



Perceptual and visuospatial abilities in chess players: a cross-sectional study

Corresponding Author:

Dr. Francesco Masedu,
University of L'Aquila, Medicine and Public Health - Italy

Submitting Author:

Prof. Marco Valenti,
University of L'Aquila, Medicine and Public Health - Italy

Article ID: WMC00668

Article Type: Research articles

Submitted on: 19-Sep-2010, 11:03:49 AM GMT **Published on:** 19-Sep-2010, 12:06:54 PM GMT

Article URL: http://www.webmedcentral.com/article_view/668

Subject Categories: PSYCHOLOGY

Keywords: Perception, Visuospatial skills, Chess, Intelligence, GEFT test, GAT-2 test, Multivariate analysis, Cross-sectional study

How to cite the article: Masedu F , Di Sabatino S , Benzi M , Tamorri S , Valenti M . Perceptual and visuospatial abilities in chess players: a cross-sectional study . WebmedCentral PSYCHOLOGY 2010;1(9):WMC00668

Source(s) of Funding:

Funding based on grants accounted to Prof Valenti at L'Aquila University.

Competing Interests:

No competing interests.

Perceptual and visuospatial abilities in chess players: a cross-sectional study

Author(s): Masedu F , Di Sabatino S , Benzi M , Tamorri S , Valenti M

Abstract

The differences in ability of chess players at different skill levels to copy and to recall positions are attributable to the experts' storage of thousands of chunks (patterned clusters of pieces) in the long-term memory.

The aim of this study was to check differences in perceptual tasks and the visuo-spatial abstraction cognitive ability of chess players compared to non-players.

A cross-sectional study was conducted by comparing the perceptual and visuo-spatial performance of 50 agonistic chess players, and a referent group of 50 age- and education-matched non-players. The following tests were undertaken by the participants: Group Embedded Figure Test (GEFT), General Ability Test 2 (GAT-2 Abstract and Spatial modules).

The status of chess player does not affect the outcome of the GEFT perceptual test or the GAT-2 abstract test, whereas a significant effect is demonstrated by the GAT-2 spatial test. This study reveals a significant difference in visuo-spatial abilities between chess players and non-players, after adjusting for age, whereas no difference could be demonstrated with respect to perceptual or abstraction skills. Visuo-spatial abilities seem not to be influenced by age, and one wonders whether visuo-spatial ability is developed only in a specific form in chess players rather than in more general forms.

Introduction

Chess is an often-used study domain in psychology and artificial intelligence because it is well defined, its performance rating systems allow easy identification of experts and their development, and chess playing is a complex intellectual task [1-3].

The extent to which the acquisition of expertise in knowledge-rich domains like chess can be influenced by general individual characteristics, such as intelligence, remains unclear. Some previous studies with children have documented significant correlations between chess skill and performance on some psychometric tests, such as performance IQ. However, no evidence was found for a correlation between

chess skill and visual memory ability in a group of adult chess players [4]. These findings, together with other data in the literature, suggest there is surprisingly little evidence that chess skill and visuospatial ability are associated in adults. On the other hand, robust results [5] suggest that a high level of general intelligence and of spatial ability are necessary to achieve a high standard of play in chess: the high spatial ability of young chess players suggested by the high performance IQs may go some way towards explaining why males tend to be more numerous than females among high-standard chess players.

Howard [6] claims that male dominance in chess is consistent with the evolutionary psychology view that males predominate at high achievement levels at least partly because ability difference is based on the premise that top level chess skill depends on a high level of IQ and visuospatial abilities. Bilalic and McLeod [7] have strongly contested this premise as not being supported by empirical evidence, since in 1927 Djakow et al. showed that world-class chess players do not have exceptional intellectual abilities [8], and this finding has subsequently been confirmed many times: different participation rates, or differences in the amount of practice, motivation and interest for chess in male and female chess players, may provide a better explanation for gender differences in chess performance [9]. In reply, Howard [10] maintains there are excellent logical reasons to expect strong ability/chess expertise links but specific research evidence to date is sparse, with mixed findings: i.e. data from Georgia, which has a high female participation rate in chess, suggest that differing gender motivation levels and participation rates impact relatively little on chess performance differences at the extreme.

