A Novel Investigation of Attack Strategies via the Involvement of Virtual Humans: A User Study of Josh Waitzkin, a Virtual Chess Grandmaster

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A novel investigation of attack strategies via the involvement of virtual humans: A user study of Josh Waitzkin, a virtual chess grandmaster

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Abstract. A growing body of evidence suggests that attack is a significant concept that has been explored by researchers from various disciplines such as marketing, psychology, and computing. Additionally, there has been substantial research undertaken on the role of attack in chess, which brought significant contributions to different fields of research. In this paper, the researcher investigates the attack concept in chess, as a strategic game by exploring virtual chess players of different strategies. In particular, the researcher explores the performance of an attacking grandmaster against three other class-A players of different chess personalities that vary in controlling the center of the chessboard. To this end, the researcher collected data from four virtual chess players: a grandmaster and three class-A players. The selected grandmaster is Josh Waitzkin who is known for his fearless attacking style and deep endgame understanding. The class-A players have different personalities: (1) a player who strongly controls the center of the board; (2) a player who ignores the center; and (3) a player who offers traps to control his opponent. The researcher measured different dependent variables including the errors of the players and the moves of the games. The findings show that class-A players of particular chess personalities perform differently. Additionally, the study reveals that there is a positive relationship between the findings and some of the existing real-life scenarios in the business domain.

Keywords: chess, chess personality, virtual humans, attack, Josh Waitzkin, grandmaster

1 Introduction

In the last twenty years, the chess world witnessed many interdisciplinary endeavors from the fields of psychology, artificial intelligence, and computer design. This resulted in many significant achievements including a machine being able to defeat Gary Kasparov, the reigning world champion in 1997. Even more, current chess applications in the market are very affordable and capable to compete at the level of a grandmaster, the highest rank a chess player can attain. Such applications offer useful features to chess players among which are providing hints, analyzing

chess positions, and allowing a player to play against another player or computer opponent.

Computer opponents can come in a variety of ways such as chess engines or virtual humans. They are widely used by chess players for training and they exist in different personalities. Throughout this paper, the term chess personality is defined as the attitude of a chess player during his games such as an attack, defense, or a mixture of both. The personality of a player can shape the direction of a chess game. For example, some grandmasters start attacking at an early stage of a game, and this might cause their opponents to act defensively. Other players like to get their Queen involved during the opening phase.

Investigating the personalities of virtual chess players can play an essential role in addressing many research problems. First, there is evidence that employing software loaded with virtual players with different personalities plays a crucial role in surgical training using a virtual reality simulator [5, 32]. Second, existing research suggests that there is a strong association between chess and business in many aspects such as patience, long-term thinking, and perseverance [19, 21, 23, 29, 30]. Third, rapid developments in building new chess applications have heightened the need for understanding chess personalities [14]. Virtual chess players helped in investigating different playing styles by allowing researchers to explore games between chess players of various personalities who existed in different eras [12]. Another key thing to remember is that virtual humans made it possible to further examine world champions such as Garry Kasparov and many other top grandmasters [12, 14, 15]. Additionally, relevant work is not only limited to virtual humans, but it also shows existing studies in virtual environments simulating different types of biological behaviors such as predator-prey ecosystems and ant colonies [9, 11, 13, 16, 28]. All these studies showed the effectiveness of simulated behaviors in coding binary information that is widely used in many research activities such as perception and visualization [10, 17, 18].

In this paper, we explore four virtual players: a grandmaster and three other class-A players. The selected grandmaster is Josh Waitzkin, who is known for being a fearless attacker with a deep endgame understanding. The class-A personalities vary in their skills with regards to traps and controlling the center. This paper builds on previous research in virtual chess players and provides an important opportunity to advance the understanding of chess personalities. The findings should make important contributions to the fields of psychology and computer science. The central question in this paper asks about the errors that virtual players of different personalities make while playing against each other. The main questions addressed in this paper are:

- How does Waitzkin behave while playing against class-A players who vary in their controlling the center and trapping an opponent's personality?
- How are class-A players of various chess personalities related to traps and controlling the center influenced while competing against Waitzkin?
- How is the length of the games played against Waitzkin influenced by the different class-A players employed in the experiment?

