Synergizing Eye Coordination and Agility in Mastering Badminton Skills

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ABSTRACT: Badminton has a split-second world, where players have to be able to read the path the shuttle is taking, make accurate footwork, and instantly respond. Agility allows them to move around, to shift weight and reposition to quickly, whereas eye-hand coordination allows them to be within focus of the shuttle, anticipate the direction of its flight and be able to have their strokes lined up exactly. In as much as each skill is essential to the other, studies have revealed that when the skills are trained together, much better outcomes are achieved than in cases where they are trained individually. Combining agility drills with visual-motor activities greatly enhanced all tested skills, demonstrating that both quickness and visual coordination are essential for excelling in badminton performance. Eye-hand coordination also increased significantly (refer to Wall Toss Test, (mean difference = -2.85, p <.001) and Coin Catch Test, (mean change = 1.12 catches, p <.001; moderate effect size). Moreover, 100 percent of the respondents demonstrated improved agility and badminton-specific performance, which was indicated by the consistent increase in the Shuttle Run and Badminton-Specific Tests. The results are consistent with the finding of recent studies that have found that integrated training techniques, including wall-toss coordination games, agility ladders and visual stimulus training, and shuttle-run-perceptual training to be effective in improving visuomotor processing, reaction time, neuromuscular control, and perceptual-motor efficiency. In general, agility and eye-hand coordination training are crucial for producing elite badminton players, aiding coaches' methods.

KEYWORDS: Eye Hand Coordination, Agility, Visuomotor Skills, Reaction Time, Badminton Performance

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Introduction

Badminton is one of the most rapid racquet sports in the world and a special set of technical precision, stamina, and perceptual intelligence are required. The speed of the shuttlecock exceeds 300 km/h, and the players have to get visual information and give the motor responses within milliseconds. Some of the most important attributes that determine success are eye coordination and agility. Although they have been practiced separately in the past, studies have shown that to achieve the desired skills in badminton both as amateurs and professionals, the two synergistically need to develop. The eye coordination (particularly hand-eye and eye-foot coordination) will allow players to follow the route of the shuttle, assess spin and speed, and prepare accurate responses in terms of stroke (Vickers, 2007).

The eyes are the primary navigators in badminton as they guide the movement of limbs which require a highly accurate time. In a deceptive play, ineffective visual-motor coordination often causes ineffective anticipation, ineffective strokes, and ineffective drop shots (Ochor & Amasiatu, 2025).

Agility, conversely, refers to the ability to make explosive moves at rapid directional changes and balance. Badminton rallies require rapid lunging, multidirectional footwork, rapid recovery and perceptual decision making under duress all of which are essential during badminton rallies. Sheppard and Young (2006) note that the current definitions of agility emphasize that it is a physical and perceptual-cognitive ability, in which a person must move in response to the movements of an opponent or the path taken by the shuttle. According to research, greater agility enhances the movement patterns in tactics, recovery rates, and the effectiveness of smash (Mangun & Subarkah, 2024). There is little research on the combination of eye coordination and agility even though they are important. These skills are in concert when real games are played: a gamer is watching a shuttle on the screen and makes the corresponding action instantly. This phenomenon is related to perceptual-motor synergy where perception and action are combined (Abernethy & Sparrow, 1992). Competitive play is integrated in nature and thus cannot be sufficiently simulated through training that only addresses visual or physical aspects. The importance of mixed perceptual-motor training is supported by the recent trends in sports science. Examples of integrated exercises that enhance efficiency of motor performance and decision-making reaction time include reactive shuttle runs, visual light-stimulus footwork, and unpredictable shuttle-feed movement tasks (Phomsoupha & Laffaye, 2015). Studies have shown that although eye-hand coordination is enhanced by relation to movement based tasks, agility is enhanced by addition of perceptual cues (Zhou et al., 2020). Moreover, both skills are good predictors of badminton performance. Although agility is useful for court coverage, focus and movement shapeness (Halim et al., 2023), eye-hand coordination is associated with stroke accuracy and reaction time (Wong et al., 2019; Ochor & Amasiatu, 2025). Also, in a study of neurocognitive assessment, visual-motor training enhances speed and accuracy of decision making and reaction processing (Chen et al., 2016).

