Visuocognitive Performance Difference Between National and State-Level Indian Football Players Assessed Using FITLIGHT Technology

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***Abstract*—Visuocognitive skills, such as peripheral vision and reaction time, play a crucial role in football performance. Still, studies in the Indian context have focused on physical fitness, with little attention to cognitive-perceptual skills. Comparisons, objective and technological in nature, and across competition levels are limited. The purpose was to compare the peripheral vision and reaction performance of male football players at the national (I-League) and state (level) levels using FITLIGHT technology. A comparative cross-sectional design was used, comprising 52 male football players (26 at the national level and 26 at the state level) aged 19 to 25 years. The total number of successful light deactivations on which the peripheral vision was measured over 30 seconds, and the reaction performance as the mean foot reaction time (milliseconds). Independent samples t-tests ($p < 0.05$) were used to examine group differences, and Cohen's d was used to compute effect sizes. As a result, the national-level players had much faster reaction times (388.0 ± 9.78ms vs. 461.8 ± 8.73ms, $p < 0.001$) and higher scores in peripheral vision (77.5 ± 1.96 vs. 65.1 ± 1.16 taps; $p < 0.001$) in comparison with state-level players. The difference in performance between the two visuocognitive measures was about 19%, with large effect sizes indicating high practical significance. It was concluded that the visuocognitive performance of Indian football players at the national level is better than that of their state-level players. This kind of finding has emphasised the relevance of incorporating visuocognitive assessment and training into talent identification and player development programs to improve competitive performance.**

***Index Terms*—Peripheral vision, Reaction time, FITLIGHT, Visuocognitive Training**

I. INTRODUCTION

In football, the ability of a player to observe the whole field and simultaneously respond to different stimuli in rapidly changing situations is a visuo-cognitive ability of human beings, especially peripheral vision and reaction abilities, which help players make decisions under pressure (Vater et al., 2019). Previous studies show that elite players consistently outperform regional players in cognitive function, visual performance, and decision-making efficiency, demonstrating that modern football is not limited to technical and physical proficiency; it is strongly linked to advanced Visuospatial-Cognitive skills (Verburgh et al., 2014; Vestberg et al., 2012).

In recent years, the growth rate of Indian football has significantly increased due to professional leagues, in which advanced practices, technologies, and dietary habits have been adopted, yet the trend in pedagogical research remains. They focused solely on physical fitness parameters, while cognitive development and its effects on performance enhancement were left untouched. Very few comparative studies have examined cognitive abilities, and no studies have explored the Visuocognitive profile in the Indian football context using validated digital assessment tools (Vater et al., 2019). This gap suggests comparing peripheral vision and reaction time between national- and state-level male football players.

This study represents the 1st application of FITLIGHT technology in Indian football. It is a validated wireless LED-based system operating through its application, which has previously shown its reliability for assessing reaction time and visuo-motor performance in athletes (Badau & Badau, 2022; Campanella et al.,

2024). The standardised effect size and objectives may support evidence-based practices and talent identification and development procedures. We aimed to compare peripheral vision capacity and foot reaction time between I-League and state-level male football players using objective FITLIGHT technology, and to determine the magnitude of performance differences to inform training protocols for performance enhancement and to level up performance with elite players.

II. MATERIAL AND METHOD

2.1 Sample population and Study Design

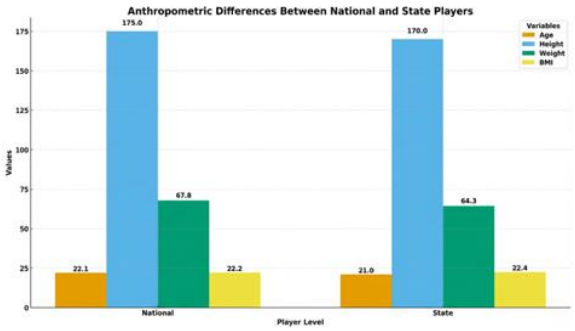
This comparative cross-sectional study was conducted between March and May 2024 in Kolkata, West Bengal, India. To calculate the sample size, we used G power software (version 3.1.9.4), based on the previous studies of visuocognitive performances on different levels of football players; a large effect size was taken (Badau et al., 2023), where effect size was f = 0.80, alpha = 0.05, and power = 0.80.

After the calculation, we obtained a sample of 52 participants, selected through purposive sampling from different clubs in Kolkata, West Bengal. They were divided into groups according to their competitive levels: national-level I-League players (n = 26) and state-level Santosh trophy players (n = 26), with some criteria such as their age, 19-25 years old, 5 years of experience in competition levels, and no musculoskeletal injuries within the 6 months.