The overall structure of this paper takes the form of six sections including this section. Section 2 begins with exploring the related studies and identifying the gaps where further research is needed; Section 3 is concerned with the study design; Section 4 analyzes the results of the experiment and presents the findings; Section 5 provides a general discussion of the research findings based on the existing literature; finally, section 6 concludes the paper, and offers suggestions for future research.

2 Related work

A large and growing body of the literature has investigated the psychology of chess players. Models were developed over the years to understand a chess player's mind. The first model was offered by Cleveland [7] and it incorporates the most vital aspects in modern chess theory and focuses on chess development. In 1965, de Groot [8] investigated chess players' thinking and memory and how they solve chess problems. De Groot exposed chess players to meaningful chess patterns and asked them to reconstruct them from memory. He found that masters outperformed novice chess players. This was followed up by the study of Chase and Simon [6] who did a similar experiment with random chess positions. They found that chess players of various skills failed to reconstruct them. The previous two experiments show the importance of chess patterns in a chess player's skill.

Chess players vary in their ability and are ranked according to a rating, which is a number that provides an estimation of a chess player's skill measured against other players in the chess community. Many organizations provide chess ratings such as the World Chess Federation and the United States Chess Federation (USCF). For example, according to the USCF [34], the highest title is a Senior Master, which is awarded to a chess player who maintains a rating of 2400 and above. Below that is a Master, for a player who maintains a rating between 2200 and 2399; Expert between 2000 to 2199; class A between 1800 to 1999 and so on.

Chess players are not only characterized by their ratings, but they can also be described by their chess personalities. These personalities are reflected by the playing style of a player during different game phases. For example, Marshall (1942-2017) is a risk-taker who offers sacrifices to gain an advantage during his games [33]. Exploring chess personalities has its roots in psychoanalysis and numerous studies have attempted to investigate it from different angles. For example, Jones [24] explored the personality of grandmaster Paul Murphy and identified many aspects in his playing styles such as attack and piece sacrifice. Similarly, Karpman [25] explored the topic of chess personalities and the conditions at which certain players play the best. He also identified contrasts in personalities among chess grandmasters and the reasons behind some game results. In the same vein, Haran [22] identified five chess personalities depending on the opening variation: normal personality, aggressive personality, defensive personality, semi-open personality, and positional personality.

The rapid developments in Artificial Intelligence and Computing Technology made it possible to include new modern features that enable further exploration of chess personalities. Among these features are the virtual chess players, which are defined as computer programs that simulate real chess players of different levels from beginners to top-rank grandmasters. Virtual humans opened new research horizons and offered alternative prospects on how to analyze chess games and explore the psychology of different players. This began with a study that investigated virtual grandmasters and class-B players that represent actual human chess players [12]. In the study, the author explored the personalities of attacking and defending grandmasters and the outcomes while they compete against less skilled players. They found that an attacker grandmaster tends to have fewer errors than a defensive grandmaster. Similarly, the author found that the class-B players in the study perform better while competing against an attacker grandmaster. These findings have grounds in social sciences as research showed that people instinctively seek to perceive the reasons behind challenging events and how they influence their existence when they face them [36]. This view is also supported by the study conducted in [15] showing that an attacker grandmaster performs better as opposed to a defensive grandmaster while competing against class-A players. What's more, these are not the only studies that investigated virtual chess players. A recent study explored the chess personality of Garry Kasparov and how he is influenced by and influencing class-A players of different personalities [14]. All these studies have emphasized the importance of virtual humans and how they are used to explore the personalities of chess players. It is also important to mention that emulating real chess players is a major area of interest within the game industry. One example is Virtual Kasparov [2], developed by Titus, which incorporates simulated chess players of different personalities. Similarly, Ubisoft developed the Chessmaster and it offers many virtual players representing real players including top grandmasters such as Kasparov and Polgar [33].

Overall, all the studies reviewed here and the tremendous industrial advancements in virtual humans highlight the need to further investigate this field of research. These studies clearly indicate that there is a strong relationship between virtual humans, personalities, and existing real-life scenarios in different fields of research including marketing, management, and psychology. However, there remain several aspects of virtual chess players about which relatively little is known.

