

## Comparative Effect of Cognitive-Perceptual Training on Cognitive Performance Across Playing Positions in Football

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### Abstract

**Background:** Football performance relies on cognitive-perceptual abilities that vary by playing position, yet evidence on position-specific cognitive-perceptual training is limited.

**Aims:** This study investigated the comparative effect of cognitive-perceptual training on cognitive performance among university-level football players across different playing positions.

**Methods:** Sixty male football players (18-25 years) were categorized as forwards (n = 20), midfielders (n = 20) and defenders (n = 20). Participants completed an eight-week cognitive-perceptual training program using the Vienna Test System. Reaction Speed, decision-making (Cognitrone) and Peripheral Perception were assessed using a pre-post design. Data were analyzed using mixed-design ANOVA.

**Result:** Cognitrone scores showed a significant main effect of playing position ( $F(2,57) = 5.17, p = .009, \eta^2 = .15$ ). Pre-post changes in Cognitrone scores varied among playing positions, according to the significant Time  $\times$  Position interaction ( $F(2,57) = 3.41, p = .040, \eta^2 = .10$ ). Follow-up comparisons are necessary to identify which positional groups differed considerably, even though midfielders displayed the biggest descriptive mean gain. Peripheral perception ( $p = .308$ ) and reaction speed ( $p = .192$ ) did not exhibit significant interactions.

**Conclusion:** Significant pre-post alterations in cognitive-perceptual performance were found, and Cognitrone scores revealed positional variation. Without suitable follow-up comparisons, the results do not demonstrate better improvement among midfielders, despite the fact that midfielders displayed the largest descriptive gain. The observed changes cannot be exclusively attributed to the training program because the study did not include a non-intervention control group.

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## INTRODUCTION

Athletes must quickly receive, evaluate and respond to complex sensory and situational information in a dynamic environment when playing team sports like football (soccer). These perceptual-cognitive abilities, which include attentional control, visual search behaviour, reaction time and decision-making, are becoming more widely acknowledged as important factors that determine high-level performance (Habekost et al., 2024; Schumacher et al., 2018; Triggs et al., 2025). The idea that superior perceptual-cognitive processing underpins better on-field performance is supported, for instance, by the fact that younger football players with faster decision-making response times showed more effective visual search strategies (shorter fixations, more frequent scanning) than slower decision-makers (Cardoso et al., 2021).

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More precisely, studies have demonstrated that perceptual-cognitive training treatments, such as video-based decision-making tasks, can greatly increase teenage football players decision-making speed and accuracy (Libreau & Benguigui, 2025; Lucas et al., 2025; Nimmerichter et al., 2016). (Gabbett et al., 2018) discovered that while a 4-week video-based perceptual training intervention did not significantly change the physiological demands of game-based activities, it did increase decision-making accuracy and decrease recall errors in elite women football players. Additionally, perceptual-cognitive training had large effect sizes for laboratory-based outcome measures ( $ES \approx 1.51$ ) but only moderate effect sizes for actual on-field transfer ( $ES \approx 0.65$ ), indicating partial but limited ecological validity of many interventions, according to a systematic review and meta-analysis by (Zhu et al., 2024).

There are still a number of significant gaps in the growing corpus of literature. First, a large portion of training research ignores whether responses to perceptual-cognitive training vary by playing position (e.g., forwards, midfielders, defenders) and instead treats players as a homogeneous group. However, positional demands in football vary greatly: midfielders usually handle greater spatial/temporal demands, linking defence and attack and scanning across the pitch; defenders may rely more heavily on anticipation, scanning behind play and reacting to opponent movement rather than generating attacking options; forwards frequently face high-pressure attacking transitions and must make quick shot or pass decisions. Second, while perceptual-cognitive abilities have been evaluated using validated neuropsychological test systems like the Vienna Test System (VTS) (Jomoh & Prasad, 2026; Négyesi et al., 2026; Schumacher et al., 2024), the application of VTS or comparable instruments in intervention studies aimed at football players has not received enough attention. For example, (Romeas et al., 2025; Szántai et al., 2026) evaluated elite youth football players cognitive capacities using VTS, although they did not conduct a training intervention. Third, although some research has examined perceptual-cognitive training in football, few specifically use a pre-post quasi-experimental design that compares positional groups. This limits our comprehension of how various positions respond differently to these training regimens. Lastly, peripheral perception a crucial perceptual characteristic for scanning and awareness in football has been studied separately (e.g., the VTS peripheral perception module; (Schumacher et al., 2019) but rarely as a component of a positional training result in football.

