysis done on these data (estimated from Howard's graph) shows that the patents numbers *decrease* as a function of time [patent = 28.87 - 0.013 year, $F(1,32) = 4.57$, $P < .05$, $r^2 = .12$]. In any case, as noted by Howard (p. 236), the interpretation of the patent data is problematic, as many confounding factors are present.

In addition, Howard's (1999) account is built on the assumption that intelligence, and in particular visuospatial intelligence, is important in chess play (p. 237). Although there is some evidence of a link between IQ measures and chess skill in children (Frank & D'Hondt, 1979; Frydman & Lynn, 1992), a link between intelligence and chess play has not been clearly established in adults, which is most relevant to the present discussion. One study has documented that chess masters perform better on some psychometric tests than non-chess-playing controls (Doll & Mayr, 1987), but other studies have not found differences (Djakow, Petrowski, & Rudik, 1927; Ellis, 1973). Most importantly, we are not aware of a single study that has shown that more skilled chess players outperform less skilled chess players on any psychometric test. Only two studies have investigated this issue: Waters, Gobet, and Leyden (in press) did not find that elite chess players (UK chess masters and grandmasters) perform better than less skilled amateur players on a task tapping visuospatial ability, and the other study (D. Lane, personal communication with N. Charness, 1980, mentioned in Cranberg & Albert, 1988, p. 161), which used a sample of players from novices to strong amateurs, also failed to identify any reliable correlation between chess ability and performance on a visuospatial task. Thus, there is little hard evidence at present to support Howard's key assumption that chess performance in adults is improved by intelligence.

In sum, we find difficulties with the intelligence-based account for the dominant performance of contemporary young players. Nonetheless, despite the lack of supporting evidence, it is still possible that a sudden increase in intelligence has recently occurred, and that these abilities might contribute to better chess play. However, we believe that there are alternative explanations for the dominance of the young that may provide as good an account as Howard's (1999). We detail these below.

3. Alternative explanations

Howard (1999) rules out two possible explanations: the role of coaching and practice, on the one hand, and factors known to improve performance in sports, on the other. With respect to the first explanation, Howard (p. 248) states that "we do not know that chess coaching is improving or that amount of practice is increasing or is more widespread or that players are learning the rules earlier. . ." With respect to the second explanation, he states that "physical sports performance has improved largely because of many known factors that do not affect chess performance. . .," and he eliminates as possible explanations factors such as better equipment, sport psychology, new coaching, and training techniques, and performance-enhancing drugs (p. 247). We suggest that Howard's rejection of these explanations is unwarranted. We first consider explanations related to coaching, age of starting playing, and amount of practice. We then address the question of how methods related to sport psychology may explain the data.

3.1. Coaching, amount of practice, and age of starting playing

There is strong evidence that there have been important changes in coaching and teaching methods in the last decades. In particular, changes in two methods of information

transmission have had a clear impact on chess training: books and computer software. The quality and quantity of chess books have increased over the last decades, with such publications as the *Chess Informant*, *New in Chess*, and technical monographs on chess openings allowing a rapid access to the relevant information (e.g., Charness, 1991). As a matter of fact, Charness, Krampe, and Mayr (1996) have shown that skill strongly correlates with the logarithm of the number of chess books owned. While both younger and older participants might be expected to benefit from this development, it is likely that it may benefit the young more if they have more time to take advantage of these materials (e.g., if they are more likely to be professionals; see below).

Chess programs and computer databases have only been in widescale use among chess grandmasters for about the last 15 years,³ but they already have revolutionized the way top players train and prepare themselves for tournaments. These computational resources may be particularly important in allowing top-level players to prepare themselves for important matches (for example, by enabling easy access to previous matches involving the opponent). Good preparation is considered vital in top-level matches; the 37-year-old Kasparov ascribed his recent defeat to the 25-year-old Kramnik in the World Chess Championship to the latter's superior preparation (ten Geuzendam, 2000).

