The Temporal Differences in Chess Between ADHD and Neurotypical Individuals

Introduction

Chess has long served as an important tool for studying human cognition and decision-making. Since Binet's pioneering studies in 1966, researchers have leveraged chess as a model system for investigating complex cognitive processes. This approach gained particular momentum with Gobet and Simon's (1996) study on template and chunking theory, which provided crucial insights into how humans organize and process complex patterns and information.

The utility of chess for cognitive science research is owed to several factors: it offers a well-defined, zero sum problem space, allows for precise measurement of decision quality, and provides precise temporal data about a cognitive process (ie, chess moves); millions of games are played each day, providing a gargantuan and ever growing database of individual decision making (chowdhary, 2023). These features have enabled researchers to investigate fundamental questions about intelligence, reasoning, and memory (Franklin, 2020). This extends beyond general cognitive science research about memory and thought but allows investigation into hard sciences. For instance, Pereira (2020) used chess tasks to examine prefrontal cortex recruitment during complex cognitive operations, while Biliac (2011) demonstrated how chess experts activate specialized brain regions like the fusiform face area when processing familiar chess board positions.

Beyond basic research, chess has proven valuable as an intervention tool across various clinical contexts. Studies have explored its therapeutic potential for conditions ranging from substance use disorders (Goncalvez, 2014) to schizophrenia (Demily et al., 2009). Particularly relevant to the present research, several studies have investigated chess as an intervention for Attention Deficit Hyperactivity Disorder (ADHD). Mohammad Nour Ed Laou (2015) found that chess training was associated with improved concentration in children with ADHD, specifically noting decreased disruptive behaviors and enhanced attention spans in class.

However, while chess has been extensively studied as a cognitive training tool and therapeutic intervention, less attention has been paid to how different populations naturally engage with and play chess. This represents a missed opportunity - rather than viewing chess solely as a standardized background for cognitive research or as an intervention, we can learn from the distinct patterns that emerge in how different groups play the game. Recent research leveraging large-scale online chess data has begun to reveal such differences, demonstrating geographical variations in strategic behavior and decision-making patterns (Szczepańska & Kaźmierczak, 2022), as well as systematic differences in response time distributions between differently ranked player populations (Sigman, 2010). These findings suggest that chess gameplay itself can serve as a window into cognitive and behavioral differences between populations.

This study pursues an independent investigation into if players with ADHD differ in their time management than players from the general population. ADHD serves as an excellent choice for this for several reasons: (1) ADHD is one of the most commonly diagnosed neurodevelopmental disabilities in the world, with 11.4% of U.S. children aged 3-17 years (7.1 million) having ever been diagnosed with ADHD by a healthcare provider as of 2022 (Danielson et al., 2024). While prevalence rates vary internationally, ranging from 2.4% to 7.5% in countries like Sweden, Italy, Australia, Iceland and Spain (Faraone et al., 2003), the global impact remains substantial. The condition carries significant lifetime implications - recent matched cohort studies indicate adults with ADHD face a reduced life expectancy, with women losing an average of 8.64 and men losing 6.78 years of life compared to non-ADHD peers (O'Nions, 2025). As one of the most studied neurodevelopmental conditions, research has documented clear functional differences in ADHD perception and working memory, particularly in domains of perceptual timing abilities (Marx & Cortese, 2021) and time management, making it an ideal condition to probe for potential differences in chess decision-making patterns.

To the best of my knowledge, this is the first investigation of a direct comparison between the chess games of ADHD and neurotypical players. While previous research has examined cognitive processes in chess players (Charness, 2001) and time management patterns in ADHD populations separately (Patros, 2019), no studies have specifically analyzed how ADHD or any neurotypical disorder for that matter influences chess performance and decision-making in actual game scenarios. Online chess, with its precise recording of response times, evaluation accuracy, and performance metrics under varying time pressures, provides an ideal laboratory for examining how ADHD manifests in complex cognitive tasks requiring sustained attention, time management strategy, and strategic planning.

- Methods

Participant / Data Collection

	(n= number of games, ADHD	Number of games, General
<1000	138	60
1000-1400	1155	1892
1400-1800	415	5280
1800+	439	2691

To recruit players, online chess communities such as reddit.com/r/chess, reddint.com/r/ADHD, reddit.com/r/lichess, and the chess substack were searched to find individuals with an extensive history of playing online chess who self-identified having diagnosed ADHD. After filtering for players with >300 games to provide an adequate sample size, these players games were downloaded, and sorted into distinct elo brackets.

Lichess.com, the largest open source chess website, publishes an enormous collection of games (stored via PGN format) every month; these game_databases contain hundreds of thousands of games played on their website across all ELO and time control categories. I used the 2017 found here (.pgn.zst); this dataset was selected as this was the first LiChess dataset to include game-evaluations and player-time-usage natively within the PGN file format, thus saving on computing power from running chess-engines natively on my computer; for thousands of positions, this remains currently unfeasible for me.

Data Structure and Research Design

In order to avoid confounding factors in the analysis that can be attributed to player skill, players were separated into granular ELO categories - and only compared to players of approximate level. Elo is a method for calculating the relative skill levels of players in zero-sum games. Higher-rated chess players make more consistent moves at shorter response times, so to ensure fair comparisons, comparisons were only held between players of equal ELO category and thus skill level.

GAME ID	EVALUATION
EVENT	EVAL_CHANGE
DATE	WINNING_CHANCES
RESULT	WINNING_CHANCES_CHANGE
WHITE_PLAYER	MATERIAL_DIFFERENCE
BLACK_PLAYER	TIME_CONTROL
WHITE_ELO	TIME_CONTROL_CATEGORY
BLACK_ELO	INITIAL_TIME
ADHD_PLAYER	INCREMENT
move_number	TIME_REMAINING
Player (perspective)	TIME_SPENT
SAN	
FEN	
GAME_PHASE	
AVG GAME_ELO	

Data focused on games where time usage and budgeting were more important. Among the varying time controls that are popular in chess are bullet, blitz, rapid. Correspondence (games played over a course of days to months) and classical games were eliminated; given their incredibly long game-times and variable long response times, these formats are not conducive to the study of temporal decision making.

Each game was then broken down into move-by-move data, with each row containing information about each player's move, time spent, effect of move on winning chances and more according to Szczepionka et .al.

Derived Variables and Operationalization

There are several variables that require inherently subjective measurements, and effort was taken to define these variables in accordance with current methods and chess theory. The first variable examined is the "phase" of the chess game being analyzed, which is traditionally defined as either opening, middlegame, or endgame. While chess players often rely on intuitive recognition of game phases, chess engines do offer an operational approach to delineating between game phases. This algorithm considers three key components: (1) non-pawn material value (with empirically calibrated weights: knights=782, bishops=830, rooks=1289, queens=2529), (2) pawn structure including passed pawns and center control, and (3) piece mobility measured through attack square calculations. These factors are combined into a phase score ranging from 0 to 128, with thresholds at 96 and 32 delineating the transitions between phases. Positions scoring ≥96 are classified as opening (representing 75% of maximum material), scores between 32-95 as middlegame, and scores <32 as endgame. Additionally, the first 10 moves (20 ply) are always classified as opening phases to align with chess theory.

