

# Do Initial Strategies or Choice of Piece Color Lead to Advantages in Chess Games?

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## Summary

**White pieces make the first move in chess games. A great deal of data suggests that the color of a chess piece affects the outcome of a chess game. The purpose of this study was to see if playing the white pieces gives a winning advantage. Our hypothesis was that there is a greater chance of winning when the first move is made with a white piece. In addition, we tested if playing certain opening or defense strategies gives a winning advantage. We played 5 games each with 4 openings and 4 defenses in Chess Titans for 10 levels, for a total of 400 games, and on chess.com, for a total of 40 games. We also analyzed a database of over 32,000 chess records. The data suggest that opening and defense strategies affect the outcome. On chess.com, the winning percentage was the same for both white and black pieces (65%), while in Chess Titans, the winning rate was higher for the white pieces (92%). Overall, the winning percentages were much higher when playing with white pieces.**

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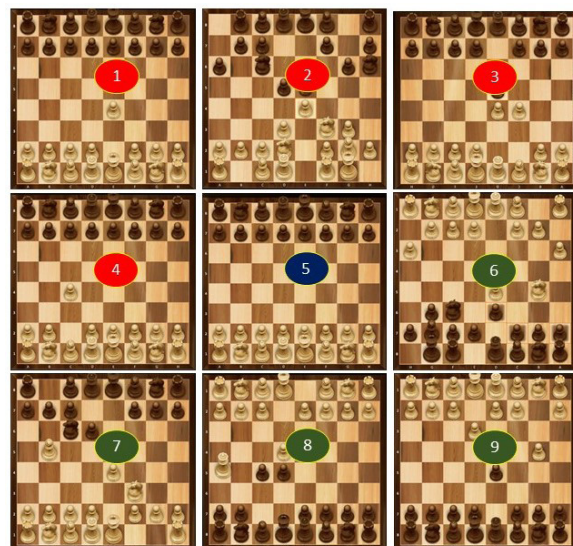
## Introduction

Chess is a two-player game played on a board with 64 black and white squares (**Figure 1**). Each player starts with 16 pieces: eight pawns, two rooks, two knights, two bishops, one king, and one queen. In a standard chess game, the player controlling the white pieces makes the first move, whereas the player controlling the black pieces responds to that move. The opening moves made by the white pieces are called an opening strategy; the moves made by the black pieces are called the defense strategy.

A chess game can end in four different results: win by checkmate, loss, tie (draw), or stalemate. A checkmate means that a king in check cannot escape being captured. A player can also win when the opponent

resigns. A draw occurs when neither of the kings can be forced into checkmate. Stalemate occurs when the king is the only piece on the board and cannot move in any direction, but is not in check. When a stalemate occurs, the result is categorized as a draw.

Many chess researchers and theorists believe in the first-mover advantage; *i.e.*, playing first and moving the white pieces offers a unique advantage in winning games [1]. Many players believe this, and hence, will want to play the white pieces. Ernest Rubin [2] observed that even masters and grandmasters are likely to draw more frequently with a white piece and lose with black pieces, while Alexander and Slater [3] concluded in their work that, on an average, white will score about 55% of the time. In this study, we tested if different starting strategies, either playing with the white pieces or playing certain opening or defensive strategies, gives a winning advantage. We first investigated opening and defensive strategies by playing games on chess.com, where registered users compete against each other. We hypothesized that all opening and defense strategies



**Figure 1. Chess boards with different opening and defense positions.** Boards 1 through 4 (Red) represent the openings: King's Pawn, King's Indian Attack, Queen's Gambit, and English, respectively. Board number 5 shows the initial starting arrangement of pieces of a chess board, while numbers 6 through 9 (Green) present the defenses: King's Indian, Steinitz, Budapest Gambit, and Scandinavian.

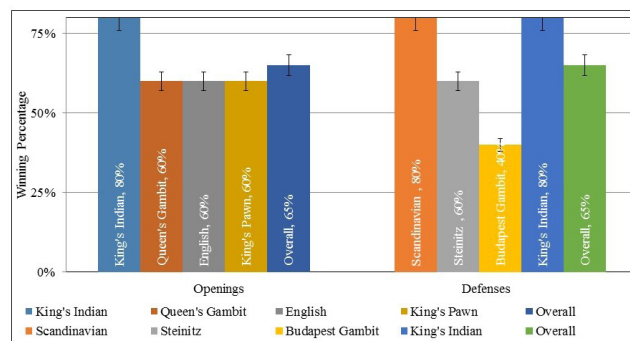
would be equally effective. To see if results would be similar when playing against a 'consistent' opponent, we chose to play against the computer of the Chess Titans software. We also analyzed a database of chess games from chesstempo.com to see if white pieces won more games overall.