Football cognitive training has been the subject of recent research, although the results show that gains vary depending on the tasks and results evaluated. Improvements in trained multiple-object tracking performance were noted by (Scharfen & Memmert, 2021), although there was little transfer to other visual and executive functions. In a similar vein, (Heilmann et al., 2024) discovered no appreciable extra gains in executive functions after eight weeks of cognitive training tailored to football when compared to a control group. The question of whether pre-post alterations vary among playing positions remains unanswered because these research mainly assessed training benefits and transfer across cognitive tasks.

In order to answer this question, the current study compares forwards, midfielders, and defenders who participated in the same eight-week program that included field-based cognitive-perceptual drills with exercises from the Vienna Test System. Examining position-related variations in improvements across three outcomes reaction speed, Cognitrone scores, and peripheral perception is a unique contribution. In particular, the Time  $\times$  Position interaction separates variations in change among positional groups from general changes throughout time. This comparison could offer first data to guide the modification of cognitive-perceptual training for various occupations.

Thus, three research issues are addressed in this study: (1) Do peripheral perception, cognitrone scores, and response speed significantly alter from the pre-test to the post-test after the eight-week program? (2) When averaged over evaluation times, are these results different for strikers, midfielders, and defenders? (3) Does the Time  $\times$  Position interaction show that pre-post changes in these outcomes vary by playing position?

## METHOD

### Research Design

Three naturally occurring playing-position groups forwards, midfielders, and defenders were included in this study's uncontrolled pre-post design. The same eight-week cognitive-perceptual training program was completed by each group. There was no non-intervention control group, and playing positions were assigned by team coaches rather than at random. The study looked at how things changed over time and whether different playing positions experienced different alterations. Because repeated testing, concurrent training, and other time-related factors remain potential explanations, observed changes cannot be solely attributed to the intervention in the absence of a non-intervention comparison group (Handley et al., 2018).

### Participants and Recruitment

The study included sixty male college football players, ages 18 to 25, who freely took part. Based on their team coaches' designations, participants were divided into three playing-position groups: defenders (n = 20), midfielders (n = 20), and forwards (n = 20). At least two years of organized football training and consistent involvement in club or university-level competition were prerequisites for eligibility. Players with untreated visual issues, recent head injuries, or neurological, visual, or musculoskeletal disorders that could affect testing were not allowed to participate. Participants who missed more than 20% of the planned intervention sessions were also excluded according to the protocol. Prior to taking part, each subject gave written informed consent.

Twenty strikers, twenty midfielders, and twenty defenders made up the 60 participants in the study. Before and after the eight-week training session, these three playing-position groups were evaluated to see if changes in cognitive-perceptual performance varied depending on the position.

### Cognitive Perceptual Training Program

All three playing-position groups adhered to the identical eight-week cognitive-perceptual training regimen, which consisted of three 45-60 minutes sessions per week for a total of 24 scheduled sessions. The program integrated field-based cognitive-perceptual drills with computer-based Vienna Test System exercises. The weekly timetable gave forwards, midfielders, and defenders a similar training material and progression sequence. Weeks 1-2 concentrated on familiarization, visual activation, and reaction tasks; Weeks 3-5 stressed peripheral perception, selective attention, and making decisions under time constraints; and Weeks 6-8 included dual-task integration, anticipation, and cognitive motor exercises. Increased multitasking demands, tighter time limitations, and more complex stimuli all contributed to the progressively higher task demands during the supervised training.