Position complexity was quantified using Elocator (Wetherell, 2023), a neural network-based complexity estimator that defines position complexity as the number of possible changes in winning percentage in an individual position. The model processes chess positions through a 780-dimensional vector space (representing an 8x8 board, 12 piece types, en-passant squares, and castling rights) and was trained on grandmaster games to predict position complexity based on observed changes in winning percentages. The result of this neural network is narrowed down via sigmoid function to a complexity score ranging from 1-10. This provides a standardized numerical measure of position complexity that goes beyond simple piece counting or possible-move enumeration.

If chess players run out of time on the clock, said player's game ends in a loss, regardless of position or evaluation. Thus, players face time-pressure, the need to make a move in order to avoid a loss. This factor was operationalized using dual criteria: an absolute threshold of 30 seconds remaining, or a relative threshold of 10% of initial time allocation. This dual-threshold approach accounts for varying time control formats while capturing both absolute and relative time pressure effects. For example, in a 10-minute rapid game, the relative threshold would trigger at one minute remaining, while in shorter time controls, the absolute 30-second threshold becomes more relevant. This approach attempts to standardize measuring time pressure across different time control formats.

Statistical Analysis

Mixed-effects models were employed to account for moves nested within games, with random intercepts for individual games. Additional polynomial and spline regressions captured nonlinear relationships in the data. All analyses were stratified by ELO bracket and time control category in order to avoid effects that stem from differences in chess skill level as well as from varying time pressures from different time controls. Heteroskedasticity was addressed using robust standard errors (HC3 estimators). All analyses were conducted in R, with significance set at $\alpha = .05$.

Results

Introductory Summary Statistics

The final filtered dataset contained a total of 9,810 games (2,150 ADHD, 7,660 control) (Table 1) across three time control categories and four ELO rating brackets. Analysis focused on Blitz and Rapid time controls, with Bullet games included as supplementary data due to sampling constraints in certain ELO brackets. These games yielded 354,385 analyzed moves (134,677 ADHD, 219,708 control) (Table 2)

Table 1: Game Distribution by Time Control and ELO Bracket

ELO Bracket	Time Control	ADHD (n)	Control (n)	Total Games
≤1000	Blitz	42	36	78
	Rapid	58	17	75
	Bullet	38	7	45
1001-1400	Blitz	535	828	1,363
	Rapid	590	548	1,138
	Bullet	28	485	513
1401-1800	Blitz	144	2,111	2,255
	Rapid	240	1,648	1,888
	Bullet	23	1,403	1,426
1801+	Blitz	171	1,267	1,438
	Rapid	75	715	790
	Bullet	186	672	858

Table 2: Move-Level Statistics by Player Group

Metric	ADHD	Control
Total Moves	134,677	219,708
Mean Eval Change	-89.47 (±213.84)	-79.47 (±178.38)
Moves Under Time Pressure	18.2%	16.8%
Average Time per Move (s)	27.39	25.84
- Normal Moves	81.3%	83.7%
- Inaccuracies	10.1%	9.2%
- Mistakes	4.2%	3.4%
- Blunders	4.4%	3.6%

Time Management Analysis

To investigate factors influencing response times in chess games, two parallel analyses were conducted via linear regression: time spent across move numbers and time spent relative to position complexity. For each relationship, iterative linear regressions were run that conducively added separate measured variables to see what could account for time effects between ADHD and non-ADHD players.

Player type (ADHD status) alone showed highly significant differences in time management patterns in both analyses. In the move number analysis, Non-ADHD players spent on average 4.71 seconds (SE = 0.28) more per move than ADHD players ($t(df = 259142) = 16.53$, $p < 2.2e\text{-}16$). Similarly, in the complexity analysis, Non-ADHD players spent 4.28 seconds (SE = 0.29) more per move ($t\ (df = 259142) = 14.86$, $p < 2.2e\text{-}16$). While these player type effects accounted for relatively smaller portions of variance (move number $R^2 = 0.046$; complexity $R^2 = 0.032$), they remained highly significant through all model iterations, suggesting fundamental differences in time management strategies between groups.

Analysis	Coefficient	SE	t-value	p-value	Rsquared
Move Number	4.71	.28	16.53	<2.2e-16	.046
Complexity	4.28	.29	14.86	<2.2e-16	.032

Regression Coefficients for Baseline Effects

The linear regression model examining time progression across a game's progression showed significant improvements across iterations. As expected, addition of time control and ELO variables substantially improved model fit ($\Delta F = 4945.91$, $p < .001$). Further inclusion of position complexity and time remaining variables contributed significant additional explanatory power ($\Delta F = 4691.58$, $p < .001$), while time pressure effects demonstrated highly significant influence on time management patterns ($\Delta F = 224.88$, $p < 1e\text{-}50$).

The complexity analysis revealed similar patterns of model improvement but with distinct characteristics in player responses. Time control and ELO variables again demonstrated the strongest improvement to model fit ($\Delta F = 5186.88$, $p < .001$), while complexity-specific variables provided substantial additional explanatory power ($\Delta F = 6122.53$, $p < .001$). Time pressure effects showed even stronger influence than in the move number analysis ($\Delta F = 256.20$, $p < 1e\text{-}57$).

	Model	Variables	R_squared	Adj_R_squared	F	Pr(>F)
1	Move1	MoveNumber*PlayerType	0.0463472685767882	0.0463288695165348	NA	NA
2	Move2	+ ELO + TimeControl	0.141048493615071	0.141012034446049	5186.87673018085	0
3	Move3	+ TimeRemaining + Complexity	0.170992282027736	0.170950695686491	6122.52648525555	0
4	Move4	+ UnderPressure	0.171709931952354	0.17166518525855	256.195075180228	1.234860145861E-57
5	Move5	+ WinningChances	0.171710578289404	0.171662635255594	0.232366640066333	0.629774933260033
6	Move6	+ All Interactions	0.173018681031489	0.172951665234365	22.7426000857043	5.70185046616529E-27

	Model	Variables	R_squared	Adj_R_squared	F	Pr(>F)
1	complexity 1	Complexity*PlayerType	0.0317848228262628	0.0317661428091077	NA	NA
2	complexity 2	+ ELO + TimeControl	0.131263058608992	0.131226184086105	4945.91278263112	0
3	complexity 3	+ TimeRemaining + MoveNumber	0.170404026926396	0.170362411075924	4691.57708817385	0
4	complexity 4	+ UnderPressure	0.171222947297302	0.171178174295138	224.882028770411	8.18284640551123E-51
5	complexity 5	+ WinningChances	0.171223690050748	0.171175718834882	0.202535494807738	0.652682381115361
6	complexity 6	+ All Interactions	0.171659866549904	0.171592740639004	68.3176175443062	2.42986982679266E-85

While the regression analysis provides robust evidence of significant differences in time management between ADHD and non-ADHD players across various conditions and controls, it is also informative to examine how these differences play out on a move-by-move basis. The following comparisons clearly illustrate that, for instance, in lower ELO brackets, the disparities in time allocation become especially pronounced as the game progresses. This more granular analysis complements our regression results by offering a concrete view of the evolving time differences during gameplay.