3 Method

3.1 Participants

Participants in this study were virtual chess players of different chess personalities. The data for the study was collected from the games between the virtual players participating in the experiment. The virtual players that were chosen for the study simulate Waitzkin, and three other class-A players of different personalities. Below is the description of each of the virtual players in the experiment, as provided by Ubisoft [33]:

- Waitzkin: a well-known chess grandmaster and author who is characterized by being a courageous attacker with a deep comprehension of the endgame.
- Buck: a player who favors openings that include a significant portion of captured pieces. His vulnerability is his almost negligence of dominating the center of the chessboard. His USCF rating is 2355.
- J.T.: he plays specific openings that are outlined to attract his opponent to fall into a prepared trap. His USCF rating is 2330.
- Lili: a player with a comprehensive opening knowledge, however, she favors particular lines of play that can be insignificantly disadvantageous. As opposed to Buck, she has excellent control over the chessboard. Her USCF rating is 2394.

The selection of these players that represent different personalities is influenced by the categories of moves offered by Chase and Simon [6, p. 259] such as opening, exchange, defense, and attack. Additionally, Chase and Simon [6] explored five chess relations between pieces: attack, defense, proximity, color, and type. It is essential to note that the ratings of the class-A players utilized in the experiment were almost identical.

3.2 Materials

The simulations were run using the Chessmaster software offered by Ubisoft [33]. The software is highly praised in the chess community, it plays at the same level as a top-rank grandmaster, and is used in different research projects [12, 14, 15].

In the design of the current experiment, the researcher manipulated two independent variables: the color of the grandmaster's pieces, and the class-A player's personality. Each class-A player played 78 games against Waitzkin, where half of the games played by each player were with the white pieces and the other half was with the black pieces. The class-A player's personality independent variable has three levels: the personalities of Buck, J.T., and Lili. The description of their personalities was provided in the previous subsection.

The researcher used the Chessmaster for analyzing the games and used the data in the analysis. That is to say, the design involves three dependent variables:

- The agreement percentage of the moves made by the grandmaster
- The agreement percentage of the moves made by a class-A player
- The number of moves in the game: a move is defined as the White player's move followed by the Black player's move

3.3 Procedure

Waitzkin played 78 games against each class-A player utilized in the study. To reduce the chance that the player's color influences the design, each player plays half of the games in the experiment with white color and the other half with black.

4 Results

The researcher conducted a two-way ANOVA to examine the effect of two independent variables (grandmaster's color and class-A player's chess personality) on each of the dependent variables. All the effects were considered statistically significant at $p < 0.05$. There was a significant main effect of the class-A player personality on the number of moves in the games, $F(2, 228) = 5.607$, $p = 0.004$. Pairwise comparisons indicate that the significant main effect reflects a significant difference ($p = 0.003$) between J.T. ($M = 68.410$) and Lili ($M = 57.372$).

There was a significant main effect of the color of the grandmaster on the agreement percentage of the moves made by Waitzkin, $F(1, 228) = 5.919$, $p = 0.016$. This indicates that the Chessmaster agrees more with Waitzkin when he plays with black pieces ($M = 98.111\%$) than when he plays with white pieces ($M = 97.385\%$). Additionally, there was a significant main effect of the color of the grandmaster on the agreement percentage of the moves made by the class-A players, $F(1, 228) = 11.132$, $p = 0.001$. More specifically, the Chessmaster agrees more with the class-A players when Waitzkin plays with the black pieces ($M = 94.410\%$) than white pieces (92.487%). Similarly, there was a significant main effect of a class-A player's personality on the agreement percentage of the moves made by class-A players participating in the experiment, $F(2, 228) = 3.529$, $p = 0.031$. Pairwise comparisons indicate that the significant main effect reflects significant differences ($p = 0.039$) between Buck ($M = 92.744\%$) and Lili ($M = 94.513\%$). Fig. 1 shows the Chessmaster's agreement percentages on the moves made by Waitzkin and the other class-A players employed in this study.