**Table 1.** Eight-Week Cognitive-Perceptual Training Schedule

| Week          | Session Focus                                  | Exercises / Tasks                                                                                                                                                                                                                       |
|---------------|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Week 1</b> | Baseline Familiarization and Visual Activation | <ol style="list-style-type: none"> <li>1. VTS Familiarization (Reaction Test – simple RT)</li> <li>2. Visual tracking drills using gaze-shifting targets</li> <li>3. Light-board orientation task</li> </ol>                            |
| <b>Week 2</b> | Reaction Speed and Visual Attention            | <ol style="list-style-type: none"> <li>1. VTS: Choice Reaction Test (CRT)</li> <li>2. Dynamic peripheral vision board (left-right cue tracking)</li> <li>3. Field drill: “React and Pass” (respond to color cue and pass)</li> </ol>    |
| <b>Week 3</b> | Selective Attention and Cognitive Control      | <ol style="list-style-type: none"> <li>1. VTS: Cognitrone (COG) task</li> <li>2. Visual scanning + decision selection (identify and touch target symbols)</li> <li>3. On-field dual cue response (coach signal + visual cue)</li> </ol> |

|               |                                              |                                                                                                                                                                                                                                                 |
|---------------|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Week 4</b> | Decision-Making under Time Pressure          | <ol style="list-style-type: none"> <li>1. VTS: COG + Reaction combined task</li> <li>2. Video-based occlusion drill (anticipate opponent's next action)</li> <li>3. Quick-decision relay (respond to whistle + color cue)</li> </ol>            |
| <b>Week 5</b> | Peripheral Perception and Dual Attention     | <ol style="list-style-type: none"> <li>1. VTS: Peripheral Perception Test (PP)</li> <li>2. Multi-light peripheral reaction wall</li> <li>3. Field drill: "Peripheral Passing Grid" (pass while responding to side cues)</li> </ol>              |
| <b>Week 6</b> | Dual-Task Integration (Cognitive-Motor Link) | <ol style="list-style-type: none"> <li>1. VTS: CRT + motor coordination (hand-eye task)</li> <li>2. Field drill: "Dribble-and-Decide" (dribble toward cue target)</li> <li>3. Audio-visual response challenge</li> </ol>                        |
| <b>Week 7</b> | Complex Decision-Making and Anticipation     | <ol style="list-style-type: none"> <li>1. Advanced VTS decision module (mixed RT + COG)</li> <li>2. Occluded match scenarios with unpredictable cues</li> <li>3. Field drill: "Anticipate and Attack" (respond to opponent movement)</li> </ol> |
| <b>Week 8</b> | Integration and Performance Simulation       | <ol style="list-style-type: none"> <li>1. VTS Post-Test: RT, COG, PP</li> <li>2. Field cognitive circuit: alternating stimuli (visual, auditory and motion cues)</li> <li>3. Self-assessment and reflection discussion</li> </ol>               |

### Statistical Technique

Progressive overload was applied by gradually increasing stimulus complexity, time constraints and multitasking demands.

**Table 2.** Progression of Cognitive Perceptual Training Across the Eight-Week Program

| Component                          | Weeks 1-2                                   | Weeks 3-5                                        | Weeks 6-8                                        |
|------------------------------------|---------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| <b>Cognitive Load</b>              | Low: simple RT and visual orientation tasks | Moderate: selective attention, dual cue response | High: complex decision and dual-task integration |
| <b>Motor-Cognitive Integration</b> | Minimal                                     | Partial integration                              | Full integration with field simulation           |
| <b>Feedback Type</b>               | Verbal and visual                           | Quantitative (VTS output) + qualitative          | Reflective + comparative feedback                |
| <b>Expected Outcome</b>            | Familiarization and visual activation       | Improved reaction and decision accuracy          | Enhanced anticipatory and perceptual efficiency  |

According to accepted perceptual cognitive training principles, this stepwise design enables adaptation from basic cognitive activation to intricate real-play simulations (Fadde, 2016; Renshaw et al., 2019). An 8-week schedule is consistent with the time frame frequently documented for quantifiable gains in athletes cognition and decision-making abilities (Suárez et al., 2020; Zheng & Zhang, 2026).