The training models for badminton in the modern era should move from isolated workload to integrative perception-action development as a consequence of the growing speed, complexity and tactical requirements. To address this large literature gap and offer practical implications for coaches, sports scientists and athlete development programs, this study investigates the additive effects of agility training and eye–hand coordination on badminton performance. Badminton is a sport that requires the combination of eye-hand coordination, agility, and concentration because these three factors allow one to respond quickly and precisely and make strategic decisions (Wong et al., 2019). Eye-hand coordination enables the players to monitor the path of shuttlecock, time measures and react to unexpected actions, and it could be trained by visual-motor training like Wall Toss and Coin Catch tasks (Abernathy, 1996; Lidor et al., 2009; Ochor & Amasiatu, 2025). Agility, which is the ability to respond quickly to directional change, balance, and cognitive-perceptual skills, enhances coverage in the court, execution of the shot, and anticipation of the opponent actions (Sheppard & Young, 2006; Halim et al., 2023) . The studies indicate that the effectiveness of the integration of these skills in training programs enhances reaction time, movement efficiency, shot accuracy, and neural processing in motor planning and attention (Chen et al., 2016; Zhou et al., 2020; Freed et al., 2021). This synergy is also mediated by mental focus that improves visual tracking and predictive decision-making, and interventions, such as visualization and mindfulness, facilitate cognitive and physical responsiveness (Huttermann et al., 2014; Chen et al., 2022).

It has been demonstrated that badminton-specific tests, such as Badminton-Specific Agility Test, are an ecologically valid measure of reactive capability, whereas conventional agility tests and visual-motor exercises are used to customize the training to achieve better performance (Phomsoupha & Laffaye, 2015; Manrique & Gonzalez-Badillo, 2003; Sheppard & Young, 2006). Although there is evidence of integrated training, there are gaps in the research, especially in the case of intermediate-level players, the long-term consequences, and neurocognitive mechanisms that can explain the existence of coordination-agility synergy (Mangun & Subarkah, 2024; Adirahma et al., 2024). On the whole, eye-hand coordination, agility, and concentration development should be simultaneous to master the skills, increase the performance, and win the competition in badminton (Abernethy, 1996; Zhou et al., 2020). Hence, this study was on the joint impact of the training of agility and eye coordination on the performance of badminton. To establish that combined training enhances reaction time, movement efficiency, and shot accuracy to build more effective and game-specific training programs, it fills the gap between conventional isolated training strategies and game-specific requirements.

Method

Sample and Research Design

This study employs a quasi-experimental research design to collect data. There were 20 badminton volunteers that fulfilled the set skill, badminton, and health assessment requirements to take part in the study. Every participant successfully passed through the pre- and post-test, and the obtained data presented a complete set of information to assess the performance change at the level of an individual and group in terms of several parameters, associated with skills and fitness.

Instruments

Eye coordination test

Wall Toss Test*:* The Wall Toss Test is a good and valid instrument of measuring hand-eye coordination among badminton players, reaction time, concentration and coordination with repeated tosses of balls on a wall (Lidor et al., 2009). It improves tracking of shuttles, acuity of shot and general movement efficiency as well as cognitive-motor integration involving working memory and inhibitory control of executive functions. The Wall Toss Test is also highly recommended as a means of assessing and training the eye-hand coordination of badminton training because of its simplicity, low cost, and its relation to on-court performance.