Chase and Simon [11] demonstrated that the differences in ability of chess players at different skill levels to copy and recall positions are attributable to the experts' storage of thousands of chunks (patterned clusters of pieces) in the long-term memory. This finding has been confirmed several times [12,13].

After reviewing the relevant theory on chess expertise, the data by Gobet and Simon [14] regarding latencies and chess relations between successively placed pieces are highly correlated with those of Chase and Simon. They conclude that chunks have psychological

reality, and extend the chunking theory to take account of the evidence for large retrieval structures (templates) in long-term memory. It is suggested that chess players, similar to experts in other recall tasks, use long-term memory retrieval structures [15] or templates in addition to chunks in short-term memory to store information rapidly; indeed, expert players recall more pieces than is predicted by the chunking theory in its original form.

The theory, which unifies low-level aspects of cognition, such as chunks, with high-level aspects, such as schematic knowledge and planning, proposes that chunks are accessed through a discrimination net, where simple perceptual features are tested, and that they can evolve into more complex data structures (templates) specific to classes of positions. Implications for the study of expertise in general include the need for detailed process models of expert behaviour and the need to use empirical data spanning the traditional boundaries of perception, memory and problem solving.

Overall, the literature suggests that further studies are needed in this domain.

Objective

The aim of this study was to check the differences in perceptual tasks and visuo-spatial abstraction cognitive ability of chess players compared to non-players.

Methods

The study design was cross-sectional. It was conducted by comparing the perceptual and visuo-spatial performance of two groups of male subjects, a study group of 50 agonistic chess players (with an average ELO rating – i.e. the official rating approved by the International Chess Federation – of 1727, range 1500–2261) and a referent group of 50 non-players with no knowledge even of chess rules. The 50 chess players were selected randomly from the subscribers' list of the Italian Chess Federation in the catchment area of study (L'Aquila and Teramo, central Italy), between March and May 2008. The 50 controls, matched to chess players by age (± 3 years) and educational qualifications, belonged to the male population of the catchment area, and were randomly selected from lists of university students and employees fitting the matching criteria.

The age range of the sample is 23–75 years (mean age 41 years for chess players, 39.5 years for non-players).

Each group included 20 subjects aged between 21 and 35 years (mean age 30 years for chess players,

28 years for non-players), 20 subjects aged between 36 and 50 years (mean age 40 years for chess players, 39 for non-players) and 10 subjects aged between 51 and 75 years (mean age 66 for chess players, 67 for non-players).

Of the subjects, 56% are graduates (52% with a scientific degree) and the remaining 44% have a high school diploma.

With regard to current occupations, in the group of chess players 20% are students, 54% workers, 13% unemployed and 13% retired, and in the control group 37% are students, 54% workers, 3% unemployed and 6% retired.

Measures

The following tests were administered to the participants:

Group Embedded Figure Test (GEFT) [16]. The GEFT is a perceptual test. The subject's task on each trial is to locate a previously seen simple figure within a larger complex figure which has been so organized as to obscure or embed the sought-after simple figure. In the strictest interpretation, therefore, scores on the EFT reflect the extent of competence at perceptual disembedding. Individual differences in EFT performance, however, appear to relate to more than differences in perceptual functioning; hence the specific rationale for using EFT to assess broad dimensions of personal functioning and the place of EFT performance in the context of a cognitive-style framework. The test measures the ability to grasp details without being 'distracted' by the complexity of the picture (analytical processing).

The test has a scale with scores ranging between 0 and 18. The final score is calculated by adding the total number of correct answers. These results are interpreted according to different reference models. The model used for high-profile cultural level deemed subjects with a score less than or equal to 10 as field dependent, with a score between 11 and 13 as neutral and with a score 14 or above as field independent.

General Ability Test 2 Abstract module (GAT-2 abstract)[17].

This is a pure logic 36-item test, where the subject is faced with a sequence of figural problems that require perceiving relations between abstract figures and arriving at a generalization without any language support. The test measures the ability to extrapolate the exact logical elements denoting relations between the various figures and to choose accordingly the figure resulting from the series which is the exact summary of the above. The GAT-2 abstract score ranges from 0 to 36. The individual score is calculated by adding the total number of correct answers.

General Ability Test 2 spatial module (GAT-2 spatial).