## Results

We began by investigating four openings: King's Pawn, King's Indian Attack, Queens Gambit, and English. In response to an opponent's opening, the following four defense strategies were used: King's Indian, Steinitz, Budapest Gambit, and Scandinavian. These opening and defense strategies were selected because they are widely used and are well known.

### Playing with People on Chess.com Revealed Similar Results Among Opening and Defense Moves

Out of the five games played with the King's Pawn opening, we won three and lost two. Similarly, we won four, three, and three games, respectively, using the King's Indian Attack, Queen's Gambit, and the English opening. Overall, we won 13 out of 20, or 65%, of the games. Using four defense strategies with black pieces, we played five games each with five opponents. Out of the five games with Scandinavian, we won four. We won three, two, and four games with the Steinitz, Budapest Gambit, and King's Indian defenses, respectively. Overall, we won 13 out of 20, or 65%, of the games. Our best opening was King's Indian Attack with 80% wins, and our best defense strategies were Scandinavian and King's Indian with 80% each. The overall winning percentages for the openings and defenses were 65% each. This leads us to believe that we were balanced players, and that we were dominant in one opening (King's Indian Attack) and two defense strategies (Scandinavian and King's Indian; **Figure 2**).



**Figure 2. Comparison of winning percentages for openings and defenses while playing with people.** The best opening strategy was King's Indian Attack, and the best defense strategies were Scandinavian and King's Indian. A total of 40 games analyzed.

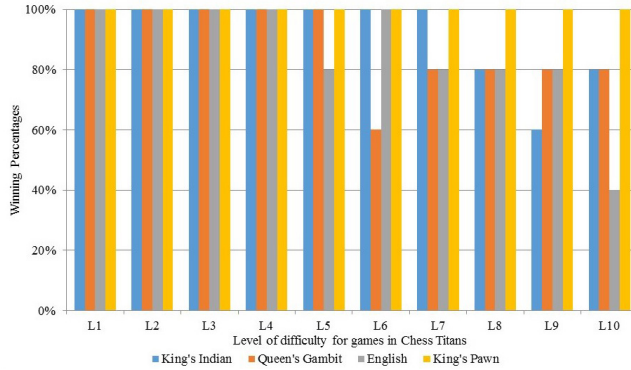
### Winning Percentages in Chess Titans Depend on Opening and Defensive Strategies

The games were repeated on the computer program Chess Titans, where we played against the computer. We used each of the four openings and defenses five times for each of the ten levels. During certain games in chess.com (human players), the opponent would not play the specific opening or defense strategy that was planned for testing. These data were not recorded as they were not relevant to the study. The software packages were also designed to assign players to a random color, thereby making the games and results unbiased and appropriate for analysis. Based on our observations, we concluded that the computer was changing its strategies every game to prevent the opponent from figuring out the strategy. As the difficulty level of the chess game increased, the strategies of the computer seemed to change, thereby making it harder to predict the computer's next move.

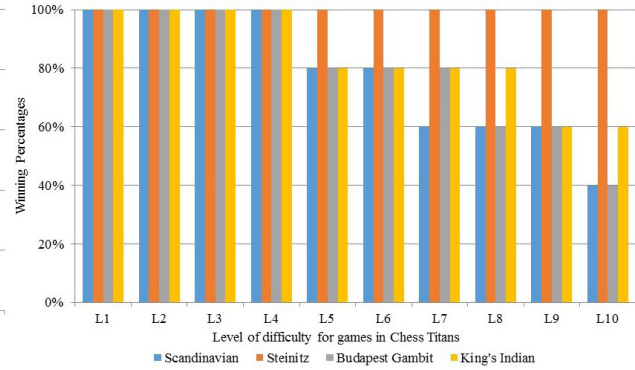
The previously applied openings and strategies were used in Chess Titans. We repeated each opening 5 times for 10 levels, which added up to a total of 200 games (4 openings x 5 games x 10 levels). Similarly, for the defenses, we played 200 games (**Figure 3**). We won 100% of the games up to level seven using the King's Indian opening. After that, our winning percentage dropped to 80%. For the Queen's Gambit, until level five, we won all the games. After that, the winning rate dropped to 80%. Similarly, for the English opening, until level four, we won all the games, after which our winning rate decreased to 40% by level ten. Using the King's Pawn, we won 100% of the games at all levels, suggesting that it was our strongest opening. Our weakest strategy was the English opening, with an 86% winning rate.