As mentioned by Howard (1999, p. 237), young people adapt faster to technology for reasons not related to intelligence, which could readily explain most of the effect Howard has identified. Interestingly, the series of records of youngest grandmasters (Table 1 of Howard, 1999), which started almost 30 years after Fischer's record in 1958, occurred shortly after chess computer databases became widely available. Similarly, the sudden rise in the proportion of very young players—under 25 years old—in the top 50 (Fig. 2 of Howard, 1999) also occurs after the introduction of chess databases.

There is also strong evidence that the best players of today have started playing earlier, which could go a long way in explaining the series of age records in obtaining grandmaster title. In his book on chess psychology, Krogus (1976) reports that the average starting age of 60 of the best players in the world between Philidor and Karpov was 10.5 years. Considering only the players born in this century, the average starting age is 9 years. Ericsson, Krampe, and Tesch-Römer (1993, p. 389), noting that the starting age of the sample of grandmasters in Doll and Mayr (1987) was 7.2 years, suggest that these data show a historical trend toward younger starting ages. Currently, the starting age is even much younger than in Doll and Mayr's sample. For example, the four players who broke the age record for becoming a grandmaster (Polgar, Leko, Bacrot, and Ponomarev; see Table 1 of Howard, 1999) started at 4, 7, 4, and 7 years, respectively. Incidentally, all had top-level coaches and training environments early on in their career (e.g., Forbes, 1992). As a consequence of the earlier starting age, players become chess professionals earlier, which impacts on their amount of deliberate practice. We now show that amount of practice has also increased in the last decades.

Evidence that amount of practice has increased can be seen from the increase of the number of tournaments, which gives more playing opportunities. Table 1 shows the number

³ ChessBase, the first widely used computer database, appeared on the market in 1987.

Table 1
 Number of tournaments as a function of decade (data from ChessBase, 2000)

Decade	Number of tournaments
1990–1999	8120
1980–1989	1931
1970–1979	871
1960–1969	695
1950–1959	434
1940–1949	239
1930–1939	296
1920–1929	283
1910–1919	143
1900–1909	153

of tournaments stored in the ChessBase (2000) database per decade. From 1900–1909 to 1990–1999, there is a 53-fold increase. Fig. 1 shows that top players who were born in the last decades played more games at young ages (e.g., at 13, 16, and 19 years) than top players