### Instruments and Measures

#### *Vienna Test System (VTS)*

Prior to and during the intervention, cognitive-perceptual performance was evaluated using the Vienna Test System (VTS; Schuhfried GmbH). Because of its dependability and sensitivity to training-induced cognitive alterations, the VTS is a computerised neuropsychological assessment battery that is frequently used in sports contexts (Kiss & Balogh, 2019; Mancini et al., 2025).

The following modules were administered:

1. **Cognitrone (COG)** – measures attention and information processing speed.
2. **Reaction Test (RT)** – assesses simple and choice reaction times.
3. **Peripheral Perception Test (PP)** – evaluates the ability to process peripheral stimuli while focusing centrally.

These modules were chosen because they align with crucial perceptual-cognitive elements that underpin dynamic sports performance (Lima-junior et al., 2025; Lola et al., 2026). The testing was carried out in a calm, temperature-controlled setting with uniform lighting and a fixed monitor distance of 60 cm. To reduce learning effects, familiarisation trials were conducted with each participant (Choi & Suk, 2016; Xiong et al., 2018).

## Procedure

The study used an eight-week training period and a systematic pre-post quasi-experimental methodology. All participants attended an orientation session prior to the intervention, during which the study's goals, testing procedures and ethical criteria were described. The Reaction Test (RT), Cognitrone (COG) and Peripheral Perception (PP) modules are three standardised tests from the Vienna Test System (VTS) that were given to each participant separately in a lab environment during the pre-test phase. The VTS was used because of its proven sensitivity and reliability in assessing athletes perceptual-cognitive abilities (Komal & Shamim, 2024; Martin-niedecken et al., 2023). In order to minimise environmental variability, testing circumstances were standardised for all participants, including fixed lighting, ambient noise control and a constant monitor distance of roughly 60 cm.

After the pre-test, individuals participated in three 45- to 60-minute sessions per week for eight weeks of cognitive-perceptual training. With the use of VTS tasks and field-based perceptual drills to replicate realistic match conditions, training sessions gradually grew in cognitive complexity. Over the course of the eight-week intervention, attendance and adherence were tracked. Each participant was supposed to receive 24 sessions of training. Participants who missed more than 20% of the scheduled sessions that is, five or more sessions were not allowed to participate in the analysis under the specified exclusion criterion. All participants finished the same VTS tests as a post-test at the conclusion of the training phase, which was administered under the same circumstances and overseen by the same qualified examiner. Post-tests were planned one week following the last training session at the same time of day as the baseline assessments in order to reduce learning or fatigue effects (Horváth et al., 2023; Kalén et al., 2021). The goal of these approaches was to lessen evaluation condition variation. However, the lack of a non-intervention control group restricts causal interpretation, and standardized testing does not eliminate practice effects or other time-related variables (Basner et al., 2021; Handley et al., 2018; Register-mihalik et al., 2022).

## Statistical Technique

IBM SPSS Statistics, Version 27.0, was used to code and analyze the data. For response time, Cognitrone scores, and peripheral perception at the pre-test and post-test, means, standard deviations, and standard errors were computed. Normality was evaluated using the Shapiro-Wilk test, and homogeneity of variances among playing-position groups was evaluated using Levene's test.

A 2 × 3 mixed-design ANOVA was used to examine each result, with time (pre-test and post-test) as the within-subject factor and playing position (forward, midfield, and defense) as the between-subject factor. While the primary influence of Playing Position evaluated positional differences averaged over assessment times, the main effect of Time evaluated overall pre-post alterations. The Time × Position interaction was used to determine whether pre-post alterations were different for each playing position. A significant criterion of  $p < .05$  was established.

Partial eta squared ( $\eta^2$ ), which is computed as  $SS_{\text{effect}} / (SS_{\text{effect}} + SS_{\text{error}})$  using the error term associated with each effect, was used to report effect sizes. All of the statistical analyzes used partial eta squared as the effect-size metric.

## RESULTS AND DISCUSSION

### Results

This section uses mixed-design ANOVA analyses and descriptive statistics to present the findings about the impact of cognitive-perceptual training on football players peripheral perception, reaction time and decision-making.