This is a visuo-spatial 80-item test, where the subject must handle processing complex geometrical shapes from the flat into three-dimensional objects. The test measures the ability to handle mental representations of geometric figures and, therefore, to choose between the various possible items proposed. The GAT-2 spatial score ranges from 0 to 36. The individual score is calculated by adding the total number of correct answers.

Both GAT-2 abstract and spatial modules were available in the Italian validated version [18]. None of the participants in the study were experienced with the administration of the mentioned tests.

Statistical Analysis

Data were modelled by a multivariate analysis of variance (MANOVA), assuming as dependent variables the normalized scores of the psychological tests (GEFT, GAT-2 abstract, GAT-2 spatial), and as independent covariates the status of chess player (player/non-player) and the age category (21–35, 36–50, 51–75 years). Age category, as an ascertained influencing factor of the cognitive area, was taken in the model as a source of error. Thus the model allowed an evaluation of the effect of the main covariate (status of chess player) on the psychological test results, adjusting for the effect of age taken as a source of error.

Results

Table 1 shows the test mean values by ages and groups.

The MANOVA analysis (Table 2) shows a good model fitting including all the dependent variables examined. The analysis of covariates shows that the status of chess player does not affect the outcome of the GEFT perceptual test or the GAT-2 abstract test, whereas a significant effect is shown for the GAT-2 spatial test.

Age significantly determines effects on GEFT, whereas it does not significantly influence the results of both the GAT-2 abstract and spatial tests.

Quite similar results were obtained when the age group was considered as simple covariate and not as a source of error (data not shown).

Discussion

One of the most fascinating aspects of chess is that, while respecting the rules, there is no prescribed way of playing. The classic-era chess world champion Jose Raul Capablanca believed there must be different patterns of conduct of the game and choosing

between them depends only on the individual characteristics of the player.

Analysis of the protocols of various players, when the choice of moves in a given position is taken into account, showed that even players of the same strength often think in very different ways.

It is very difficult to discern the sort of algorithm that players have in their mind, as is usually the position itself, which suggests the requested 'strategy of thought'. In any case 'calculating', i.e. the ability to visualize and plan, from a chess configuration, as many as possible variations of sound game situations, is crucial in chess analysis.

Schematically, a way to classify styles in playing chess is the dichotomy [19] between tactical style (based on problem solving, it benefits from improved efficiency and speed of calculation) and positional-style strategy (a logical order or meaning given by groups of moves in succession and because of this made up of procedures to bear in mind at the same time).

The problem is that often tactical thinking and positional-strategic thinking are so completely intertwined and mutually interdependent that defining a player in either way is, usually, just a subjective view; there can never be precise definitions.

The game of chess allows intelligence to be discussed in a relative sense, referring to the ability of scheduling the game better than does the opponent to achieve the goal, that is victory. Briefly, we are used to talking about 'intelligent chess playing' behaviour, in the sense that we increase the chances of victory through careful planning exploiting as best as possible our knowledge. The ability to create a system of knowledge and experience considered as a very large reserve of chess diagrams as an 'intuitive database' requires a certain kind of intelligence, although some people are more inclined to think in a pure logical fashion than others. In this respect there are strong players, even great masters, who are not logically gifted at all but possess a large pool of patterns that make possible a rapid and positional perception of good quality [20].

On the other hand, based on empirical evidence, it seems that creative development is not well correlated with IQ. In fact, some studies [21] found that there is no relationship between higher IQ and higher scores of creative performance.

With reference to the game of chess and the ELO scoring, Levitt [19] has formulated the formula:

$$ELO \approx (10 \times IQ) + 1000.$$

Although Levitt himself does not take too seriously this equation, it represents an attempt to establish, on the basis of a set of parameters, the maximum reachable strength of a player according to ELO.

The tactical thought fits questions with exact answers better, so that it combines better with the IQ test: therefore it is natural to expect a high score. The strategic and positional thought, instead, resorts more to decision, to the intuitive database as well as assumptions, so it matches better to questions with no answers, which by their nature, do not fit well to the IQ tests.

If the strength of a player as a result of these two styles of thought is considered, it is certainly possible that two players have quite different styles but possess the same overall strength in their chess playing.

