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State and Trait Anxiety Differences Across Performance Levels in Competitive Chess Players

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Abstract

Competitive chess represents a cognitively demanding performance environment characterized by sustained attentional control, strategic planning, time-constrained decision making, and emotional regulation. Anxiety has long been recognized as a critical psychological variable influencing performance outcomes in sport settings. However, limited empirical attention has been directed toward understanding anxiety patterns in cognitively intensive sports such as chess. The present study examined differences in state and trait anxiety among chess players across three performance levels. A total of 300 competitive chess players (aged 18–35 years) were categorized as high, moderate, and low achievers based on official rating classifications. State and trait anxiety were assessed using the State–Trait Anxiety Inventory developed by Charles D. Spielberger. Due to violations of normality assumptions, non-parametric statistical procedures were applied. The Kruskal–Wallis H test revealed statistically significant differences among groups for both state anxiety ($H(2) = 20.18$, $p < .001$, $\eta^2 = .061$) and trait anxiety ($H(2) = 16.73$, $p < .001$, $\eta^2 = .049$). High-performing players demonstrated significantly lower levels of state anxiety and comparatively lower trait anxiety than moderate and low performers. The findings suggest that emotional regulation and dispositional stability are associated with superior chess performance. The study contributes to performance psychology literature by emphasizing the role of anxiety management in cognitively demanding competitive environments.

Keywords: state anxiety, trait anxiety, chess performance, competitive stress, emotional regulation, performance psychology

1. Introduction

Chess is widely regarded as one of the most cognitively demanding competitive activities. Unlike physically intensive sports where physiological endurance predominates, chess performance depends heavily on sustained concentration, complex pattern recognition, anticipatory reasoning, executive functioning, and emotional control under time pressure. In tournament settings, players must maintain strategic clarity over prolonged durations while simultaneously coping with evaluative scrutiny and competitive stakes.

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Anxiety represents a central psychological construct within sport psychology research. It is particularly relevant in high-precision activities where small cognitive errors may determine outcomes. Competitive anxiety has been associated with attentional disruption, working memory overload, increased cognitive interference, and impaired decision accuracy.

In the context of chess, anxiety may exert a pronounced influence because each move is deliberate, irreversible, and strategically consequential. Excessive emotional arousal may compromise calculation depth, reduce flexibility in responding to dynamic board positions, and impair long-term planning. Conversely, controlled arousal may facilitate alertness and cognitive engagement.

Despite extensive research on anxiety in physical sports, relatively little empirical attention has been directed toward cognitively intensive sports such as chess. Therefore, the present investigation sought to examine whether state and trait anxiety differ across performance levels among competitive chess players.

2. Theoretical Framework

The conceptual distinction between state and trait anxiety originates from the work of Charles D. Spielberger, who conceptualized anxiety as comprising both situational and dispositional components.

State anxiety refers to a transient emotional condition characterized by heightened tension, apprehension, and physiological activation in response to immediate situational demands. It fluctuates depending on environmental stressors.

Trait anxiety, in contrast, represents a stable personality disposition reflecting the tendency to perceive a wide range of situations as threatening and to respond with elevated anxiety.

Within performance psychology, anxiety–performance relationships have been explained through several models:

1. **Inverted-U Hypothesis** – Proposes that performance improves with arousal up to an optimal point, beyond which excessive anxiety leads to decline.
2. **Catastrophe Theory** – Suggests that high cognitive anxiety combined with physiological arousal may cause sudden performance breakdown.
3. **Cognitive Interference Theory** – Argues that anxiety consumes working memory resources, reducing task efficiency.

Chess performance heavily relies on executive functions such as inhibitory control, working memory updating, and cognitive flexibility. Elevated anxiety may disrupt these processes, particularly under time constraints.

Furthermore, trait anxiety may predispose players to experience heightened state anxiety during competitions, thereby influencing long-term performance consistency.

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Thus, from a theoretical standpoint, lower anxiety levels — particularly situational anxiety — may differentiate high-performing chess players from their counterparts.