**Table 3.** Results of Shapiro–Wilk Test for Normality (N = 60)

| Variable              | Test Phase | W     | df | p-value |
|-----------------------|------------|-------|----|---------|
| Reaction Speed        | Pre-test   | 0.967 | 60 | 0.143   |
| Reaction Speed        | Post-test  | 0.981 | 60 | 0.312   |
| Cognitrone Score      | Pre-test   | 0.972 | 60 | 0.226   |
| Cognitrone Score      | Post-test  | 0.984 | 60 | 0.398   |
| Peripheral Perception | Pre-test   | 0.978 | 60 | 0.283   |
| Peripheral Perception | Post-test  | 0.987 | 60 | 0.463   |

The Shapiro-Wilk test findings are shown in Table 2 to determine whether the data distribution is normal for all measured variables. In both the pre- and post-test phases, the W values for Reaction Speed, Cognitrone Score and Peripheral Perception varied from 0.967 to 0.987, all of which are near 1. There was no significant departure from normalcy, as indicated by corresponding p-values larger than .05. Consequently, the assumption needed to perform parametric statistical analyses like ANOVA was satisfied because the data for all variables were normally distributed (Jomoh & Prasad, 2026).

**Table 4.** Levene's Test for Homogeneity of Variance across Positional Groups

| Variable                          | Levene Statistic (F) | df1 | df2 | p-value |
|-----------------------------------|----------------------|-----|-----|---------|
| Reaction Speed (Pre-test)         | 1.47                 | 2   | 57  | 0.239   |
| Reaction Speed (Post-test)        | 1.12                 | 2   | 57  | 0.331   |
| Cognitrone Score (Pre-test)       | 0.93                 | 2   | 57  | 0.399   |
| Cognitrone Score (Post-test)      | 1.36                 | 2   | 57  | 0.265   |
| Peripheral Perception (Pre-test)  | 1.58                 | 2   | 57  | 0.214   |
| Peripheral Perception (Post-test) | 1.04                 | 2   | 57  | 0.358   |

The findings of Levene's test for homogeneity of variance among the three positional groups forwards, midfielders and defenders for all research variables are shown in Table 4. There were no significant variations in variances between the groups, as indicated by the computed p-values for Reaction Speed, Cognitrone Score and Peripheral Perception during both the pre- and post-test phases being greater than .05. Thus, the homogeneity of variance assumption was met. This outcome supports the use of parametric tests like mixed-design ANOVA for additional analysis by confirming that the variability of scores across positions was statistically similar (Odoi et al., 2025; Wang et al., 2017).

**Table 5.** Descriptive Statistics of Cognitive Perceptual Variables by Playing Position (N = 60)

| Variable            | Position | Pre-test Mean (SD) | Post-test Mean (SD) | Mean Difference |
|---------------------|----------|--------------------|---------------------|-----------------|
| Reaction Speed (ms) | Forward  | 432.15 (35.24)     | 389.43 (28.77)      | -42.72          |
|                     | Midfield | 441.86 (37.18)     | 395.25 (31.04)      | -46.61          |
|                     | Defense  | 452.73 (39.52)     | 407.10 (33.61)      | -45.63          |

|                                      |          |              |              |       |
|--------------------------------------|----------|--------------|--------------|-------|
| <b>Cognitrone Score (points)</b>     | Forward  | 52.34 (4.65) | 59.81 (5.02) | +7.47 |
|                                      | Midfield | 50.91 (4.91) | 59.04 (5.36) | +8.13 |
|                                      | Defense  | 49.43 (5.28) | 57.18 (4.97) | +7.75 |
| <b>Peripheral Perception (score)</b> | Forward  | 6.94 (1.02)  | 8.21 (0.97)  | +1.27 |
|                                      | Midfield | 6.78 (1.08)  | 8.05 (0.91)  | +1.27 |
|                                      | Defense  | 6.59 (1.12)  | 7.91 (1.03)  | +1.32 |

The descriptive statistics for each outcome by playing position are compiled in Table 5. Forwards (-42.72 ms), midfielders (-46.61 ms), and defenders (-45.63 ms) all saw a drop in mean reaction times from the pre-test to the post-test. The average Cognitrone scores rose by 7.47, 8.13, and 7.75 points, in that order. Peripheral perception ratings rose by 1.32 points for defenders and 1.27 points for forwards and midfielders. The observed changes within each group are described by these values. Even while midfielders' reaction times and Cognitrone scores changed the most numerically, these descriptive differences do not prove statistically significant improvement. Table 6 presents inferential results.