For the Scandinavian defense, we kept winning all the games until level four. After that, our winning percentage decreased and ended up at 40% by level ten. For the Budapest Gambit, until level four, we had a winning percentage of 100%, after which the rate dropped to 40% by level ten. Similarly, for the King's Indian, until level four, we had a 100% winning rate, after which it started decreasing. For Steinitz, we won all the games at all levels, indicating that this is our strongest defense (**Figure 4**).

Our strongest opening was the King's Pawn opening with a 100% winning rate, and our strongest defense was the Steinitz defense with a 100% winning rate (**Figure 5**). Our overall winning rates were 92% and 86% for opening and defense strategies, respectively. For the King's Indian Attack opening, our lowest winning percentage was 60% and our highest was 100%. The average winning percentage for all the levels was 92%.



**Figure 3. Opening winning percentages while playing against a computer.** A total of 200 games were analyzed. Our strongest opening was the King's Pawn opening with a 100% winning rate.



**Figure 4. Defense winning percentages while playing against a computer.** A total of 200 games were analyzed. Our strongest defense was the Steinitz defense with a 100% winning rate.

Statistical Analysis Suggests Favorability of White Pieces When Playing Against Computer, But Not Human Opponents

In order to test whether the outcomes of games using white pieces were significantly different from those using black pieces, we performed analysis of variance (ANOVA) [4], which compared the mean winning percentages for the four opening and four defense strategies. In the case of Chess Titans, there was a significant advantage to playing with the white pieces (openings) instead of the black pieces (defending) (Table 1). Among the four openings, the mean winning rates were not significantly different ( $p = 0.06$ ). However, the results for the four defenses were significantly different ( $p = 0.007$ ). The winning percentages among the openings were consistent and did not vary significantly. There were also statistically significant differences between the ten levels for both openings and defense games.

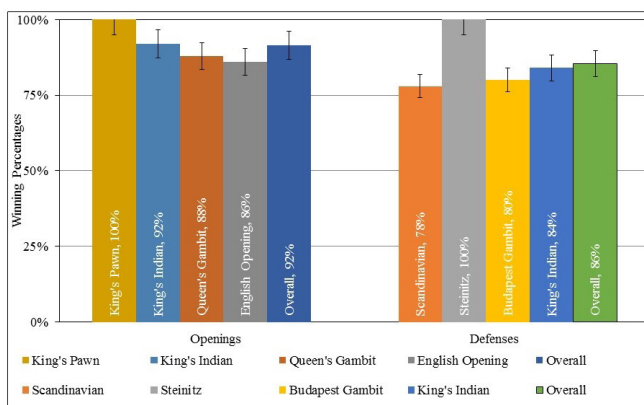
In the case of the chess.com games, the mean

winning percentages were not significantly different among the four opening strategies played with white pieces or the four defensive strategies played with black pieces when considered individually (Table 1). The low sample size or the error introduced by playing against humans could be one reason for this result. In summary, the larger sample size of the Chess Titans dataset indicates that chess piece color affects the opening lead outcomes.

Winning Percentages from Online Dataset Suggests a White Piece Advantage

In addition to the strategies tested above, we hypothesized that there is a greater chance of winning games with white pieces than with black pieces. In order to analyze other players' winning percentages, a larger dataset (chesstempo.com) was studied. This website enables anyone to search all the games played using a certain opening or defense and gives the winning, draw, and losing percentages. For the four openings and defenses, we collected data from this website (Table 2). Data from 26,684 games revealed that the winning percentage of white pieces was higher than that of black. The King's Indian Attack was the most frequent opening, accounting for 61% of all openings, followed by King's Pawn. Based on 5,592 games, the winning percentages were lower for all defense strategies except Scandinavian. The Steinitz defense was played most frequently, accounting for 44% of all defenses.

The first two set of results come directly from this study, but the third set of results are from an external source. The first two datasets have higher winning percentages when compared with chesstempo.com, possibly because there are no draws in the others. Also, given that chessteempo.com is a much larger dataset, the data may be seen as more reliable.



**Figure 5. Comparison of openings' and defenses' winning percentages while playing against a computer.** A total of 400 games were analyzed. Our overall winning rates were 92% and 86% for opening and defense strategies, respectively.



	df	F	P-value	F crit
chess.com				
Among the 4 Openings	3	0.182	0.907	3.239
Among the 4 Defenses	3	0.733	0.547	3.239
*Between Openings and Defenses	1	3.758	0.060	4.098
Chess Titans				
Among the 4 Openings	3	2.508	0.060	2.651
Among the 4 Defenses	3	4.192	0.007	2.651
*Between Openings and Defenses	1	881.331	0.000	2.718
Among 10 Levels – Openings	9	2.261	0.020	1.929
Among 10 Levels – Defenses	9	3.756	0.000	1.929
*Among Levels - Openings and Defenses	1	881.331	0.000	2.718

\*Hypothesis-related comparisons

Table 1. Analysis of Variance for different Combinations.