Performance by Move Number

In Blitz games at the 1000-1400 ELO level, ADHD players showed consistently higher time expenditure per move, with the difference increasing as the game progressed. At move 1, ADHD players spent on average 17.38 seconds compared to non-ADHD players' 12.83 seconds (difference: +4.56s). This disparity grew markedly by move 40, where ADHD players averaged 38.98 seconds compared to 19.87 seconds for non-ADHD players (difference: +19.12s).

ELO	TIME CONTROL	MOVE NUMBER	ADHD_TIME	NONADHD_TIME	TIME_DIFFERENCE
1001-1400	Blitz	1	17.38	12.83	4.56
1001-1400	Blitz	10	22.37	14.45	7.92
1001-1400	Blitz	20	27.91	16.26	11.65
1001-1400	Blitz	30	33.44	18.06	15.38
1001-1400	Blitz	40	38.98	19.87	19.12
1001-1400	Rapid	1	9.73	17.06	-7.33
1001-1400	Rapid	10	15.34	23.95	-8.6
1001-1400	Rapid	20	21.58	31.59	-10.01
1001-1400	Rapid	30	27.82	39.24	-11.42
1001-1400	Rapid	40	34.06	46.89	-12.83

In Rapid games, however, the pattern reversed. Non-ADHD players consistently spent more time per move, with the difference widening throughout the game. Initial moves showed ADHD players using 9.73 seconds compared to non-ADHD players' 17.06 seconds (difference: -7.33s). By move 40, this gap had expanded to ADHD players using 34.06 seconds versus non-ADHD players' 46.89 seconds (difference: -12.83s)


Chess Move Timing Analysis: 1001-1400
Bullet Games
Time Spent (seconds)
0
4
8
12
16
20
0
50
100
150
200
Move Number
Player Type
ADHD
Non-ADHD

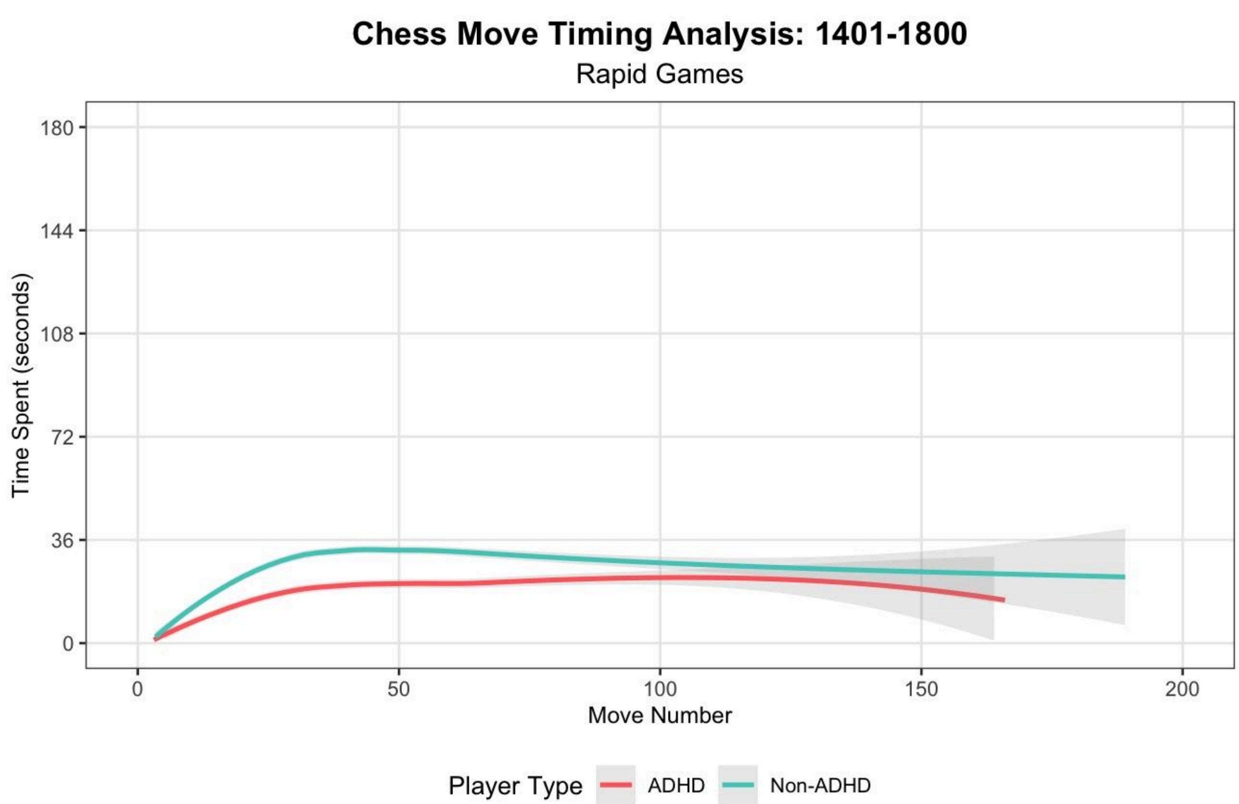

Chess Move Timing Analysis: 1001-1400
Rapid Games
Time Spent (seconds)
0
36
72
108
144
180
0
50
100
150
200
Move Number
Player Type
ADHD
Non-ADHD

In the 1400-1800 ELO bracket, both time allocation and group differences showed distinct patterns from the lower-rated cohort. Across all time controls, non-ADHD players consistently spent more time per move than ADHD players, with the gap widening as games progressed.

This disparity was most pronounced in Rapid games, where initial differences of -10.85 seconds (ADHD: 11.98s, non-ADHD: 22.83s) nearly tripled by move 40 (difference: -30.98s; ADHD: 21.23s, non-ADHD: 52.20s). Similar patterns, though less pronounced, emerged in Blitz games, where the time difference grew from -1.73 seconds at move 1 to -5.72 seconds by move 40.