Coin Catch Test: Coin Catch Test is also a valid measure of hand-eye and reaction time in badminton players; it can be used to measure the ability of a player to catch a falling coin in the shortest and most accurate time (Lidor et al., 2009). Test performance indicates visual tracking, motor response, and ocular-motor integration, which play a major role in predicting the trajectory of a shuttlecock as well as making accurate and precise shots. The practice and specific training with the help of the test may improve the reaction time, coordination, and overall gameplay, and digital versions offer objective measures that can be used to track the progress. In general, the Coin Catch Test is a non-invasive, easy to administer, and carry out approach to assessing and training the eye-hand coordination required in badminton and other high-speed sports.

Agility Test

5-10-5 Shuttle Run (Pro Agility Test): The Pro Agility Test or the 5-10-5 Shuttle Run is a test to assess the agility, speed, and quickness and is widely utilized to measure the ability of an athlete to change direction in short distances quickly (Sheppard & Young, 2006; Baechle & Earle, 2008). Lower-body power, coordination, reactive strength, and neuromuscular control reflect on performance and are important in the sport that involves lateral movements and swift transitions (Hachana et al., 2013; Paul et al., 2016). It is an easy tool with little equipment needs and high reliability and therefore can be utilized effectively to assess functional agility during training and competitively, such as professional combines. The common practice to improve the test performance is to use plyometric, resistance, and sport specific agility exercises which improve the direction change and general athletic performance.

Badminton Specific Agility Test: Badminton-Specific Agility Test (BSAT) as an evaluation is more agile-specific (lunge, side shuffle, and backward) and reflects the requirements of real match play when compared to conventional tests (Phomsoupha & Laffaye, 2015; Manrique & Gonzalez-Badillo, 2003). Elite and novice players show a difference in these tests because of higher reaction speeds, lower-body power, and efficient movement mechanisms, BSAT makes the test useful in identifying technical weaknesses and monitoring training development (Mei et al., 2022). Its ecological validity also enables coaches to make a training with specific and badminton-based training that improves the agility on the court, economy in movement and competitiveness.

Statistical Analysis

Descriptive data was used to overview performance of the participants in concentration, eye coordination, agility and badminton skills, with the occurrence of trends in terms of means, standard deviations, median, ranges, and frequencies. The effectiveness of the integrated training program was the subject of comparative pre- and post-test scores, implemented by paired t-tests. The improvement of all measured variables was studied, which revealed positive intervention effects.

Results

Table 1

Normality Test Results (Shapiro–Wilk Test)

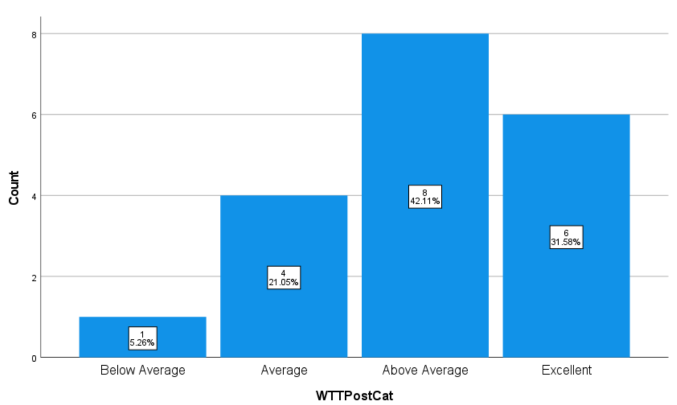
Test	Statistic	p-value	Normality
Wall Toss Test (meanWTT)	0.936	0.198	Normal
Coin Catch Test (meanCCT)	0.964	0.634	Normal
Simple Reaction Time (meanSRT)	0.899	0.040	*Not Normal*
Badminton Skill Test (meanBST)	0.836	0.003	*Not Normal*

Note: The Shapiro–Wilk normality test was done to evaluate if the variables were normally distributed. For meanWTT (Wall Toss Test) and meanCCT (Coin Catch Test), the p-values were 0.198 and 0.634, respectively, which are both greater than 0.05. As a result, these variables are regarded as regularly distributed as they satisfy the normality assumption. The p-values for meanSRT (Simple Reaction Time) and meanBST (Badminton Skill Test) were 0.040 and 0.003, respectively, which are less than 0.05, suggesting that these datasets do not have a normal distribution.

