Introduction

Several facets of the game of chess have been used in the past to model and evaluate a myriad of psychological theories in a variety of empirical studies. Most of these studies have taken either an experimental or a correlational approach (Table 1.1). Over half a century ago Lee Cronbach examined in detail the evolution of empirical psychology stemming from these two lines of work (Cronbach, 1957). Cronbach contended that a combination of the experimental and correlational approaches would be the most rewarding for advancing psychology, in both basic and applied research. Analogous arguments have repeatedly been brought up, while advocating for a greater degree of cooperation between cognitive scientists and differential psychologists regarding the study of human intelligence (Deary, 2001). Individual differences in several psychological attributes other than intelligence are critical for understanding the behaviour of people. In the past forty years there has been growing interest in the role of these individual differences, because they appear to modulate human behaviour in important domains such as work, health, and education.

Chess can provide a commensurate model of human behaviour, akin to the Drosophila model in the biological sciences (Simon & Chase, 1973). Chess has typically been used in terms of the experimental approach to model several theories concerned with cognitive psychology topics. Moreover, the studies carried out in the domain of chess have also increasingly suggested that there are individual differences in several human behavioural attributes, such as brain functioning, memory, thinking, decision-making, intellectual human performance, personality, and motivation. This book compiles and describes this latter body of research.

1.1 A Very Brief Opening to the Game of Chess

The origins of the game of chess can be traced back to ancient India around the sixth century AD. Chess travelled first to the West, then, later, to the rest of the world. Nowadays chess has become the universal intellectual game par excellence, practised by millions of individuals of diverse nationalities, ages, and backgrounds. Chess is played on an eight by eight squared board, divided into thirty-two light squares and thirty-two dark squares. Each square is uniquely

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identified by a coordinate system using Latin letters from a to h and numbers from 1 to 8. This board imitates a battlefield on which two armies, one black and one white, confront each other in a merciless fight. Each of the two armies comprises eight pawns, two rooks (R), two knights (N), two bishops (B), a queen (Q), and a king (K). The left diagram in Figure 1.1 shows an ongoing typical chess clash with all these intervening pieces. The specific moves of all pieces are described briefly in the Glossary, together with the value of each piece, indicated by the points usually assigned to it. The aim of the game...
A VERY BRIEF OPENING TO THE GAME OF CHESS

A very brief opening to the game of chess consists in checkmating the opponent’s king. The army that first checkmates the enemy king wins.

The basic rules of the game are very simple and very easy to learn, even at younger ages and at any educational level. Yet the game as a whole becomes extremely complex. There are literally several millions of millions of different combinations among the contending pieces in a single chess game. These combinations can be represented with a chess tree, an informational device in which the solution is the path leading to victory. A chess tree typically generates a massive and unmanageable amount of combinations \(10^{120}\) even for the most powerful and fastest computer chess engines, let alone for human beings (Shannon, 1950).

Because each of the pieces involved in the game obeys different movements, the game is intellectually demanding, while requiring the interplay of a variety of major psychological attributes and processes, such as perception, memory, reasoning, decision-making, problem solving, will, motivation, interests, and creativity.

Consider, for instance, the right diagram in Figure 1.1. This represents a typical chess problem with the white forces to play and win. There is an efficient sequence leading to the white victory that comprises five precise moves, with an average time limit to solve it of about ten minutes. The correct sequence of moves in algebraic notation is shown below, for both white and black pieces:

<table>
<thead>
<tr>
<th>White</th>
<th>Black</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 B×f7+</td>
<td>R×f7</td>
</tr>
<tr>
<td>2 Q×e8+</td>
<td>N×e8</td>
</tr>
<tr>
<td>3 R×e8+</td>
<td>R×f8</td>
</tr>
<tr>
<td>4 d7</td>
<td>Q×d6</td>
</tr>
<tr>
<td>5 R×f1!!</td>
<td>1–0</td>
</tr>
</tbody>
</table>

Each of the five chess moves comprise two plies: one ply for white, and one ply for black. The ply corresponding to black in the fifth move indicates that white has won the game (scoring one point), however, because, after the last ply of white (R×f1), there is no possible legal move by black to avoid being checkmated at the very next move by white. Capital letters stand for the specific chess piece being moved and the × symbol indicates that a piece captures an opponent’s piece. For instance, the first ply for white (B×f7+) indicates that the white bishop (B), initially placed in the b3 square, is capturing the pawn located in the f7 square. The + symbol indicates that the black king is placed in check. A ply depicting a single square only indicates a pawn move. For instance, the fourth ply for white (d7) indicates that the pawn placed in the square d6 advances to the square d7. The double exclamation mark in the fifth
ply for white (Rf1!!) indicates a brilliant and very strong move. In this specific game, it was a coup de grâce move, winning the game.