1401-1800	Blitz	1	9.76	11.49	-1.73
1401-1800	Blitz	10	10.78	13.43	-2.65
1401-1800	Blitz	20	11.91	15.58	-3.67
1401-1800	Blitz	30	13.04	17.74	-4.69
1401-1800	Blitz	40	14.18	19.89	-5.72
1401-1800	Rapid	1	11.98	22.83	-10.85
1401-1800	Rapid	10	14.12	29.61	-15.49
1401-1800	Rapid	20	16.49	37.14	-20.65
1401-1800	Rapid	30	18.86	44.67	-25.82
1401-1800	Rapid	40	21.23	52.2	-30.98


Chess Move Timing Analysis: 1401-1800
Blitz Games
Time Spent (seconds)
60
48
36
24
12
0
0
50
100
150
200
Move Number
Player Type
ADHD
Non-ADHD


Chess Move Timing Analysis: 1401-1800
Rapid Games
Time Spent (seconds)
180
144
108
72
36
0
0
50
100
150
200
Move Number
Player Type
ADHD
Non-ADHD

Performance by Complexity

The relationship between position complexity and time management reveals distinct patterns across ELO brackets and time controls. Analysis of both lower-rated (1001-1400) and higher-rated (1401-1800) players shows significant differences in how ADHD and non-ADHD players handle increasing position complexity.

In bullet chess (1001-1400), ADHD players maintain relatively stable time expenditure across complexity levels, with only a slight increase from 4.41s at complexity level 2 to 13.61s at level 10. Non-ADHD players show a similar pattern but with consistently lower time investment, ranging from 2.09s to 7.42s.

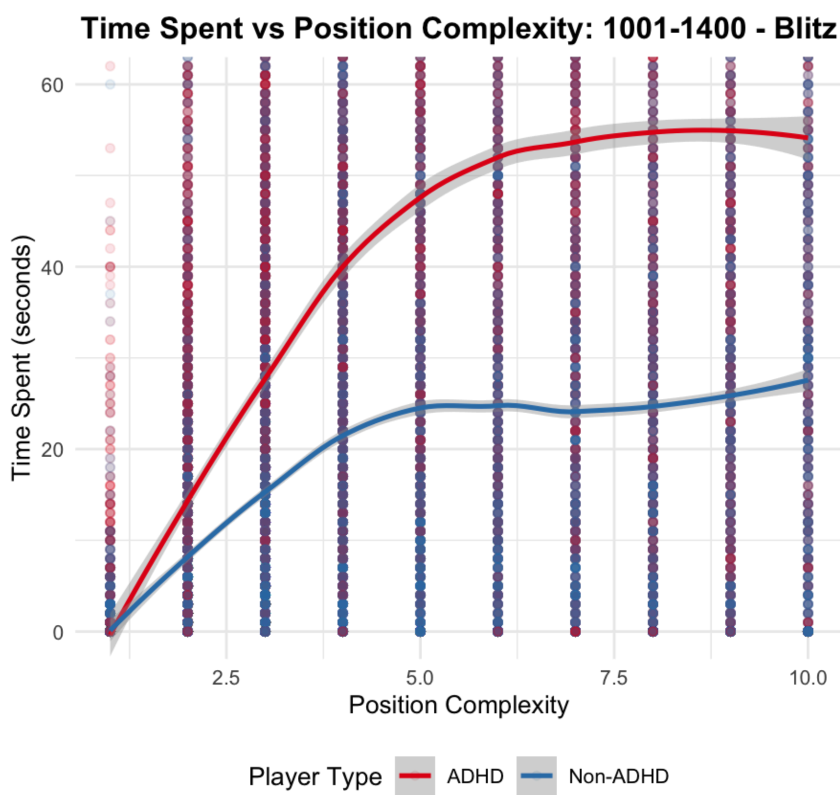
BULLET

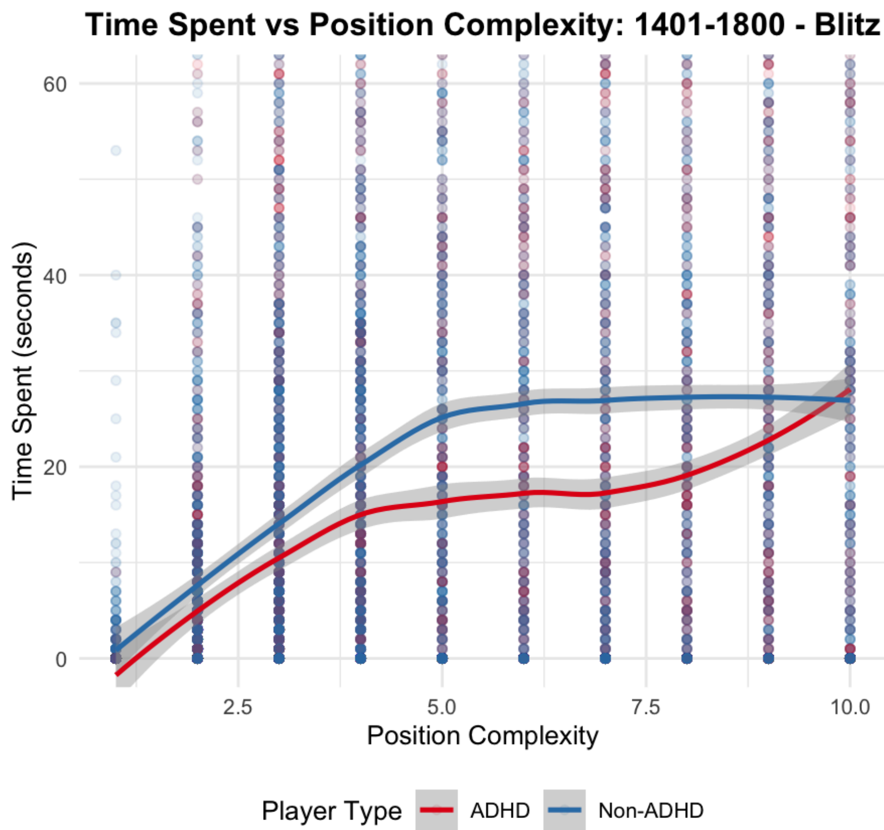
	1001-1400_ADHD	1001-1400_NonADHD	1401-1800_ADHD	1401-1800_NonADHD
Complexity 2	4.41	2.09	0.95	1.67
Complexity 4	8.5	5.57	2.34	4.68
Complexity 6	5.96	6.31	3.85	5.21
Complexity 8	8.9	7.05	6.96	5.57
Complexity 10	13.61	7.42	3.53	5.47

Blitz

	1001-1400_ADHD	1001-1400_NonADHD	1401-1800_ADHD	1401-1800_NonADHD
Complexity 2	12.3	7.54	3.88	7.08
Complexity 4	41.04	22.57	16.07	20.58
Complexity 6	52.8	23.52	16.78	28.21
Complexity 8	52.3	24.38	16.54	26.55
Complexity 10	54.59	28.17	29.48	26.57

Blitz games reveal more pronounced differences. In the 1001-1400 bracket, ADHD players demonstrate a steeper response to complexity, increasing from 12.3s to 54.59s between complexity levels 2 and 10. This contrasts with non-ADHD players who show a more moderate increase from 7.54s to 28.17s. This pattern suggests ADHD players may require more time to process complex positions in intermediate time controls.