Discussion

We hypothesized that there is a greater chance of winning more games with white pieces (i.e., making the first move or playing an opening strategy) than with black pieces (i.e., a defense strategy). This hypothesis was supported by the data collected in this study as well as the larger database of other players. Thus, this work supports the generally accepted notion that first movers have an advantage in the game of chess. Players also appear to prefer certain opening and defense strategies, particularly the Kings Indian opening and Steinitz defense. In the future, it would be interesting to research why players choose these opening and defense strategies. As expected, when playing against the computer, as the level of difficulty increased, the winning percentage decreased. Also, it is more difficult to play against other players than against a computer. This may be because people refine their tactics through experience and practice, making it harder to predict their next move. One of the limitations of this study is that initially the results from one player’s games were considered to be sufficient to draw conclusions about the effectiveness of various opening and defensive strategies. However, a larger dataset was used to support the work. To overcome this limitation in the future, it would be appropriate

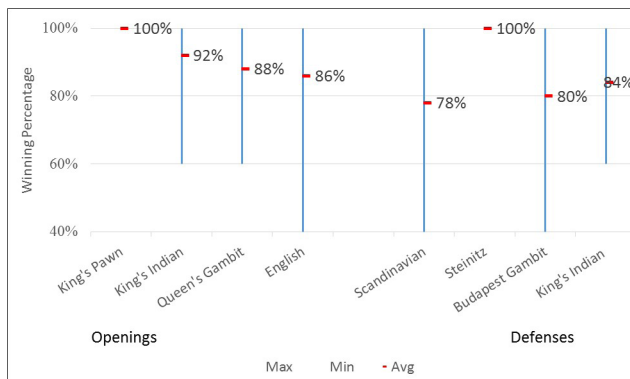


Figure 6. Maximum, minimum, and average winning percentages by the level of the game in Chess Titans. A total of 400 games were analyzed.

Opening	Piece	Number of games	Player win %	Draw %	Opponent win%
King's Pawn	Wht	6,028	39%	24%	37%
King's Indian	Wht	16,217	39%	35%	26%
Queens Gambit	Wht	364	41%	40%	19%
English	Wht	4,075	37%	28%	35%
Defense					
King's Indian	Blk	784	31%	28%	41%
Steinitz	Blk	2,426	21%	20%	59%
Budapest Gambit	Blk	629	24%	23%	53%
Scandinavian	Blk	1,753	43%	19%	38%

Table 2. White vs. black pieces' winning rates. Table 2 shows 26,684 openings played by numerous individuals, for all four openings. The winning percentage was higher using the white pieces.

to perform an analysis with results from several other chess players. Another limitation is that the number of games played against other players differed from those against the computer. Ideally, it would be preferable to have about the same number of games in both cases.

As a next step, it would be interesting to compare computer versus computer games to analyze the outcomes of various openings and defenses. This could be accomplished by using software programs such as Komodo 9.3 and Stockfish 7. Because chess software is usually designed to not make unforced errors, or errors made by a player due to lack of experience, it would be interesting to analyze the move-by-move approach of the software module. In addition, we would like to study the games of other chess players and see how they adjust their strategies. Comparing the results of our 440 games (Figure 6) with the 32,276 games of other players (Figure 7), we conclude that our original hypothesis, that there is a greater chance of winning more games with white pieces, is supported. Our own performance with chess.com shows the same winning rates for white and black pieces (65%). Using Chess Titans, however, white and black pieces (openings and defenses) yielded winning rates of 92% and 86%, respectively. Despite having the same winning rate on chess.com, the winning rate with white pieces was higher in the 400-game Chess Titans dataset and the larger Chesstempo.com database, supporting the hypothesis.

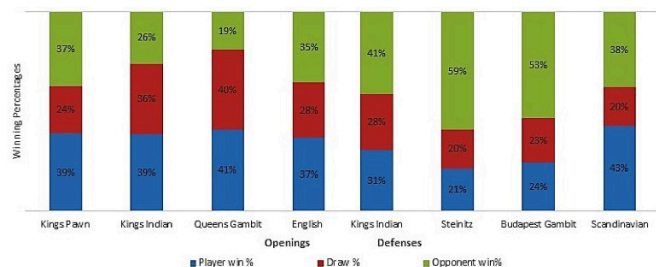


Figure 7. Win, draw, and loss percentages from chesstempo.com data. 23,276 games of other players were analyzed.