III. DATA COLLECTION

3.1 Anthropometric Measurement

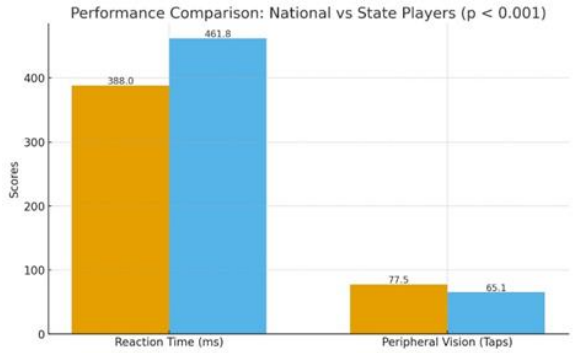
Participants' ages were verified using the government-issued document, Aadhaar Card. Height was measured with a calibrated stadiometer (Seca 213, Hamburg, Germany) while standing barefoot, with measurements recorded to the nearest 0.1 cm. Weight was measured using a digital weighing machine to the nearest 0.1 kg. Body mass index (BMI) was calculated as weight (kg) divided by height (m^2). All anthropometric procedures followed standardised measurement guidelines commonly applied to ensure reliability. (Ismail et al., 2013)



3.2 Visuocognitive performance assessment

FITLIGHT Trainer ™ System was used (FITLIGHT Corp, Aurora, Ontario, Canada) to measure all the Visuocognitive tests. This tool has eight LED pods, which are placed in a 10 cm diameter, and controlled through the software. The reliability of the instruments was established from the previous studies (Badau et al., 2023; Badau & Badau, 2022; Hassan et al., 2022)

The pods were placed on the floor in a semi-circular path extending to 180^0 and away from the standing point, 1.5 meters from the standing point, to be easily accessible for foot response. Participants engaged in a 10-minute dynamic warm-up that included running, stretching, and test-specific movements. Then they performed the test as a trial to familiarise themselves with the procedure.

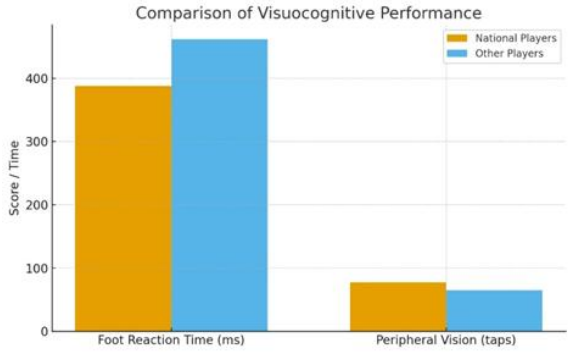


Peripheral vision assessment: standing at the previously decided central point and trying to deactivate the randomly illuminated pods as quickly as possible with their feet. These are unpredictably sequentially patterned across 180 degrees, requiring peripheral monitoring and quick responses. The successful deactivations of the pods are recorded as a score in 30 seconds based on the previous research protocols (Badau et al., 2023)

Foot reaction time assessment: From that particular position, participants reacted to the illuminated pod by contacting their foot as quickly as possible. The FITLIGHT operated application automatically recorded the reaction speed in milliseconds. Each participant completed five repetitions with 15 seconds of rest between the attempts. The mean reaction time was used as the final measurement using the FITLIGHT-based reaction-time protocol from the previous study (Hassan et al., 2022).

IV. STATISTICAL ANALYSIS

Data were analysed using JAMOVI software (version 2.5.6, Sydney, Australia). Descriptive statistics were calculated; the Shapiro-Wilk test was used to assess the normality of the data; and an independent-samples t-test was used to compare between-group differences in anthropometric and performance measurements, with a significance level of $\alpha = 0.05$ (two-tailed). Effect sizes (Cohen's d) were calculated using pooled SD, and their magnitudes are interpreted based on established benchmarks.



Results

The mean age of the national-level football players was 22.1 ± 1.7 years, whereas the state-level players averaged 21.0 ± 1.5 years. Mean height 175.0 ± 2.8 cm and 170.0 ± 2.9 cm, and weight 67.8 ± 3.6 kg and 64.3 ± 3.7 kg show the higher anthropometric values of the National players. BMIs were almost similar between the groups, 22.2 ± 1.3 and 22.4 ± 1.5 kg/m^2. The variables' data are normally distributed according to the Shapiro-Wilk test ($p > 0.05$).

As with the anthropometric variables, national players dominate the visuospatial tasks, peripheral vision, and reaction time. The mean foot-reaction time was 388.0 ± 9.78 ms and 461.8 ± 8.73 ms, and in the peripheral vision task, 77.5 ± 1.96 and 65.1 ± 1.16 taps.

Independent-samples t-test analyses confirmed statistically significant differences between national- and state-level players for both variables ($p < 0.001$). The mean difference in reaction time was -73.8 ms, and the difference in total taps was 12.4, favouring the National-level players.