3. Methodology

3.1 Research Design

The present investigation employed a quantitative, cross-sectional comparative research design to examine differences in state and trait anxiety among competitive chess players across varying levels of performance. The design was non-experimental in nature, as the independent variable—performance level—was not manipulated but rather existed naturally within the competitive structure of organized chess tournaments. A comparative approach was selected to determine whether statistically meaningful differences in anxiety profiles could be observed across three distinct categories of players: low, moderate, and high achievers.

The study was grounded in psychological assessment methodology and sought to quantify emotional variables using standardized psychometric tools. By adopting a cross-sectional framework, anxiety levels were assessed at a specific time point within the competitive cycle, allowing for an objective comparison across groups.

3.2 Participants

The participants for the present study consisted of 300 competitive chess players drawn from district- and state-level tournaments conducted in North India. These players were actively engaged in organized chess competitions and had formal rating classifications. The age range of the participants was 18 to 35 years, representing a competitive adult population characterized by cognitive maturity and active tournament participation.

To ensure balanced representation, a stratified random sampling technique was implemented. Initially, players were categorized into three performance strata based on their official rating status. Within each stratum, participants were selected randomly to minimize selection bias and to maintain proportional group sizes.

The final sample comprised 100 low-performing players (unrated or rating below 1000), 100 moderate-performing players (rating between 1001 and 1500), and 100 high-performing players (rating above 1500). This equal group distribution enhanced the statistical robustness of between-group comparisons and ensured adequate statistical power.

Participants were included in the study only if they had a minimum of two years of competitive experience and had participated in at least three rated tournaments in the preceding year. Individuals with diagnosed psychological disorders or those currently under anxiolytic medication were excluded to prevent confounding influences on anxiety measurement.

3.3 Variables of the Study

The independent variable in this study was performance level, categorized into low, moderate, and high achievers. The dependent variables were state anxiety and trait anxiety, both measured as continuous psychological constructs.

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State anxiety refers to the temporary emotional tension experienced in a specific competitive situation, whereas trait anxiety reflects a relatively stable personality predisposition to perceive circumstances as threatening. These constructs were measured quantitatively using a standardized psychological inventory.

3.4 Instrumentation

Anxiety was assessed using the State–Trait Anxiety Inventory (STAI), developed by Charles D. Spielberger. The STAI is widely recognized in psychological and sport sciences research for its robust psychometric properties and conceptual clarity in differentiating situational anxiety from dispositional anxiety.

The inventory consists of two separate 20-item subscales: one measuring state anxiety and the other measuring trait anxiety. Participants respond to each statement using a four-point Likert scale reflecting intensity of emotional experience. The possible score range for each subscale extends from 20 to 80, with higher scores indicating greater anxiety levels.

The reliability of the instrument within the present sample was examined using Cronbach's alpha coefficient. The state anxiety subscale demonstrated an internal consistency coefficient of 0.89, while the trait anxiety subscale yielded a coefficient of 0.87, indicating high reliability and measurement stability within the competitive chess population.

3.5 Procedure of Data Collection

Prior to data collection, formal permission was obtained from tournament organizers and relevant chess associations. Participants were informed about the objectives and nature of the study, and written informed consent was secured.

To accurately capture situational anxiety, the state anxiety subscale was administered approximately thirty minutes before the commencement of a scheduled competitive match. This timing ensured that participants were experiencing genuine competitive anticipation without being immediately engaged in gameplay. The trait anxiety subscale, in contrast, was administered in a neutral, non-competitive environment to assess stable personality tendencies independent of immediate situational stressors.

Participants required approximately 12 to 15 minutes to complete the inventory. Confidentiality of responses was maintained throughout the process, and anonymity was assured to prevent performance-related evaluation bias.

3.6 Statistical Analysis

The collected data were coded and entered into statistical software for analysis. Preliminary data screening included checking for missing values, identifying outliers, and testing statistical assumptions.

Normality of distribution was examined using the Shapiro–Wilk test. The results indicated significant deviations from normality in both state and trait anxiety scores across groups ($p < .05$). Given this violation of parametric assumptions, non-parametric statistical procedures were employed.

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To determine whether significant differences existed among the three independent performance groups, the Kruskal–Wallis H test was applied. This test serves as a non-parametric alternative to one-way ANOVA and is appropriate for comparing more than two independent groups when data are not normally distributed.