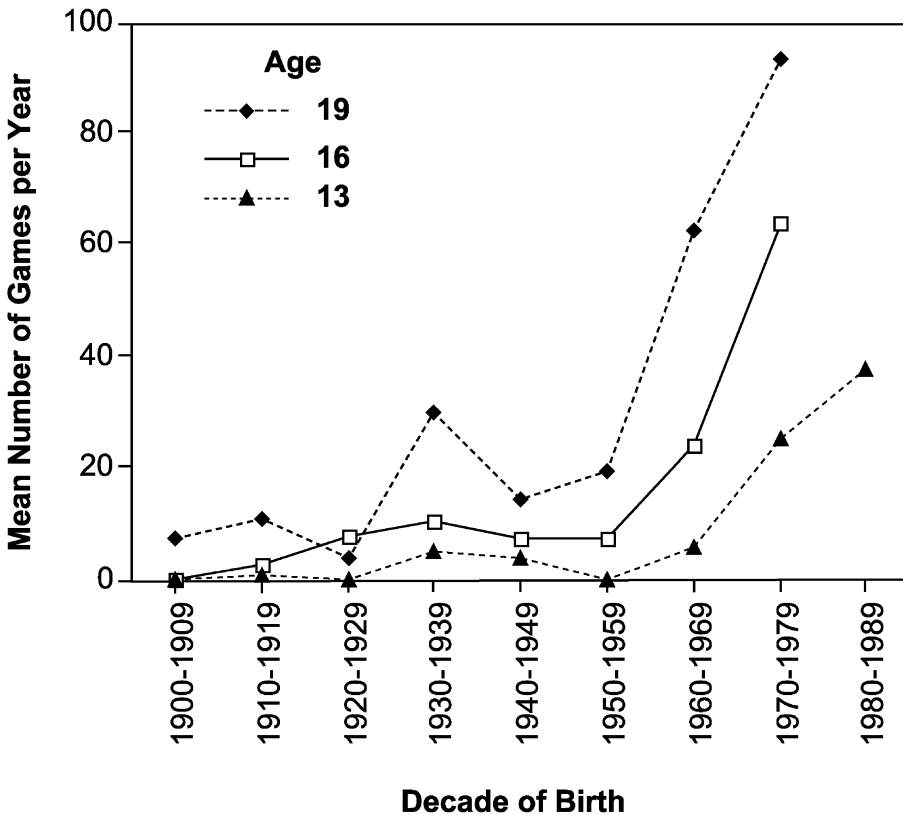


Fig. 1. Number of games played at a given age by the five stronger grandmasters born in each decade (data taken from ChessBase, 2000).

who were born in previous decades. Incidentally, the money prizes of these tournaments has also improved. For example, while in 1972 Fischer and Spassky played their world championship for a US\$250,000 total prize, in 1990, Kasparov and Karpov competed for a US\$3,000,000 total prize. Indeed, Fischer is credited for raising chess prizes to a “reasonable” level: the previous world-championship matches held in Soviet Union involved little money. Interestingly, we again find that the seventies witnessed a key change in the chess world.

The increase in number of tournaments and the increase in prize money at professional level have led to more opportunities to turn professional in recent times. De Groot (1978, pp. 362–364) presents a table with the occupation of 55 grandmasters, from Philidor (born in 1726) to Fischer (born in 1943). More than 70% had an academic or professional training outside of chess (e. g., law, mathematics, engineering) and about one-third were chess professionals. Nowadays, most top grandmasters are chess professionals and will spend most of their time studying chess. Thus, if there are currently more professionals among the young players than the old players, this is likely to favour the performance of the former. Younger players may also be more mobile than older players (e.g., due to lack of family obligations), which allows them to travel and participate in a greater number of tournaments, and thus gain valuable experience.

3.2. *Factors related to sport*

While we agree with Howard (1999) that equipment plays only a minor role in chess games and has stayed stable, we believe that sport psychology has been applied to chess and has improved over the years. Krogus’ (1976) popular book on chess psychology describes improvement techniques rather informally (e.g., blindfold chess, simultaneous games, or rapid games), but more recent monographs on chess training directly import training techniques from sport psychology (e.g., Bönsch, 1987; Munzert, 1988). Like in other sports, these changes in training techniques are more likely to benefit the young (Danish, Petitpas, & Hale, 1995).

As doping tests have been applied in chess only very recently,⁴ it is not possible to find official cases of doping; however, anecdotal evidence suggests that at least some chess players use illegal drugs and food supplements to enhance performance in chess competitions (Ree, 1999).

3.3. *Number-based explanations*

According to Howard (1999), “perhaps the strongest evidence that the age decline is due to an intelligence rise is the four new grandmaster age records set since 1991” (p. 247). However, the type of mathematical analysis used by Charness and Gerchak (1996) to explain

⁴ Since the acceptance in 2000 of chess as an Olympic sport, antidoping regulations have been introduced by the world chess federation and by national federations.

why Russian and males dominate chess can account for these records easily, without incorporating any notion of intelligence. The idea, which follows directly from the mathematics of extreme-value distributions (Lindsey, 1995), is that the expected highest achievement in a group is a function of its size. Thus, the decrease in the age of becoming a grandmaster could be due to the fact that more people (and, proportionally, more youngsters) are playing than before. There is strong evidence that this is the case. For example, the list used by the U.S. Chess Federation had 19,405 players in 1977 and 26,665 players in 1990 (Charness & Gerchak, 1996), and the list of the International Chess Federation had about 600 players in 1971 (this lists only included players with a minimum of 2200 points) and about 18,000 in 2001 (with the same minimum of 2200 points). Just by chance, the record of youngest grandmasters is more likely to be beaten if more people are playing.