The question of the relationship between intelligence and strength in chess playing is better explained by the fact that computers can achieve levels of strength (measured in ELO) higher than humans, although not adopting intelligent behaviour. In fact, the problem is the computational complexity of the algorithm: the number of moves to analyse and store grows exponentially as the number of moves of the game increase. This means that soon numbers so large are reached that all the moves cannot be analysed in a reasonable time even by a very well-performing computer.

Given the result of a chess game, the computer, differently from man, does not use any intelligent behaviour. This enormous computing power makes the computer a tough opponent bestowing on it an almost perfect tactical game provided that the variations generated do not go beyond the scope of the machine.

The best tactical humans, in fact, cannot compete with this style playing against a computer in the vast majority of positions, but retain a distinct advantage in judging and in strategic and positional style of play in which awareness, intuition and mental plasticity, present in humans and absent in the machine, are key to reaching the goal.

In the competitive game an element to consider is the incidence of age, analysed in two respects: the age at which starting to play and the age during a game. No players who have reached the highest levels began practising the sport after the age of 20 years. Perhaps the explanation lies in the potential and talent in a specific subject in the form of predispositions developed at a young age [22]. On the other hand, the majority of older players lose many of their competitive skills, but their visuospatial abilities remain quite stable throughout life: hence evidence that many intrinsic and extrinsic factors affect the strength of a chess player.

The statistical results of our study show a significant difference in visuo-spatial abilities between chess players and non-players, after adjusting for age, whereas we could not demonstrate any difference with

respect to perceptual or abstraction skills. Visuo-spatial abilities seem not to be influenced by age. Reflecting on the results, one wonders whether visuo-spatial ability is developed only in a specific form in chess players rather than in more general forms.

The hypothesis of a cognitive development due to highly specific forms could find a favourable match in the same way that it has been found in other cognitive skills of the game already analysed, such as that of memory, as already seen, has grown so precisely through the recognition of thousands of patterns and chunk positions of the game.

Conclusion(s)

It is definitely clear that chess deals with many aspects of mental functioning. Many forms of attention and memory are involved, and there is good evidence of the full involvement of thought in its multifaceted insights and deductions.

Authors Contribution(s)

Francesco Masedu draft the manuscript and conducted the statistical analysis.

Stefano Di Sabatino recruited the subjects and participated into the test administration.

Manuela Benzi and Stefano Tamorri interpreted the perceptual and visuospatial test results.

Marco Valenti designed the study protocol.

References

1. Holding, D.H. (1992). Theories of chess skill. *Psychological Research*, 54, 10-16.
2. Gobet, F., de Voogt, A.J. & Retschitzki J. (2004). *Moves in Mind: The Psychology of Board Games*. London: Psychology Press.
3. Howard, R.W. (2006a). A complete database of international chess players and chess performance ratings for varied longitudinal studies. *Behavioural Research Methods*, 38, 698-703.
4. Waters, A.J., Gobet, F. & Leyden, G. (2002). Visuospatial abilities of chess players. *British Journal of Psychology*, 93, 557-565.
5. Frydman, M. & Lynn, R. (1992). The general intelligence and spatial abilities of gifted young Belgian chess players. *British Journal of Psychology*, 83, 233-235.
6. Howard, R.W. (2005). Are gender differences in high achievement disappearing? A test in one

intellectual domain. *Journal of Biosocial Science*, 37, 371-380.

7. Bilalic, M. & McLeod, P. (2006). How intellectual is chess? A reply to Howard. *Journal of Biosocial Science*, 38, 419-421.

8. Djalow, I.N., Petrowski, N.W. & Rudik, P.A. (1927). *Psychologie des Schachspiels*. Berlin: de Gruyter.

9. Linn, M.C. & Petersen, A.C. (1985). Emergence and characterization of sex differences in spatial ability: a meta-analysis. *Child Development*, 56, 1479-1498.

10. Howard, R.W. (2006b). IQ, visuospatial ability and the gender divide: A reply to Bilali? and McLeod. *Journal Biosocial Science*, 38,423-426.

11. Chase, W.G. & Simon, H.A. (1973). Perception in chess. *Cognitive Psychology*, 4, 55-81.

12. Charness, N. (1976). Memory for chess positions: Resistance to interference. *Journal of Experimental Psychology*, 2, 641-653.