Where significant overall differences were identified, post hoc pairwise comparisons were conducted using the Dunn–Bonferroni correction method to control for Type I error. Additionally, effect size (η^2) was calculated to determine the magnitude of observed differences, thereby providing insight beyond statistical significance.

Descriptive Statistics

Table 1 presents the mean and standard deviation values for state and trait anxiety across performance groups.

Table 1. Descriptive Statistics of State and Trait Anxiety

Performance Level	N	State Anxiety (Mean ± SD)	Trait Anxiety (Mean ± SD)
Low Performers	100	54.20 ± 6.84	51.30 ± 7.12
Moderate Performers	100	49.80 ± 6.15	47.50 ± 6.48
High Performers	100	42.60 ± 5.72	44.10 ± 5.95

The descriptive results indicate a consistent decline in both state and trait anxiety as performance level increases. High-performing players exhibit the lowest mean anxiety scores, suggesting superior emotional regulation.

Inferential Statistics

Table 2. Kruskal–Wallis Test for State Anxiety

Variable	H	df	p-value	Effect Size (η^2)
State Anxiety	20.18	2	< .001	.061

The analysis revealed a statistically significant difference in state anxiety across performance levels, with a medium effect size.

Table 3. Kruskal–Wallis Test for Trait Anxiety

Variable	H	df	p-value	Effect Size (η^2)
Trait Anxiety	16.73	2	< .001	.049

Trait anxiety also differed significantly among groups, though with a slightly smaller effect magnitude.

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Table 4. Post Hoc Pairwise Comparisons

Comparison	State Anxiety (p)	Trait Anxiety (p)
Low vs Moderate	.042*	.071
Low vs High	< .001*	.003*
Moderate vs High	.018*	.049*

(*p < .05)

Post hoc analysis confirmed that high-performing players differ significantly from low performers in both state and trait anxiety.