5 General discussion

This study set out with the aim of assessing the importance of chess personality in the errors made by virtual chess players of different personalities. The results of this study indicate that a chess player can perform differently depending on the personality of his opponent. Surprisingly, the findings showed that Waitzkin performed better with black pieces as opposed to when he had white pieces. Likewise, the virtual class-A players performed better with the black pieces than when they had white pieces. It is interesting to note that previous research indicated that the performance of less-skilled chess players, measured by the errors they make is consistent with the performance of their grandmaster opponent. For example, in a former study exploring two groups of chess players: grandmasters and class-B players, the researcher found that class-B players had fewer errors when they played against Anderssen (i.e. an attacker grandmaster), as opposed to when they played against Leko (i.e. defensive grandmaster). Similarly, the same study showed that Anderssen had fewer errors than Leko when they both played against the same class-B players. One possible explanation of why Waitzkin in this experiment performed better with black pieces is related to chess opening. A chess

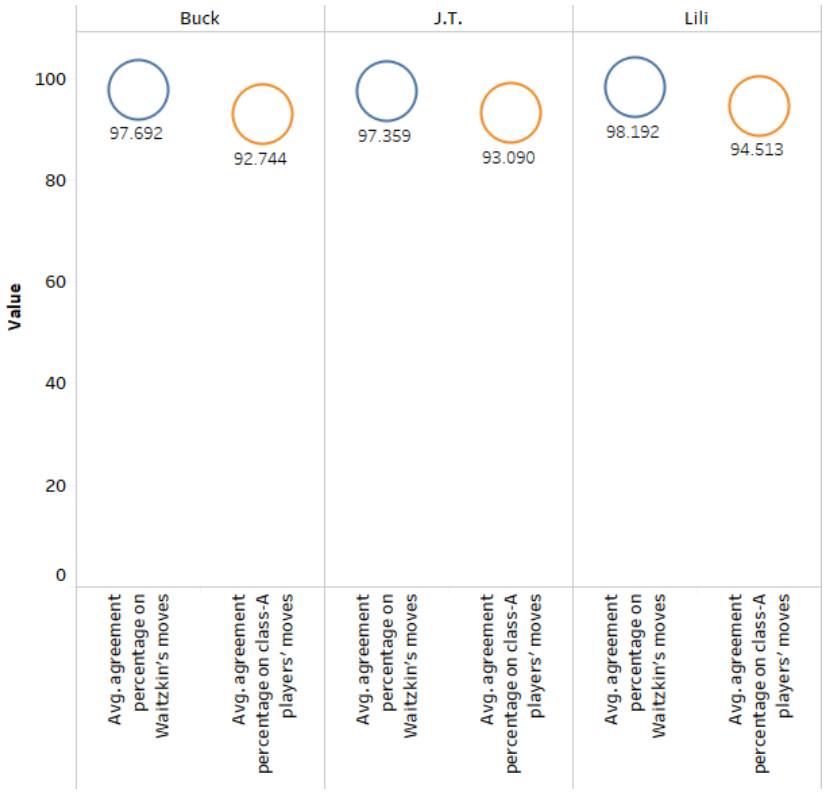

Fig. 1. The Chessmaster's agreement percentages on the moves made by Waitzkin and the other class-A players utilized in the study. As shown in the figure, Waitzkin performed the best while competing against Lili as opposed to the other class-A players. Likewise, Lili did the best among the other class-A players employed in the study.

player sometimes tends to perform better when he encounters an opening he is familiar with [14].

Openings are not just important in chess, but existing research in the marketing domain showed the importance of carefulness in handling a new product. One example is the purchase of Snapple by Quaker, which owned Gatorade at that time. On the day of declaring that Quaker would purchase Snapple for 1.7 billion dollars, their stock price decreased by about 10%, and three years later, after several attempts to merge Snapple into their environment with Gatorade, Triarc purchased Snapple for 300 million dollars [26]. The example shows that Snapple and Gatorade are different brands and should not be treated as equals without carefulness. Likewise, in chess, openings are different, and not being familiar with a particular opening can result in making more mistakes and probably losing a game. This is further evidenced by the outcomes of the analysis showing that the games against J.T. last the longest (Fig. 2), although

he has almost the same rating as the other class-A players utilized in this experiment. However, J.T. utilizes opening traps while playing, and these can probably make his opponent further resist, especially if not aware of particular opening lines.