People may differ greatly in terms of their chances of finding out this sequence of moves. If you are a proficient chess player at the master level, you may be able to ‘see’ the sequence at a glance. It could also be the case that you may remember this position because you have already studied it in the past, during your long chess career. On the other hand, if you are a typical club chess player with a moderate level of chess skill, you might invest the suggested amount of time, but you may end up unable to figure out what the correct solution is at all. If you are a beginner chess player, or you just know the basic chess rules, the likelihood of experiencing serious difficulties in finding the solution may be so great as to be insurmountable. This is a very basic example of individual differences in chess performance and chess skill.

1.2 Overview of This Book

Nowadays there is a considerable volume of chess studies that have highlighted noteworthy individual differences. For example, some of these chess studies use problems such as that shown in Figure 1.1 as experimental stimuli. This book is an attempt to compile and summarize the latest research about the psychology of chess with a focus on individual differences. Besides, this volume aims to provide an overview of the findings from more than forty years of research, from the mid-1970s to date, about chess and individual differences. This body of research has sometimes yielded inconclusive and even controversial results, suggesting, for instance, that the development of chess skill over time may largely depend on the combination of individual differences in several traits or broad clusters of traits. This book organizes the body of knowledge that uses chess as a model environment, while providing useful scientific information about a variety of individual differences in brain functioning, intelligence, personality, expertise, and sex, and in applied fields such as business, health, and education.

The book is mainly aimed at scholars within the broad spectrum of the social and behavioural sciences who have an interest in the psychology of chess. The book can be of interest to psychologists, sociologists, educators, neuroscientists, and behavioural scientists in general. The chapters are intended to cover the topics typically addressed by social scientists interested in individual differences working in a diversity of fields. Those researchers and academics working in brain functioning, human abilities, and personality may find the book appealing. Moreover, the book may also arouse the curiosity of researchers and academics working with topics such as expertise, sex differences, and education, or with a focus on applied fields. In addition, the book may also be of interest for people who play chess themselves. In particular, chess players wishing to gain a more in-depth understanding of the scientific
work undertaken with chess as a model domain from a psychological approach may find some stimulating information within these pages.

Chapter 2 describes the Elo chess rating. What makes chess an optimum field for the study of individual differences is the availability of this objective quantitative measure to gauge a player’s chess strength. The Elo rating system is by far the most popular and accepted indicator worldwide for quantifying accurately individual differences in chess skill. Every chess player participating regularly in rated chess tournaments holds an Elo rating. The Elo rating changes according to the outcomes of the games played within a given time period, while considering the Elo rating of the opponents. The chapter describes how the Elo ratings of thousands of chess players are kept and periodically updated. It also outlines the updating mechanisms and some basic statistics of the Elo rating. In addition, the chapter describes some recent alternatives to rating chess skill, such as the Universal Rating System (URS). Appendix 1 summarizes the studies that have used the Elo rating as related to a variety of human behaviours.

Chapters 3 and 4 provide an overview of the main findings from the cognitive and the individual differences approach to the psychology of chess, respectively. Chapter 3 reviews the main research findings from the cognitive or experimental paradigm within psychology, which originated with the precursor scientific works about the psychology of chess. Three main basic facets of human behaviour have been addressed within this general approach: perception, memory, and thinking. The main conclusions from this extensive body of research can be summarized by emphasizing the role of individual differences. Chapter 4 outlines the main tenets and constructs of differential psychology, the discipline that studies individual differences in behaviour relevant for central social realms such as health, education, and work. The chapter is structured around three main themes. First, it describes the characterization and appraisal of individual differences. Second, the PPIK theory is suggested as an optimal starting point to conceptualize and examine individual differences. This framework comprises traits from four broad dimensions: intelligence as process, personality, interests, and intelligence as knowledge. Third, the chapter closes by addressing the old but compelling debate about the heredity versus environment dichotomy in explaining complex human intellectual behaviour.

Chapter 5 describes the studies addressing human biological factors in chess, with a focus on psychophysiology and brain imaging. Human psychophysiology is a multi-faceted and complex phenomenon. The game of chess has provided a proper domain for the study of the central psychophysiological mechanisms underlying psychological processes such as stress, emotion evaluation, and decision-making. Moreover, novel technologies designed to provide high-resolution brain imaging are being increasingly used to explain human behaviour. These technologies have also been used with chess players to
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examine the interrelationships of brain and cognitive functioning, and with personality and intelligence factors. In particular, this chapter outlines the research undertaken with electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and positron emission tomography (PET). The chapter summarizes this body of evidence while underlining the most significant conclusions that may be derived from this intriguing and thought-provoking field of research.