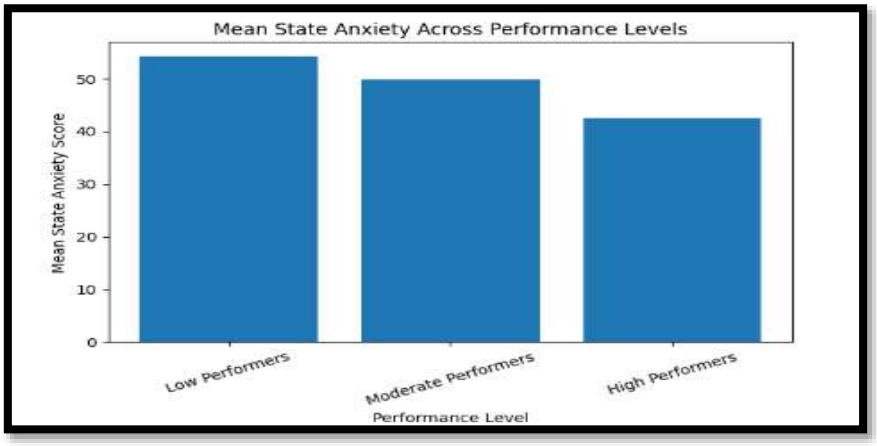

Figure 1

Mean State Anxiety Across Performance Levels

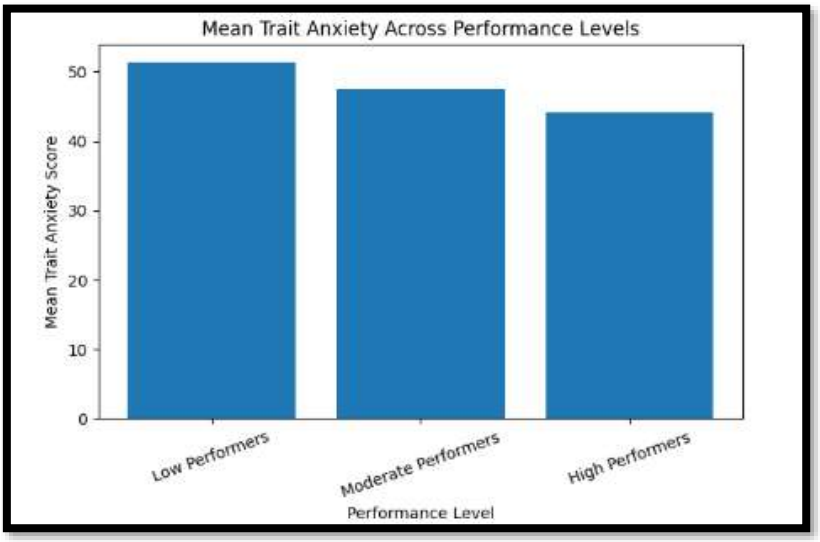

Figure 2

Mean Trait Anxiety Across Performance Levels

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4. Results

The primary objective of the present study was to examine differences in state and trait anxiety among competitive chess players across three performance levels. The analysis was conducted using non-parametric statistical procedures due to violations of normality assumptions.

4.1 Preliminary Analysis

Prior to conducting inferential analysis, the dataset was screened for missing values, outliers, and assumption violations. No missing values were detected, and boxplot inspection revealed no extreme outliers that required removal. The Shapiro–Wilk test indicated significant deviations from normality for both state anxiety and trait anxiety scores across performance groups ($p < .05$). Consequently, non-parametric statistical techniques were employed to ensure analytical appropriateness.

4.2 Descriptive Statistics

Descriptive statistics revealed a consistent decline in anxiety levels as performance level increased.

Low-performing players demonstrated the highest mean state anxiety ($M = 54.20$, $SD = 6.84$), followed by moderate performers ($M = 49.80$, $SD = 6.15$). High-performing players reported the lowest state anxiety ($M = 42.60$, $SD = 5.72$).

A similar pattern emerged for trait anxiety. Low performers recorded a mean of 51.30 ($SD = 7.12$), moderate performers 47.50 ($SD = 6.48$), and high performers 44.10 ($SD = 5.95$).

The downward trend suggests that superior competitive performance in chess is associated with lower emotional tension, both situational and dispositional.

4.3 Differences in State Anxiety Across Performance Levels

The Kruskal–Wallis H test revealed a statistically significant difference in state anxiety among the three performance groups, $H(2) = 20.18$, $p < .001$.

The calculated effect size ($\eta^2 = .061$) indicated a medium magnitude of difference. This suggests that approximately 6% of the variance in state anxiety scores can be attributed to performance level.

Post hoc pairwise comparisons using the Dunn–Bonferroni correction revealed:

- A significant difference between low and high performers ($p < .001$),
- A significant difference between moderate and high performers ($p = .018$),
- A marginally significant difference between low and moderate performers ($p = .042$).

These findings indicate that high-performing players experience significantly lower situational anxiety compared to both moderate and low performers.

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4.4 Differences in Trait Anxiety Across Performance Levels

A statistically significant difference was also observed for trait anxiety, $H(2) = 16.73$, $p < .001$.

The effect size for trait anxiety ($\eta^2 = .049$) indicated a small-to-medium effect, suggesting that performance level accounts for approximately 5% of the variance in dispositional anxiety.

Post hoc analysis revealed:

- A significant difference between low and high performers ($p = .003$),
- A significant difference between moderate and high performers ($p = .049$),
- No statistically significant difference between low and moderate performers ($p = .071$).

These results suggest that high-performing chess players not only manage competitive anxiety more effectively but may also possess inherently lower trait anxiety characteristics.

4.5 Comparative Trend Analysis

When comparing the magnitude of differences between state and trait anxiety, the results indicate that state anxiety demonstrates slightly stronger differentiation across performance groups. This finding implies that situational emotional regulation may play a more immediate role in competitive chess performance than stable personality predispositions.

The graphical representations (Figures 1 and 2) further support this interpretation, as the decline in state anxiety across groups appears more pronounced than the decline in trait anxiety.

4.6 Hypothesis Testing Summary

H_1: There is a significant difference in state anxiety across performance levels. Result: Supported.

H_2: There is a significant difference in trait anxiety across performance levels. Result: Supported.