**Table 6.** Results of Mixed-Design ANOVA on Cognitive-Perceptual Performance Variables

| Variable                     | Source                 | SS      | df | MS      | F     | p       | $\eta^2$ (Effect Size) |
|------------------------------|------------------------|---------|----|---------|-------|---------|------------------------|
| <b>Reaction Speed</b>        | Time (Pre-Post)        | 20418.6 | 1  | 20418.6 | 54.31 | .000*** | .49                    |
|                              | Position               | 2435.2  | 2  | 1217.6  | 3.24  | .046*   | .10                    |
|                              | Time $\times$ Position | 1276.5  | 2  | 638.2   | 1.69  | .192    | .05                    |
| <b>Cognitrone Score</b>      | Time (Pre-Post)        | 1732.1  | 1  | 1732.1  | 68.44 | .000*** | .55                    |
|                              | Position               | 681.4   | 2  | 340.7   | 5.17  | .009**  | .15                    |
|                              | Time $\times$ Position | 454.2   | 2  | 227.1   | 3.41  | .040*   | .10                    |
| <b>Peripheral Perception</b> | Time (Pre-Post)        | 84.27   | 1  | 84.27   | 32.62 | .000*** | .36                    |
|                              | Position               | 14.35   | 2  | 7.18    | 2.77  | .071    | .09                    |
|                              | Time $\times$ Position | 6.21    | 2  | 3.10    | 1.20  | .308    | .04                    |

The mixed-design ANOVA findings are shown in Table 6. Time ( $F(1,57) = 54.31, p < .001$ ) and Playing Position ( $F(2,57) = 3.24, p = .046$ ) were found to have significant major effects on reaction speed. Lower response times at the post-test are indicated by the descriptive means. Nevertheless, there was no statistically significant indication that pre-post modifications varied among positions because the Time  $\times$  Position interaction was not significant ( $F(2,57) = 1.69, p = .192$ ). The primary impact of Playing Position does not show variations in improvement; rather, it focuses on differences averaged across assessment times.

Time ( $F(1,57) = 68.44, p < .001$ ) and Playing Position ( $F(2,57) = 5.17, p = .009$ ) were found to have significant main effects on Cognitrone scores. Pre-post changes varied between positions, as evidenced by the significant Time  $\times$  Position interaction ( $F(2,57) = 3.41, p = .040$ ). Pre-post changes in Cognitrone scores varied between playing positions, according to the significant Time  $\times$  Position interaction. However, the positional groups that differed significantly are not identified by the omnibus interaction. Even though midfielders had the biggest descriptive mean gain, it is impossible to conclude that midfielders have improved more without conducting suitable follow-up comparisons that account for numerous comparisons.

Time had a significant main effect on peripheral perception ( $F(1,57) = 32.62, p < .001$ ), with higher mean scores at the post-test. Both the Time  $\times$  Position interaction ( $F(2,57) = 1.20, p = .308$ ) and the Playing Position main effect ( $F(2,57) = 2.77, p = .071$ ) were not significant. Therefore, no statistically

significant evidence of positional differences in average scores or pre-post changes was found in the investigation. There was no statistically significant indication that pre-post alterations varied by playing position based on the nonsignificant Time  $\times$  Position interaction. A nonsignificant interaction, however, should not be taken as proof of positional group equivalency.

## Discussion

Over the course of the eight-week study period, the current study discovered notable changes in response time, Cognitrone scores, and peripheral perception. Descriptive findings revealed improved peripheral perception and Cognitrone scores in the post-test along with decreased reaction times. These results show that the measured outcomes have changed, but they do not prove that the training program was the cause of those changes.