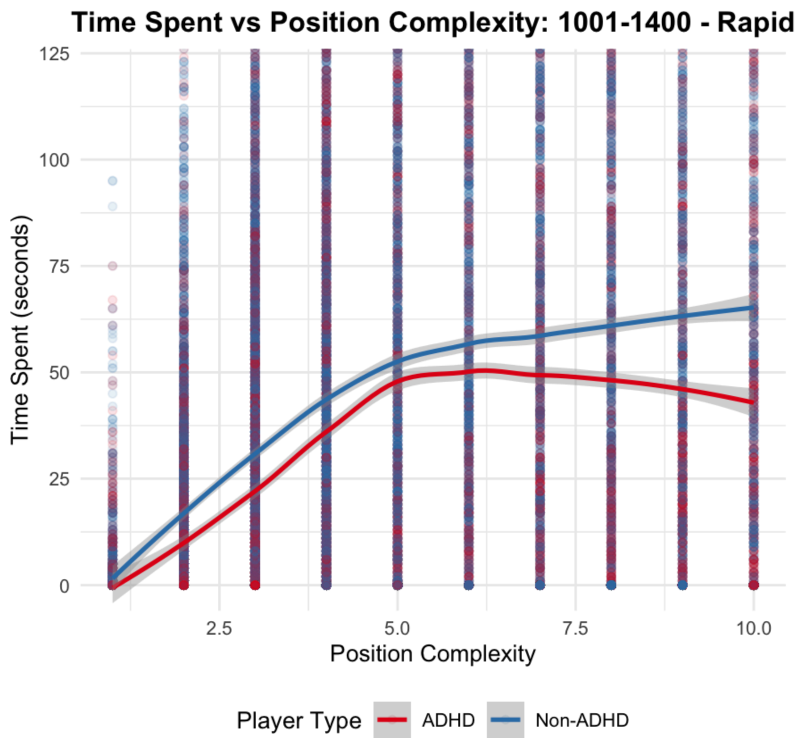


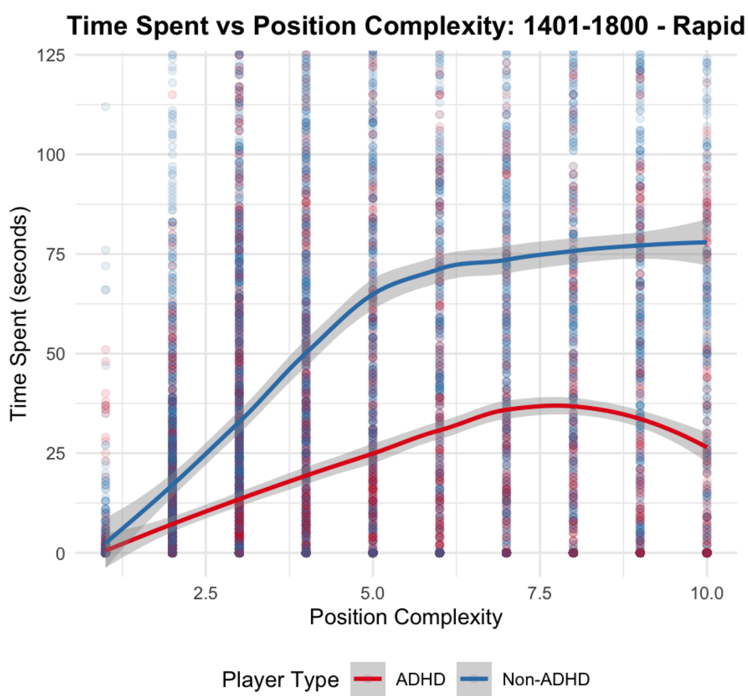


Rapid games show an intriguing reversal. Non-ADHD players in both ELO brackets consistently spend more time than ADHD players as complexity increases. This is particularly evident in the 1401-1800 bracket, where non-ADHD players' time expenditure rises sharply with complexity (18.2s to 62.4s) while ADHD players show a more modest increase (12.4s to 35.8s).

RAPID

	1001-1400_ADHD	1001-1400_NonADHD	1401-1800_ADHD	1401-1800_NonADHD
Complexity 2	8.25	15.83	6.07	15.43
Complexity 4	35.58	44.02	19.07	49.64
Complexity 6	50.97	55.9	33.46	70.87
Complexity 8	47.74	59.82	39.17	72.29
Complexity 10	42.55	65.67	25.21	77.77