4.7 Key Findings

The analysis demonstrates that performance level significantly differentiates both state and trait anxiety among competitive chess players. High-performing players exhibit lower levels of situational anxiety prior to competition and comparatively lower levels of dispositional anxiety.

5. Discussion

The present study aimed to examine differences in state and trait anxiety among competitive chess players across three performance levels. The findings revealed statistically significant differences in both forms of anxiety, with high-performing players exhibiting consistently lower levels of state and trait anxiety compared to moderate and low performers.

These findings align with the theoretical distinction proposed by Charles D. Spielberger, who conceptualized state anxiety as situationally induced emotional arousal and trait anxiety as a relatively stable personality disposition. The lower state anxiety observed among high

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performers suggests superior situational emotional regulation during competitive anticipation. Since chess demands sustained attention, working memory efficiency, and strategic foresight, excessive situational anxiety may disrupt cognitive processing and increase decision-making errors.

The results also support the cognitive interference perspective, which proposes that anxiety consumes limited attentional resources. High-performing players likely possess enhanced attentional control mechanisms, enabling them to maintain task-focused concentration even under evaluative pressure. Reduced cognitive interference may preserve calculation accuracy and improve strategic consistency.

The significant, though slightly smaller, differences in trait anxiety suggest that dispositional emotional stability may contribute to long-term competitive success. Players with lower trait anxiety may interpret competitive stressors as challenges rather than threats, thereby minimizing chronic performance-related stress.

Interestingly, the effect size for state anxiety was marginally higher than that for trait anxiety. This finding implies that situational anxiety regulation may have a more immediate influence on chess performance than stable personality characteristics. In cognitively intensive sports, momentary fluctuations in arousal and emotional state can directly impact decision precision.

Overall, the findings reinforce the importance of psychological preparedness in chess, highlighting anxiety regulation as a distinguishing characteristic of high-level performers.

6. Practical Implications

The findings have important applied implications for sport psychologists, coaches, and competitive chess players.

First, structured psychological skills training programs focusing on anxiety management may enhance performance outcomes. Techniques such as diaphragmatic breathing, progressive muscle relaxation, and pre-performance routines may help reduce excessive state anxiety prior to matches.

Second, cognitive restructuring strategies can assist players in reframing competitive pressure as a performance opportunity rather than a threat. Developing attentional control through mindfulness-based interventions may further improve focus and emotional regulation.

Third, early identification of high trait anxiety tendencies in developing players may allow for targeted psychological interventions aimed at strengthening emotional resilience.

Given the cognitive demands of chess, integrating psychological conditioning alongside technical training may significantly contribute to performance optimization.

7. Limitations of the Study

Despite its contributions, the present study has several limitations.

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The cross-sectional design restricts causal interpretation. While anxiety differences were observed across performance levels, it cannot be definitively concluded whether lower anxiety leads to higher performance or vice versa.

Second, anxiety was measured using self-report instruments, which may introduce response bias. Although the instrument used demonstrated strong reliability, subjective reporting may not fully capture physiological arousal.

Third, the study sample was geographically restricted to North India, which may limit generalizability to broader international chess populations.

Future research may incorporate longitudinal designs, physiological anxiety indicators, and cross-cultural comparisons to strengthen findings.

8. Future Directions

Future investigations may explore:

- The mediating role of attentional control between anxiety and chess performance
- Longitudinal changes in anxiety profiles across competitive seasons
- Experimental intervention studies testing anxiety management programs
- Neurocognitive correlates of anxiety regulation in elite chess players

Such research would further deepen understanding of psychological determinants of cognitive sport performance.

9. Conclusion

The present study demonstrates that both state and trait anxiety significantly differentiate competitive chess players across performance levels. High-performing players exhibit lower situational anxiety prior to competition and comparatively lower dispositional anxiety.

The findings emphasize that emotional regulation is a critical psychological determinant of success in cognitively demanding sports such as chess. Effective management of competitive anxiety may preserve attentional resources, reduce cognitive interference, and enhance strategic decision-making.

The study contributes to sport psychology literature by extending anxiety-performance research into intellectual competitive domains, highlighting the importance of psychological stability in high-level chess performance.

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