The effect size indicates an exceptionally large difference (Cohen's $d > 7.5$), reflecting a substantial difference between national- and state-level players. That said, this is one of those moments where the numbers deserve a second look, not blind celebration. The unusually high effect sizes are largely driven by very low within-group variability and the millisecond-level precision of the FITLIGHT automated system. When standardised effect size metrics are applied to homogeneous athletic samples and high-resolution digital tools, some inflation is almost inevitable. In practical terms, the performance gap is real and meaningful, but Cohen's d, in this context, likely tells a slightly louder story than the true population-level effect would.

V. DISCUSSION

This study revealed a significant difference in Visuospatial-Cognitive performance between national- and state-level male football players in India. The national-level football players are dominating in both tests: peripheral vision and reaction ability. The scale of the differences reflects very large effect sizes (Cohen's d = 7.51-7.87), suggesting that the Visuocognitive capability is an evocative dimension that distinguishes competitive levels in Indian football. The 73.8ms reaction time advantage observed in the national-level football players is genuinely significant because, in football, the movements occur in mere hundreds of milliseconds, consistent with the previous study showing faster reaction times between different competitive-level players in different sports (Campanella et al., 2024; Verburgh et al., 2014; Vestberg et al., 2012). In the study of (Hassan et al., 2022) Shows the significant improvement of reactive agility in basketball players, supports our findings that elite players develop superior stimulus-response capabilities, and (Badau et al., 2023) In their study, they reflect the perceptual demands at competitive levels through a significant difference in peripheral

vision, which is higher in advanced athletes. May the performance difference or the domination of national-level football players be a reason for their high-quality practice in game-like situations, which helps to adapt visual perception with motor execution, and high-tempo decision-making environments enhance their cognitive-motor integration, accelerate the stimulus response procedure (Ashford et al., 2021). They are also involved with the high-quality instruments, structured training protocol, visual scanning drills, and tactical stimulations, which are executed in the i-league matches, where demanding continuous peripheral monitoring, adapting to unpredictable situations, and responding to the stimulations are required (Roca et al., 2013)

This study may have practical implications for the development of Indian football. The difference between Visuocognitive performance suggests that integrating structured visual-cognitive training, reactive drills, peripheral scanning games, and small-sided games, emphasising scanning skills, and reducing the performance gap (Badau & Badau, 2022; Campanella et al., 2024). This study highlights the significance of visuocognitive capacity across all levels of competition. It aims to integrate it into the talent identification process in grassroots and state-level programs, potentially helping to reduce performance gaps and optimise talent development trajectories. Coaching education programs for player development should emphasise the importance of visuocognitive development alongside physical, technical, and tactical training. Designing practice environments with unpredictable stimulations, fewer decision-making spaces, and complex visual demands may develop players' perceptual-cognitive expertise (Roca et al., 2012)

Previous research has suggested the dominant performance of elite players in visuospatial tasks (Badau & Badau, 2022; Verburgh et al., 2014; Vestberg et al., 2012). (Steff et al., 2024) shown in their study that athletes using similar technology exhibit superior coordinative abilities, while Campanella et al. (2024) reported enhanced cognitive-motor performance in elite judo athletes following FITLIGHT® training. However, the effect sizes we observed substantially exceed those typically reported in comparative research, possibly reflecting the considerable structural and resource differences between competitive levels in the Indian football context.
Limited prior research has examined visuocognitive performance across competitive levels, specifically in Indian football. Our study extends the literature by providing the first objective, technology-based comparison of visuocognitive capacities across competitive levels of Indian football, establishing baseline performance data for this population.

VI. CONCLUSIONS

This comparative study shows that national-level football players have superior peripheral vision and faster foot reaction times than state-level players. The very large effect size of the study shows not only statistical significance but also the practical importance of Visuocognitive abilities in different competition levels.
Future studies could be longitudinal or interventional to examine the impact of Visuocognitive training on improvements in reaction time and peripheral awareness. Studies may involve female athletes to understand their cognitive behaviour and patterns. In the coaching practices, they might be tailored to how evidence-based practice models are adaptable to the diverse training environment found across Indian football.

6.1 Limitations

This study has several limitations. First, the use of convenience sampling from Kolkata limits the generalizability of the findings to the broader Indian football population. Second, the lab-based FITLIGHT assessments offer high measurement precision, but they may not meet the decision-making demands of a match. Playing position, previous training history, and innate ability were not examined, which may influence the performances.

6.2 Author contributions

The authors carried out the conceptualisation and study design. Both did data collection, statistical analysis, and interpretation of results. Each author drafted the manuscripts, revised the content, and gave consent for the final version to be published.

6.3 Supporting Agencies

No support from any agencies

6.4 Disclosure Statement

The authors declared no conflicts of interest.

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