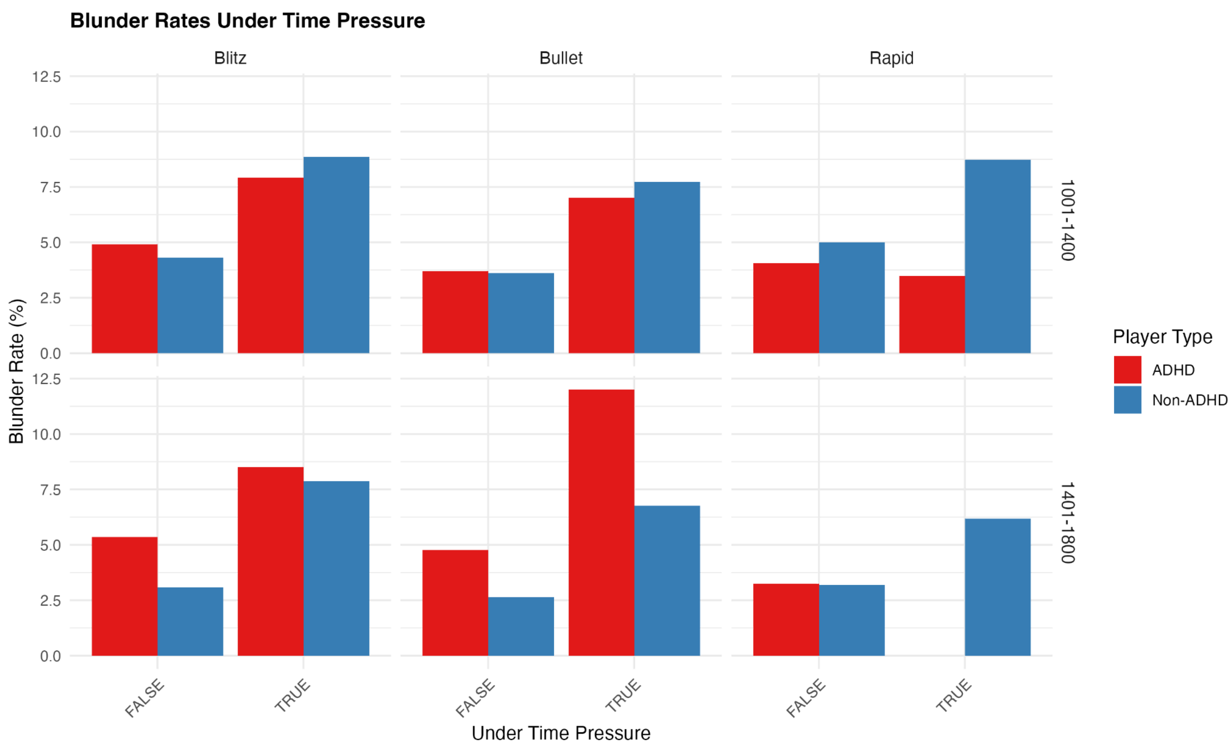


The higher ELO bracket (1401-1800) exhibits different patterns. In blitz and rapid games, both groups show more pronounced responses to complexity, but ADHD players consistently spend less time than their non-ADHD counterparts across all complexity levels. This suggests that at higher skill levels, ADHD players may develop more efficient decision-making strategies or rely more on intuitive play.

These findings suggest that time control significantly modulates how ADHD affects chess decision-making, with the relationship between ADHD and time management varying substantially across different time controls and skill levels.

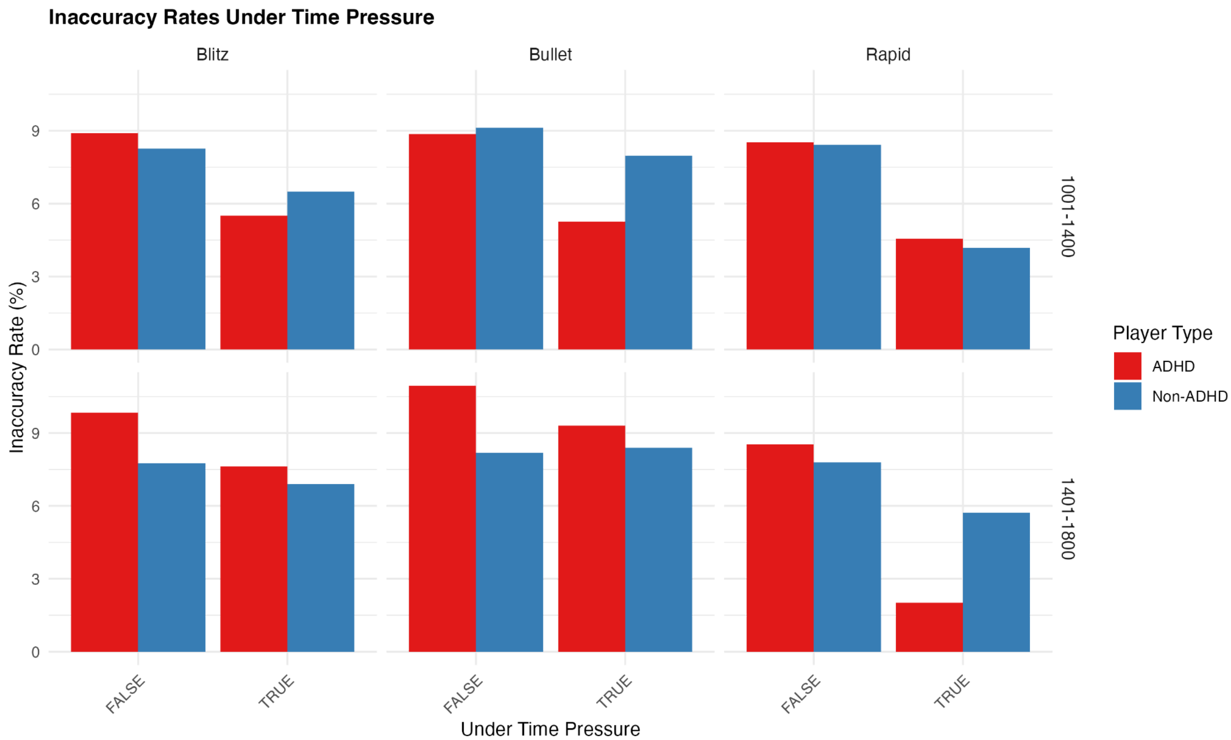
Performance Under Time Pressure

Time pressure shows distinct effects on error rates across skill levels and time controls. In the intermediate ELO range (1001-1400), both ADHD and non-ADHD players demonstrate similar increases in blunder rates under time pressure in Blitz games (ADHD: 4.91% to 7.92%; non-ADHD: 4.31% to 8.87%). However, the pattern becomes more pronounced in higher-rated players (1401-1800), where ADHD players show a particularly marked increase in blunder rates during Bullet games, jumping from 4.76% to 12.02% under time pressure.