## Methods and Materials

### Chess.com Games

This work was carried out in two steps. The first method involved playing games on chess.com with people who are registered on this website. For each of the four openings and four defenses, five games were repeated, which added up to a total of 40 games.

After creating an account on chess.com, we applied the opening and defense strategies. The software starts the player at a rating of 500. Upon winning or losing, a player's rating goes up or down, but not by the same amount each time, and the computer chooses opponents with ratings close to that of the player's. Since the first author is familiar with the software, and because it is a great resource, we decided to use it as the first method. To maintain the same conditions, the first author tried to play the games when there were no distractions around, trying to concentrate only on the current game and not on the results of the previous game. This helped to put emotions aside and play as accurately as the first author could while minimizing unforced errors.

### Chess Titans

Each of the four openings and four defenses were repeated five times in Chess Titans. This was repeated for ten levels of difficulty for a total of 400 games. This game is available as a default game on Microsoft Windows.

### ChessTempo.com

To get a better understanding of the opening and defense strategies played by thousands of players across the world, we analyzed winning percentages obtained from chesstempo.com. These data were then compared with our own results.

### Statistical Tests of Significance

In order to test whether the results from playing with white and black pieces were significantly different, a statistical test was performed. Using the analysis of variance (ANOVA) [4] test, we compared the mean winning percentages for the four opening and four defense strategies. The 'win' and 'loss' values were re-coded as '1's and '0's respectively. These values for the four openings and four defenses from the chess.com and Chess Titans results were compared, and the ANOVA procedure in Microsoft Excel was used. In each case, the null ( $H_0$ ) and alternate ( $H_A$ ) hypotheses can be stated as follows:

$H_0$ : Chess piece color does not affect the opening lead outcomes.

$H_A$ : Chess piece color affects the opening lead outcomes.

If the ANOVA's  $p$ -value is less than 0.05 at a 95% confidence interval, then there is a significant difference in the mean winning percentages. If the  $p$ -value is more than 0.05, there is no statistically significant difference among the winning percentages. **Table 1** shows the results of the ANOVA for various combinations. The degrees of freedom (df) are also shown; 'df' is calculated as the number of groups being compared minus one. The F-stat and F-critical are also shown. If the F-stat is less than F-critical, then we do not reject the null hypothesis, indicating that the mean values are not statistically different.

### Strategy Definitions

*King's Pawn opening:* The King's Pawn Game is any chess opening starting with the move e4. 'e4' means that the pawn in front of the king (**Figure 1-1**) moves two steps forward. Along with King's Indian, this is among the most popular opening moves in chess [5].

*King's Indian Attack:* This opening is not a series of specific moves, but rather a system [6] that can be played from many different move orders. Though the King's Indian opening is often reached via 1.e4 followed by d3, Nd2, Ngf3, g3, Bg2, and 0-0 (castle), it can also arise from 1.g3, 1.Nf3, or even 1.d3 (**Figure 1-2**). The '1' in 1.e4 refers to the first step in the order of moves where the pawn in front of the king moves first; regardless of what the opponent does, the opener will make the second move called d3, which means that the pawn in front of the queen will move one step forward. The next step involves Nd2, which means the knight moves from its current position to a new position (d2). The next move is Ngf3, and not Nf3, because it is the knight on the right side that moves to f3, and not the knight that is already in d2.

*Queen's Gambit opening:* The Queen's Gambit (**Figure 1-3**) starts with the moves d4, d5, and c4; d4 refers to moving the pawn in front of the queen two steps [7].

*English opening:* The English opening [8] begins with the move c4, moving the pawn in front of the bishop (**Figure 1-4**).

*King's Indian defense:* This is a commonly applied strategy [9]. It arises after the moves d4 and Nf6, which means the pawn in front of the queen moves two steps and the knight moves up two steps and over one step to the left (**Figure 1-6**).

*Steinitz defense:* The Ruy Lopez, also called the Spanish opening or Spanish Game, is a chess opening that begins with moving the pawn in front of the king by two

steps. The Steinitz is a variation of the Ruy Lopez [10] where e4 and Nf3 moves occur (*i.e.*, the pawn in front of the king moves two steps followed by the knight, which moves two steps up and one step to the left; **Figure 1-7**).

*Budapest Gambit*: This defense begins with the moves e4 (*i.e.*, moving the piece in front of the king by two steps), followed by c4 (*i.e.*, the pawn in front of the bishop which moves two steps forward) [11] (**Figure 1-8**).

*Scandinavian*: This strategy begins with the move d5 (*i.e.*, the pawn in front of the queen moves by two steps) [12] (**Figure 1-9**).

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