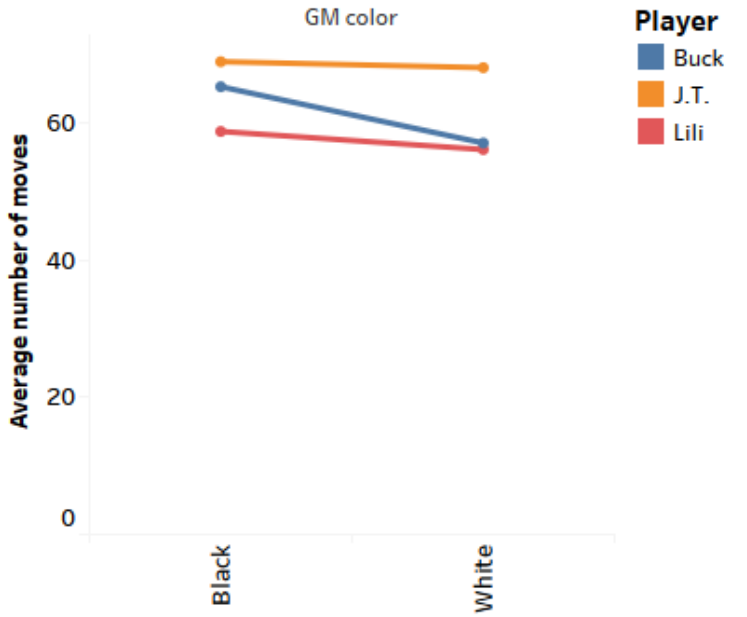

Fig. 2. The average number of moves in the study while competing against Waitzkin. The figure shows that on average, the games involving J.T., a players who considers traps in the openings were the longest

Another important finding was that, although having almost the same rating, the class-A players in the study performed differently while competing against Waitzkin. The experimental results revealed that the Chessmaster significantly agrees more on the moves made by Lili than the moves made by Buck. Controlling the center is an essential chess strategy and for some chess openings, a player sacrifices material to gain more control of the center of the board [4, 20, 27]. Interestingly, existing research shows that controlling the center, and other activities encountered by students while playing a chess game are analogous to some management principles [4]. In his research, students learn the concept of controlling the center of the board, which leads to controlling the game. Additionally, his research shows that such a concept is comparable to winning the domination in the industry and developing into the performing standard [4].

The findings in this study further support the idea of exploring the personalities of chess players and how players perform while competing against other players. That is to say, the findings of this study are consistent with the findings of other studies involving virtual chess players confirming that players of the same rating perform differently depending on the personalities of the opponents they are competing with. For example, in a previous study that investigates the personality of Garry Kasparov, the findings show that the performance of Kasparov varied while competing against other less-skilled players [14].

6 Conclusion

The purpose of the current study was to determine how a chess grandmaster who considers attacking strategies performs while playing against class-A players of different personalities. For this purpose, the researcher employs virtual players that simulate Waitzkin, as an attacker grandmaster, and other class-A players. Like real players, virtual players have certain characteristics and they follow different game strategies such as attack, defense, and controlling the center. The three class-A players vary in their personalities: a player who tends to capture the opponent's pieces, a player who considers offering traps in the opening phase, and a player with solid center control and comprehensive opening knowledge.

This study has shown that a grandmaster performs differently depending on his opponent's strategy. Likewise, players of the same rating perform differently while competing against the same grandmaster. These findings are consistent with the previous findings exploring grandmasters and less skilled players [12, 14, 15]. For example, class-B players of almost the same ratings and different chess personalities had different reactions while competing with two grandmasters of different styles [12]. Likewise, the same study showed that Anderssen, an aggressive grandmaster performed better than Leko while competing against less skilled players of the same rating category.

The findings in this study suggest that in general, chess personality is a crucial factor to consider when evaluating the outcomes of chess games between different players. In other words, although chess players are evaluated based on their chess ratings, this does not seem to be the only way to assess their performance. Additionally, since chess is a fundamentally strategic game, these findings can be extended to be explored in other domains such as psychology, business, and computing. The findings reported here shed new light on the psychology of competition and how the personalities of virtual humans are related to many aspects in domains exploring many attitudes such as aggressiveness and defense. That is to say, the researcher believes that the present study lays the groundwork for future research into exploring how virtual humans can aid in understanding new elements in business strategies. To develop a full picture of the personalities of chess players, additional studies will be needed that explore different aspects of personalities. For example, further studies, which take personality traits into account, will need to be undertaken [1, 3, 31, 35].

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