3.4. Changes in the chess environment

We would like to argue that changes in ratings reflect more changes in the sociology of chess than changes in average human intelligence. Contrary to what Howard (1999, p. 236) states, the chess environment has changed drastically (we have already mentioned the presence of more knowledge sources, including computer programs and databases). Significantly, the balance between knowledge and experience, on the one hand, versus physical stamina and age-related decline, on the other, has clearly shifted towards the latter; changes in chess regulations, which have mainly occurred in the last 20 years, have resulted in less thinking times. While, until the seventies, the typical tournament game was played with a thinking time of 2.5 hours for 40 moves, with an adjournment after 40 moves, nowadays the thinking time is only 2 hours for 40 moves, and adjournments have disappeared and have been replaced by “sudden-death” arrangements. There are also less resting days in tournaments. Finally, it is now common to use semirapid (30 minutes for the entire game) and rapid games (5 minutes for the entire game) to break ties in tournament, mainly to make tournaments more exciting for spectators and the media. As cognitive and perceptual abilities are known to decrease starting from the twenties (Birren & Schaie, 1996), these changes differentially favour the young. The negative effects of age on chess players’ memory and search processes have been documented by Charness (1981a, 1981b).

An important point in Howard’s (1999) argumentation is that intelligence suddenly changed in the USSR and Russia in the last 30 years, while several putative causal factors had been present since 1920, such as the fact that chess was a national sport, that many millions played, that chess participation rate was very high, that chess was taught in schools and factories, and that talent was identified early and given special training, sizeable government salaries, and overseas travel. Howard’s reasoning is that if these factors, rather than rising general intelligence, were the explanation for the decreasing age of younger chess top players after 1970, the age trends should have appeared earlier. However, several reasons, some of them already mentioned, can explain this phenomenon. For example, the USSR did not encourage professionalism and forced players to get an academic background, forbidding players to spend all their time playing chess as some do now; there is increased availability of better learning methods (books, computers); the number of tournaments has increased steadily since

1970, and more money is involved; and there are more opportunities to play abroad (cf. the flood of players from the former USSR after the breakdown of communism in eastern Europe).

4. Conclusion

Motivated by Flynn's (1984, 1987) research adducing strong evidence that IQ test scores have been rising for several decades and by the controversy of whether this evidence indicates an increase in intelligence, Howard (1999) has collected nontest, real-world data from the domain of chess, from the number of patent granted and from educational statistics. In the discussion, Howard notes that "the overall results are consistent with the view that average human intelligence really is rising" (p. 246). As we have seen, however, the SAT scores and the patent data do not support this assertion, and the chess data can be accounted for by a number of alternative explanations.

Ironically, the case could be made that today's chess players are *less* intelligent than before. As we have seen, contemporary top-level grandmasters are professionals, while their counterparts in the past had a variety of occupations, including lawyers, engineers, and scientists (De Groot, 1978). The ability to reach a high level of performance in two different domains can be seen as strong evidence for intelligence and the "narrowness" of contemporary grandmasters' interests could be taken as indicating a smaller intelligence.

In sum, contemporary younger players have typically started chess at an earlier age, they are more likely to be professional, they can make greater use of computational and other chess resources, they may benefit more from advances in chess training, and, probabilistically, they are more likely to yield grandmaster-level players very early because of the size of the chess-playing population. We suggest that these factors may cumulatively underlie the youth effect in top-level chess in addition to, or instead of, any intelligence-related effect.