Chapter 6 provides an account of the studies addressing chess and intelligence. Human intelligence is one of the main general objects of study in individual differences research. There are indeed multiple models about and approaches to human intelligence, which are briefly described within this chapter. Chess has been typically associated with a high level of intelligence. Whether chess players are more intelligent on average than the general population is a recurrent question that has elicited a considerable body of research. There are unsettled issues as to what constitute the most advantageous cognitive abilities required in chess, and whether playing chess makes people smarter. These topics have been addressed with both children and adults. The scientific evidence in connection with this topic is inconclusive, however, and controversial in some instances. This chapter addresses these matters of contention by summarizing the state of the art in this particularly cogent field of research. The final section in the chapter includes novel empirical findings comparing chess skill and chess motivation in the prediction of chess performance, suggesting that non-cognitive traits might also be influential for chess performance.

Chapter 7 analyses what is already known about chess and human personality. Personality is the other main broad domain addressed within the general framework of individual differences. In contrast with intelligence, however, the body of research concerning the personality of chess players is rather scarce. There have been some interesting findings recently, however, and these are summarized within this chapter. After describing briefly the main approaches to addressing human personality, some questions addressed in this chapter are whether personality influences chess playing style, or whether a chess player’s personality differs in some special way from that of other people. In addition, whether personality factors may interact with cognitive abilities in chess players is an interesting and relatively novel topic. The chapter closes by presenting novel data about the interplay between personality, motivation, and emotional regulation in predicting chess skill.

Chapter 8 analyses expertise, one of the most prolific fields in empirical research using chess as a model domain. Expertise is of great importance in several realms of human intellectual activity. The role of practice in the development of chess expertise is reviewed in detail in this chapter. Moreover, the role of practice is contrasted with talent, because the deliberate practice approach has advanced the idea that expert performance depends
A consistent body of evidence suggests that deliberate practice alone is unable to explain the individual variability in chess expertise, however. The present chapter addresses this controversy by framing these findings in the nature versus nurture debate, one of the central themes within individual differences research. Furthermore, this chapter also explores age-related cognitive decline in human intellectual activity, which appears to occur to a lesser extent in the chess domain. For instance, recent findings suggest in particular two interrelated factors that may be highly relevant in preventing cognitive decline in chess: the level of expertise attained, and the amount of tournament activity.

Chapter 9 tackles the issue of sex differences in chess. On average, men tend to start earlier, perform at a higher level, and persist longer than women in the chess domain. Moreover, women are highly underrepresented in chess, which is also apparent in several other domains, such as those connected with STEM fields (science, technology, engineering, and mathematics). The marked difference in the number of men and women participating in chess has led to the assumption that the differences in chess performance between men and women are attributable to a statistical effect derived from the differences in participation rates. In contrast, other findings suggest that men might have an innate advantage in terms of chess playing, enhanced by certain cultural factors. These two points of view are addressed in this chapter. The alternative explanation to the marked disparity in chess participation and performance between the two sexes may be related to the participation of men and women in STEM fields. In addition, there are some noticeable differences in the chess playing of men and women, even though women are able to play very strong chess, just like men. The chapter closes by presenting a statistical analysis with data from the chess domain, which relates to sex differences in performance at different levels of practice. The findings from this analysis suggest that sex differences in the Elo ratings tend to increase with increasing practice, pointing to factors other than practice as the underlying causes of these sex differences.

Chapter 10 deals with the applications of chess in three major fields of human activity: business, health, and education. Chess has been used in the business field with two main aims. First, chess has been used for educational purposes to teach and consolidate concepts connected with this discipline. Second, some studies have used chess as a model to evaluate game-theory aspects of the game. The game of chess has also been increasingly used to address health-related problems such as attention deficit hyperactivity disorder (ADHD), neurodegenerative disorders, and schizophrenia. Moreover, chess has become an increasingly popular pedagogical method in several school settings across the world. A number of studies claim that chess training entails several educational benefits for core academic subjects such as languages and mathematics, and also for concentration and self-control, or the development of socio-affective competences. Several of the instructional experiences that use chess to enhance these
behaviours are described in this chapter. Some recent studies suggest that significantly higher levels of academic performance for schoolchildren and adolescents are associated with chess-based teaching or the practice of chess on a regular basis, when compared with those students who are not involved in chess playing or chess instruction. Another set of studies have questioned the purported benefits of chess training for formal education, however. From this latter point of view, there are both conceptual and methodological concerns that compromise to a great extent the available evidence about the association of chess training with academic achievement. Two of these issues relate to the transfer of abilities across domains, and to the concept of statistical power.

Chapter 11 is the closing chapter of this book. This chapter argues why chess has become an interesting domain to address topics of interest for individual differences research. It also summarizes the most robust available evidence to date by outlining the key findings, while suggesting some tentative and potentially promising steps for advancing the field.