13. Lories, G. (1987). Recall of random and non-random chess positioning in strong and weak players. *Psychologica Belgica*, 27, 153-159.

14. Gobet, F. & Simon, H.A. (1998). Expert chess memory: Revisiting the chunking hypothesis. *Memory*, 6, 225-255.

15. Ericsson, K.A. & Chase, W.G. (1982). Exceptional memory. *American Scientist*, 70, 607-615.

16. Witkin, H.A., Oltman, P.K., Raskin, E. & Karp, S.A. (2002). *Group Embedded Figure Test: Manual and Sampler Figures and Scoring*. Menlo Park, CA: Mind Garden Inc.

17. Smith, P., Whetton, C. & Caspall L. (2007). *GAT-2 General Ability Test-2*. Firenze: Giunti OS Organizzazioni Speciali Editore.

18. Chiarotti, S. & Di Fabio, A. (2007). Norme Italiane (appendice A). In *GAT-2: General Ability Test-2* (edited by Smith, P., Whetton, C. & Caspall, L). Firenze: Giunti OS Organizzazioni Speciali.

19. Levitt, J. (1997). *Genius in Chess*. London: Batsford.

20. De Groot, A.D. (1965). *Thought and Choice in Chess*. The Hague: Mouton & Co.

21. Barron, F. & Harrington, D. (1981). Creativity, intelligence and personality. *Annual Review of Psychology*, 32, 439-476.

22. Krogus, N.V. (1972). *Chess Psychology*. Chicago, IL: Alfred Kalnajs & Son.

Illustrations

Illustration 1

Table 1

Running head: Perceptual and visuospatial abilities in chess

Perceptual and Visuo-spatial Test Scores by Age and Group (Mean and Standard Deviation in parentheses)

CLASS 1 (21–35 years)

<i>GROUPS</i>	<i>GEFT</i>	<i>GAT-2 abstract</i>	<i>GAT-2 spatial</i>
CHESS PLAYERS	16.1 (3.2)	19.50 (3.0)	61.91 (6.8)
CONTROLS	15.6 (2.9)	18.75 (3.1)	55.25 (6.5)

CLASS 2 (36–50 years)

<i>GROUPS</i>	<i>GEFT</i>	<i>GAT-2 abstract</i>	<i>GAT-2 spatial</i>
CHESS PLAYERS	15.9 (2.7)	18.67 (2.8)	59.33 (5.5)
CONTROLS	15.3 (3.0)	17.67 (2.9)	53.58 (6.1)

CLASS 3 (51–75 years)

<i>GROUPS</i>	<i>GEFT</i>	<i>GAT-2 abstract</i>	<i>GAT-2 spatial</i>
CHESS PLAYERS	12.83 (2.3)	16.67 (3.1)	57.67 (5.6)
CONTROLS	12,16 (2.6)	13,33 (3.2)	50,16 (5.3)

Illustration 2

Table 2

Effect of Covariates on Test Scores (Manova Test)

		GEFT Model fit p<0.0001		GAT-2 ABSTRACT Model fit p=0.0158		GAT-2 SPATIAL Model fit p=0.0149	
	d.f	F	p-value	F	p-value	F	p-value
Status of Chess Player	1	1.40	0.2421	2.95	0.0914	3.87	0.0271
Age	2	6.91	0.0001	2.45	0.0570	2.42	0.0591

Disclaimer

This article has been downloaded from WebmedCentral. With our unique author driven post publication peer review, contents posted on this web portal do not undergo any prepublication peer or editorial review. It is completely the responsibility of the authors to ensure not only scientific and ethical standards of the manuscript but also its grammatical accuracy. Authors must ensure that they obtain all the necessary permissions before submitting any information that requires obtaining a consent or approval from a third party. Authors should also ensure not to submit any information which they do not have the copyright of or of which they have transferred the copyrights to a third party.

Contents on WebmedCentral are purely for biomedical researchers and scientists. They are not meant to cater to the needs of an individual patient. The web portal or any content(s) therein is neither designed to support, nor replace, the relationship that exists between a patient/site visitor and his/her physician. Your use of the WebmedCentral site and its contents is entirely at your own risk. We do not take any responsibility for any harm that you may suffer or inflict on a third person by following the contents of this website.