References

- Birren, J. E., Schaie K. W. (Eds.) (1996). *Handbook of the psychology of aging* (4th ed.). San Diego, CA: Academic Press.
- Bönsch, E. (1987). *Schachlehre für Lehrende und Lernende* (Chess teaching for teachers and learners). (2nd ed.). Berlin: Sportverlag.
- Charness, N. (1981a). Aging and skilled problem solving. *Journal of Experimental Psychology, General*, *110*, 21–38.
- Charness, N. (1981b). Visual short-term memory and aging in chess players. *Journal of Gerontology*, *36*, 615–619.
- Charness, N. (1991). Expertise in chess: the balance between knowledge and search. In K. A. Ericsson, & J. Smith (Eds.), *Studies of expertise: prospects and limits* (pp. 39–63). Cambridge: Cambridge University Press.
- Charness, N., & Gerchak, Y. (1996). Participation rates and maximal performance: a log-linear explanation for group differences, such as Russian and male dominance in chess. *Psychological Science*, *7*, 46–51.
- Charness, N., Krampe, R., & Mayr, U. (1996). The role of practice and coaching in entrepreneurial skill domains: an international comparison of life-span chess skill acquisition. In K. A. Ericsson (Ed.), *The road to excellence* (pp. 51–80). Mahwah, NJ: Erlbaum.
- ChessBase (2000). ChessBase big database 2000. Hamburg: ChessBase.

- Cranberg, L., & Albert, M. L. (1988). The chess mind. In L. K. Obler, & D. Fein (Eds.), *The exceptional brain. Neuropsychology of talent and special abilities* (pp. 156–190). New York: Guilford Press.
- Danish, S. J., Petitpas, A., & Hale, B. D. (1995). Psychological interventions: a life development model. In S. H. Murphy (Ed.), *Sport psychology interventions* (pp. 19–38). Champaign, IL: Human Kinetics.
- De Groot, A. D. (1978). Thought and choice in chess. The Hague: Mouton (De Groot, revised translation published 1946, 2nd ed.).
- Djakow, I. N., Petrowski, N. W., & Rudik, P. A. (1927). *Psychologie des Schachspiels* (Psychology of the game of chess). Berlin: de Gruyter.
- Doll, J., & Mayr, U. (1987). Intelligenz und Schachleistung—eine Untersuchung an Schachexperten (Intelligence and performance in chess—a study of chess experts). *Psychologische Beiträge*, 29, 270–289.
- Ellis, S. H. (1973). *Structure and experience in the matching and reproduction of chess patterns*. Unpublished doctoral dissertation, Carnegie Mellon University, Pittsburgh, PA.
- Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100, 363–406.
- Flynn, J. R. (1984). The mean IQ of Americans: massive gains 1932 to 1978. *Psychological Bulletin*, 95, 29–51.
- Flynn, J. R. (1987). Massive IQ gains in 14 nations: what IQ tests really measure. *Psychological Bulletin*, 101, 171–191.
- Forbes, C. (1992). *The Polgar sisters: training or genius?* New York: Henry Holt.
- Frank, A., & D'Hondt, W. (1979). Aptitudes et apprentissage du jeu d'échecs au Zaïre (Aptitudes and learning of the game of chess in Zaïre). *Psychopathologie Africaine*, 15, 81–98.
- Frydman, M., & Lynn, R. (1992). The general intelligence and spatial abilities of gifted young Belgian chess players. *British Journal of Psychology*, 83, 233–235.
- Howard, R. W. (1999). Preliminary real-world evidence that average human intelligence really is rising. *Intelligence*, 27, 235–250.
- Krogius, N. (1976). *Psychology in chess*. London: R.H.M. Press.
- Lindsey, J. K. (1995). *Introductory statistics. A modelling approach*. Oxford: Oxford Press.
- Lynn, R. (1990). The role of nutrition in secular increases in intelligence. *Personality and Individual Differences*, 11, 273–285.
- Munzert, R. (1988). *Schachpsychologie* (The psychology of chess). Hollfeld: Beyer.
- Neisser, U. (1997). Rising scores on intelligence tests. *American Scientist*, 85, 440–447.
- Neisser, U. (1998). *The rising curve*. Washington, DC: American Psychological Association.
- Ree, H. (1999). The road to lowly paid slavery. *New in Chess*, 7, 81–84.
- ten Geuzendam, D. K. (2000). Kasparov–Kramnik, Part 2. *New in Chess*, 8, 48–71.
- Waters, A. J., Gobet, F., & Leyden, G. (in press). *Visuo-spatial abilities in chess players*. *British Journal of Psychology*.