False = not under time pressure, true = under time pressure

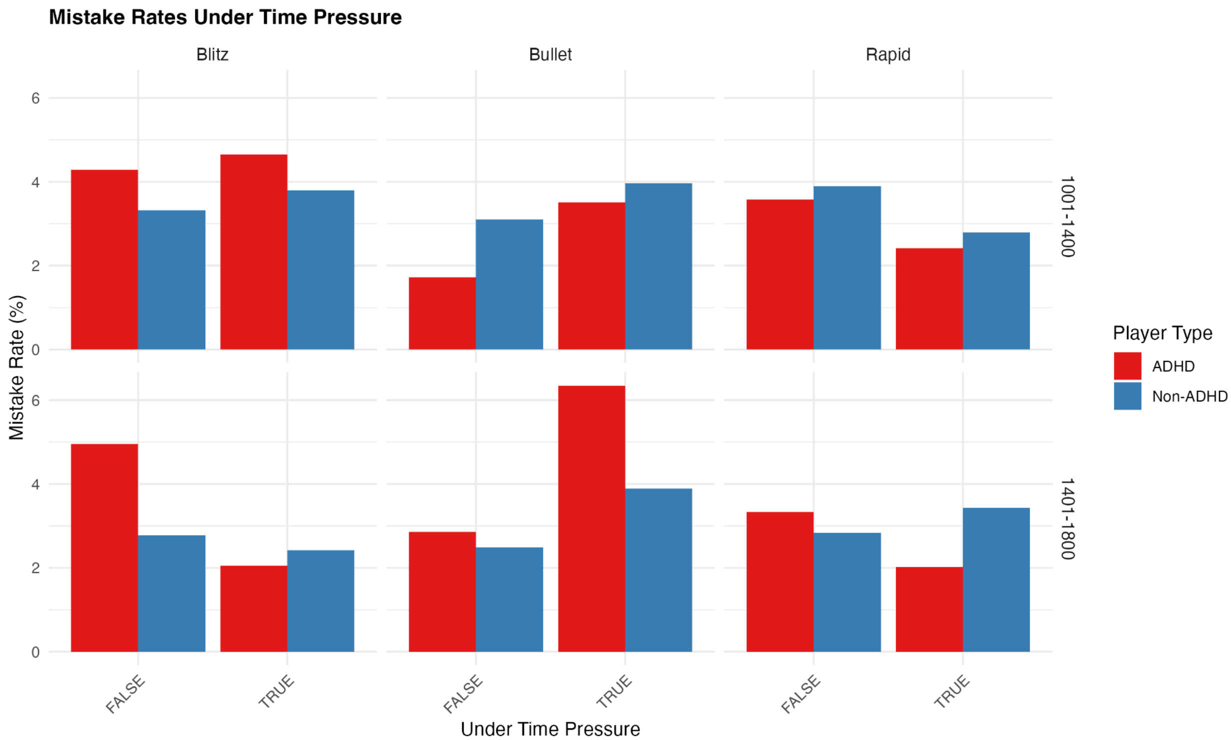
An unexpected finding emerges in the pattern of inaccuracies—minor imprecisions in play. While blunder rates increase under time pressure, inaccuracy rates often decrease. For example, in the 1401-1800 ELO bracket during Blitz games, ADHD players' inaccuracy rates drop from 9.83% to 7.62% under pressure - in comparison to non-ADHD players whose inaccuracy rates began at 7.76% and dropped 6.9%. This suggests that time pressure may influence ADHD players to bypass minor errors in favor of more significant mistakes at a greater rate than their neurotypical counterparts.

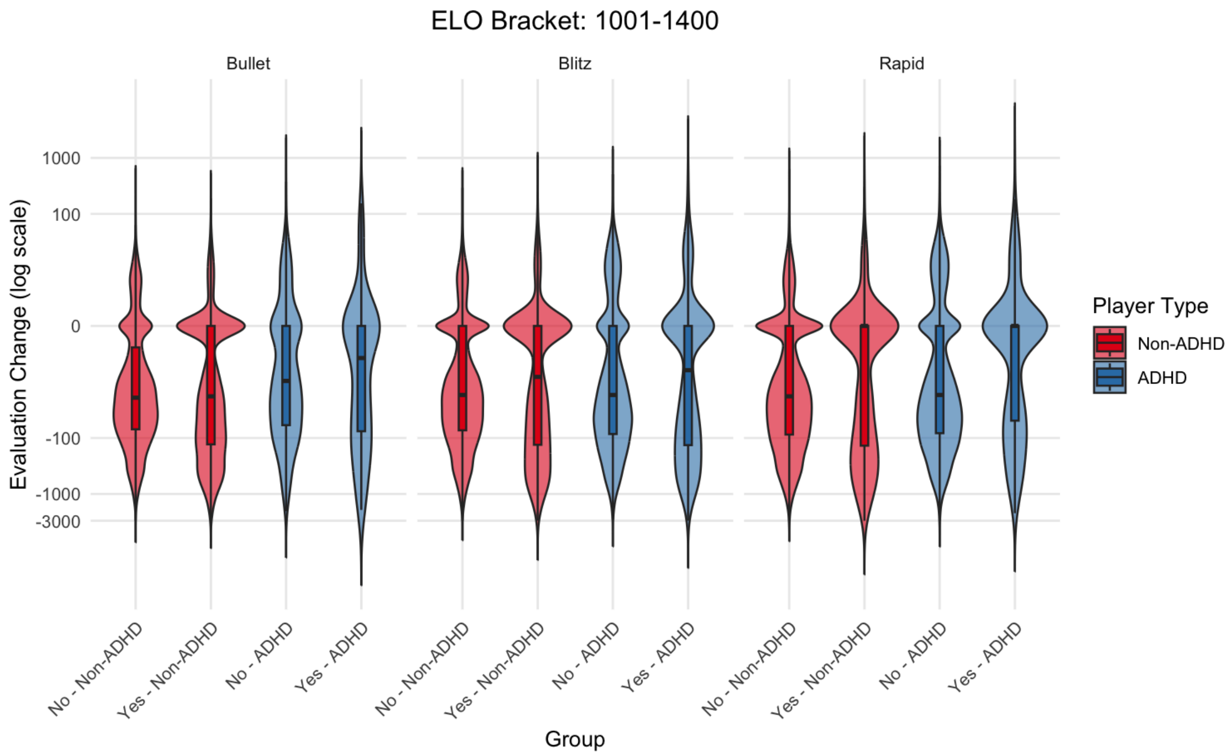


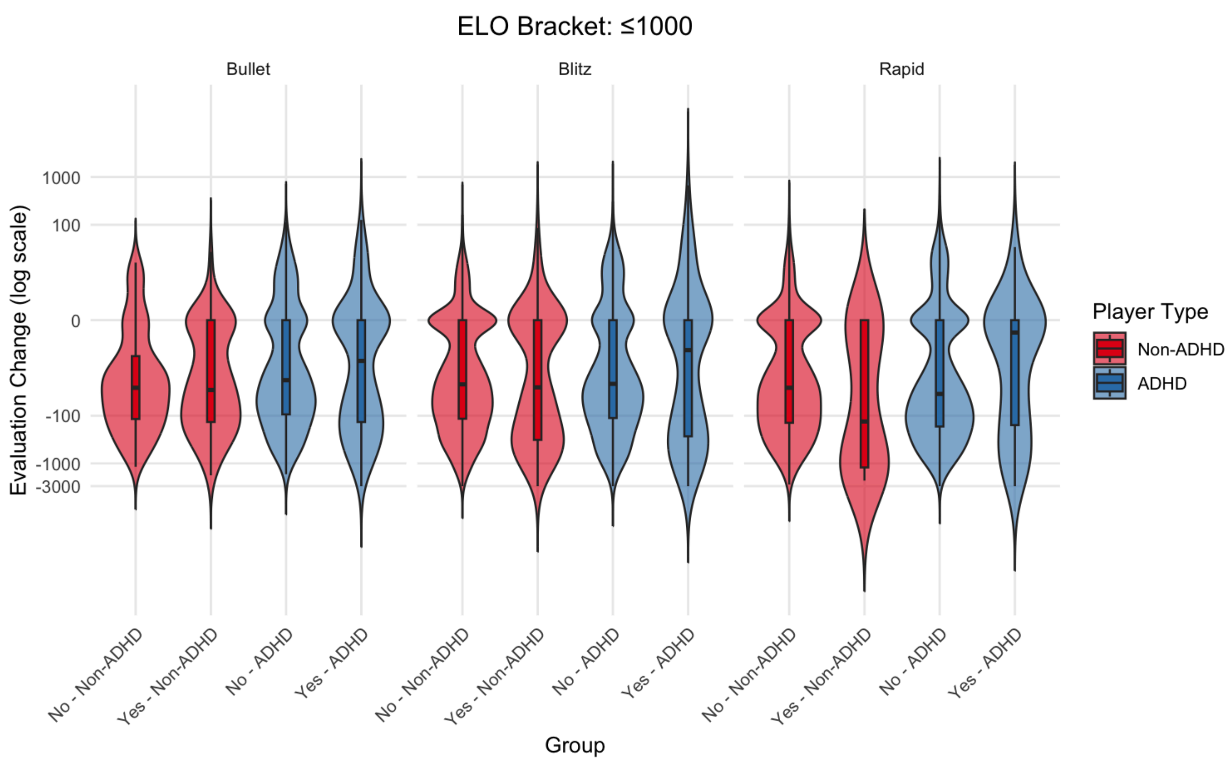
False = not under time pressure, true = under time pressure