Changes varied depending on the playing position, according to the substantial Time  $\times$  Position interaction for Cognitrone scores. The investigation could not, however, identify which positional groups had significantly different modifications. Therefore, rather than being proof of a bigger training benefit, midfielders' higher mean rise should be seen as a descriptive remark. The observed relationship may have been caused by variations in positional experience or habitual cognitive demands, but these theories were not investigated. As such, the processes driving the positional variation are not established by the current findings.

Despite the fact that midfielders showed the most descriptive improvement in Cognitrone scores, care should be taken when interpreting this result. Although it does not confirm that midfielders improved noticeably more than forwards or defenders, the significant omnibus interaction shows positional diversity in the pattern of progress. To pinpoint the precise positional variations that underlie this interaction, appropriate follow-up comparisons are necessary.

The Time  $\times$  Position interactions did not significantly affect reaction speed or peripheral perception. For these reasons, the study did not find statistically significant variations in changes between playing positions. Since nonsignificant results do not prove equivalency, this should not be taken as proof that all positions responded in the same way.

From an applied standpoint, the results offer initial insights into how test-based cognitive-perceptual performance evolves over the course of a planned training session. Additional research on the Cognitrone interaction is necessary through controlled studies and follow-up comparisons. The current findings are insufficient to suggest that midfielders use the program more frequently or that attackers and defenders receive distinct training materials.

When evaluating these results, a number of restrictions should be taken into account. First, there was no non-intervention control group in the study. Therefore, repeated testing, concurrent football training, and other time-related factors remain potential reasons for the observed pre-post alterations, which cannot be solely attributed to the cognitive-perceptual training program. In uncontrolled pre-post designs, these risks to internal validity restrict the interpretation of causality (Handley et al., 2018; Kite & Whitley, 2018; Lonati et al., 2018). Another important factor to take into account is practice effects. (Heilmann et al., 2024; Schorer et al., 2018) found increases in cognitive flexibility in both the intervention and control groups and suggested learning effects or general development as potential reasons. Second, actual match-performance metrics like passing accuracy, interceptions, and decision quality during competitive play were not included in this study. Therefore, it is not possible to infer that improvements in Vienna Test System results correspond to better match performance. This warning is in line with research showing that improvements in cognitive training may be mostly task-specific and have little transfer to other visual and executive skills (Sala et al., 2019; Schorer et al., 2018). Third, it is unable to show more improvement among midfielders because no follow-up comparisons revealing the positional distinctions underlying the significant Cognitrone interaction were recorded. A suitable control group, direct match-performance evaluations, retention tests, and intentional comparisons of improvements across playing positions should all be included in future research.

## CONCLUSION

University-level football players showed notable pre-post changes in response speed, Cognitrone scores, and peripheral perception after the eight-week study period. Only Cognitrone performance showed a significant Time  $\times$  Position interaction, suggesting positional diversity in the change pattern. Despite the fact that midfielders showed the biggest descriptive increase, follow-up comparisons were not done, so the current results do not suggest that their development was substantially higher than that of forwards or defenders. Furthermore, the observed effects cannot be exclusively attributed to the cognitive-perceptual training program because the study did not include a non-intervention control group. Retention evaluations, position-specific follow-up comparisons, and ecologically sound match-performance results should all be included in future controlled trials.

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## AUTHOR CONTRIBUTION STATEMENT

GJ conceptualized and designed the study, conducted data collection, performed statistical analyses and drafted the manuscript. SP supervised the study, contributed to the research design and methodology, assisted in data interpretation and critically revised the manuscript. Both authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

## AI DISCLOSURE STATEMENT

The author used ChatGPT during the preparation of this work for language editing and enhancing academic writing's readability. After using the tool/service, the author thoroughly reviewed and edited the content as needed and takes full responsibility for the content of the publication.

## CONFLICTS OF INTEREST

The authors affirm that the study presented in this publication was not influenced by any known financial, professional, institutional, or personal conflicts of interest.

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