Under time pressure, our analysis reveals that both ADHD and Non-ADHD players suffer greater evaluation losses per error, though the magnitude and pattern differ between groups and time controls. In Blitz games (Elo 1001–1400), players typically face an average evaluation drop of approximately –640 centipawns under normal conditions. However, when under time pressure, the drop deepens markedly—to about –710 centipawns for ADHD players and nearly –757 centipawns for Non-ADHD players. This suggests that time constraints exacerbate the cost of errors, with Non-ADHD players experiencing a slightly larger penalty in this format.

The effect is even more pronounced in Rapid games. For ADHD players, the mean evaluation loss per error increases from –89 centipawns in regular conditions to around –96 centipawns when under time pressure. In contrast, Non-ADHD players show a substantial jump from an average loss of –103 centipawns without time pressure to –170 centipawns under time pressure. These findings indicate that while both groups are vulnerable to the pressures of the clock, the errors made by Non-ADHD players under rapid conditions tend to be more consequential.


Mistake Rates Under Time Pressure
Blitz
Bullet
Rapid
1001-1400
1401-1800
Mistake Rate (%)
0
2
4
6
FALSE
TRUE
Under Time Pressure
Player Type
ADHD
Non-ADHD


ELO Bracket: 1001-1400
Bullet
Blitz
Rapid
Evaluation Change (log scale)
1000
100
0
-100
-1000
-3000
No - Non-ADHD
Yes - Non-ADHD
No - ADHD
Yes - ADHD
Group
Player Type
Non-ADHD
ADHD


ELO Bracket: ≤1000
Bullet
Blitz
Rapid
Evaluation Change (log scale)
1000
100
0
-100
-1000
-3000
No - Non-ADHD
Yes - Non-ADHD
No - ADHD
Yes - ADHD
Group
Player Type
Non-ADHD
ADHD

Discussion

Our analysis revealed distinct patterns in chess decision-making between ADHD and non-ADHD players, with notable variations across time controls and skill levels. Regression analysis confirmed significant effects for both Move Number ($\beta = 4.71$, $p < .001$, $R^2 = .046$) and Position Complexity ($\beta = 4.28$, $p < .001$, $R^2 = .032$), though the modest R^2 values suggest these factors explain only part of the behavioral variance.

A particularly striking finding emerged in the temporal dynamics of play. While ADHD players generally spent less time per move than their neurotypical counterparts across most conditions, this pattern reversed specifically in lower-rated (1001-1400 ELO) blitz games. In this context, ADHD players averaged 4.56 seconds more per move in opening positions, with this difference expanding to 19.12 seconds by move 40. This reversal was not observed in rapid games, where ADHD players consistently demonstrated faster play, ranging from -7.33 to -12.83 seconds difference across move numbers."

The distinct temporal patterns we observed in chess play may reflect underlying differences in working memory and attention mechanisms. Marx et al. (2022) found that timing performance is fundamentally linked to working memory, attention, and inhibition, with impaired working memory contributing to altered time perception in the range of seconds. This theoretical framework helps explain our observation that ADHD players demonstrate significantly different time management strategies across different time controls. Particularly, the dramatic reversal in lower-rated blitz games, where ADHD players progressively increase their time usage (from +4.56s to +19.12s over 40 moves), might reflect compensatory mechanisms for managing working memory load under acute time pressure.

Limitations

The primary limitation of this study stems from its recruitment methodology and characteristics from the resultant sample. The ADHD group was relatively small (n=13) compared to the general population sample, necessitating a focus on players with extensive game histories to ensure sufficient data for analysis. Additionally, the self-selection bias inherent in online recruitment may have produced a sample not representative of the broader ADHD chess-playing population, particularly regarding demographics such as age, sex, socioeconomic status, and country of origin

A significant methodological limitation of this nature can be attributed to this informal nature of participant recruitment, particularly, in the inability to verify diagnostic information about the participants condition. These include, but are not limited to:

- Specific ADHD classification/subtype
- Age and circumstances of diagnosis
- Medication status and adherence
- Treatment history and current management strategies

Future Directions

Chess will continue to serve as a valuable tool for cognitive science research, but this study demonstrates the need for more rigorous measurement of differences between player groups. The findings reveal distinct differences between how ADHD and neurotypical individuals play chess, suggesting that chess should be elevated beyond its traditional role as a backdrop for cognitive science. The game provides an excellent laboratory for studying decision-making, offering remarkable precision in measuring both move selection and timing effects.

Given additional resources and funding, several promising research directions emerge. First, introducing eye-tracking technology would be extremely valuable, particularly given chess's structured 64-square layout. This would allow tracking with precision which squares players focus on and how attention shifts across the board. While implementing this at scale would present technical challenges, it could provide unprecedented insight into chess-specific visual attention patterns.

Another compelling direction would involve neuroimaging studies to investigate whether ADHD and neurotypical players engage different brain regions during active chess cognition. While conducting experiments in an MRI environment would present logistical challenges, understanding the neural correlates of chess decision-making across different populations could provide valuable insights into diverse cognitive processing strategies.

Most critically, future research would benefit from a more robust and controlled sample of ADHD players. This would require not only more players and games but also careful control of variables not accounted for in the current study - including medication timing, specific ADHD diagnosis type, severity of symptoms, and other factors that might influence chess play. This enhanced methodology would provide a clearer and more verifiable understanding of how ADHD affects chess-related decision-making.

While these limitations highlight the scope for further investigation, these initial findings suggest that the relationship between ADHD, chess cognition, and decision-making processes merits deeper exploration.

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