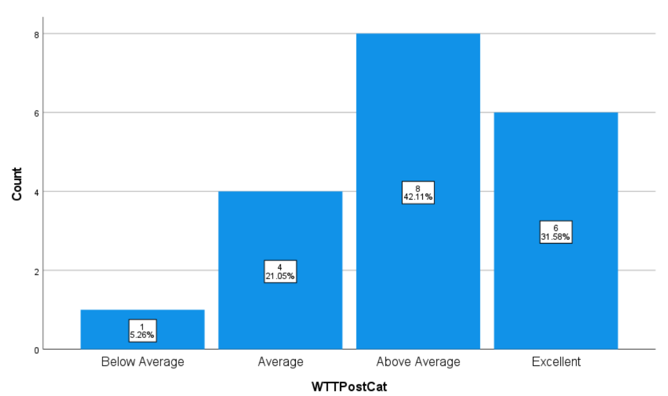
Figure 1

*Normality Test Results of **Shapiro–Wilk** Test*

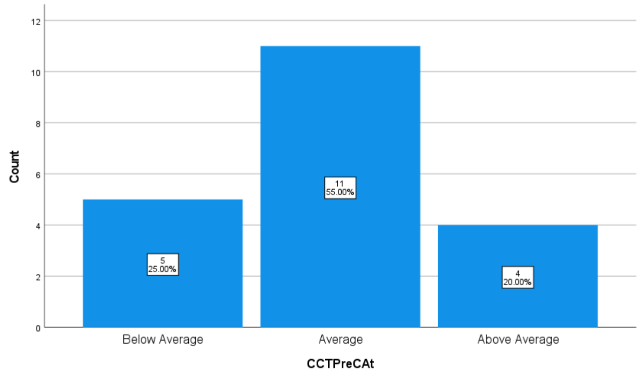
Wall Toss Pre Test



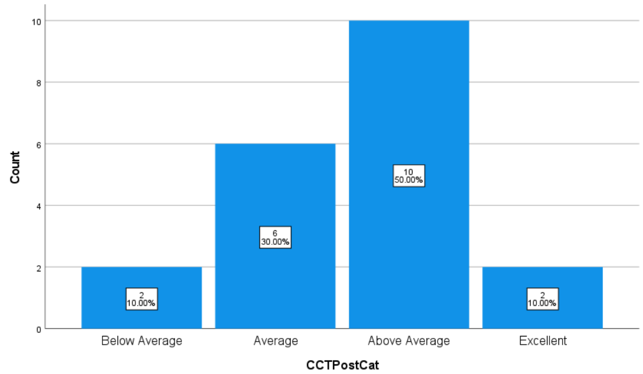
Wall Toss Post Test



Coin Catch Pre Test



Coin Catch Post Test

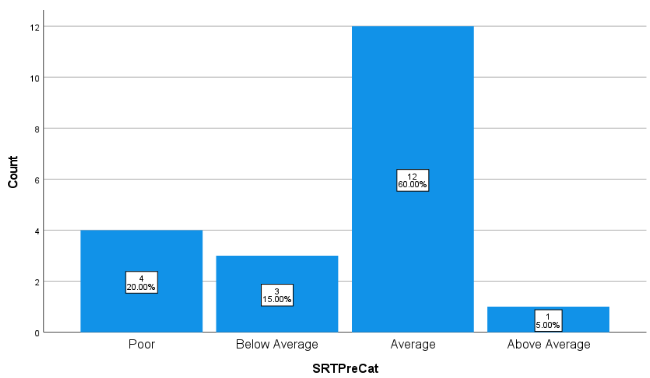


Note: The provided histograms graphically depict the wall toss and coin catch test (both pre and post). Both histograms also exhibited normal distributions, aligning with the results of normality testing for the T. test on wall toss Pre-Test and Post-Test. The coin catch Pre-Test and Post-Test also show normal distributions in line with their respective normality tests.

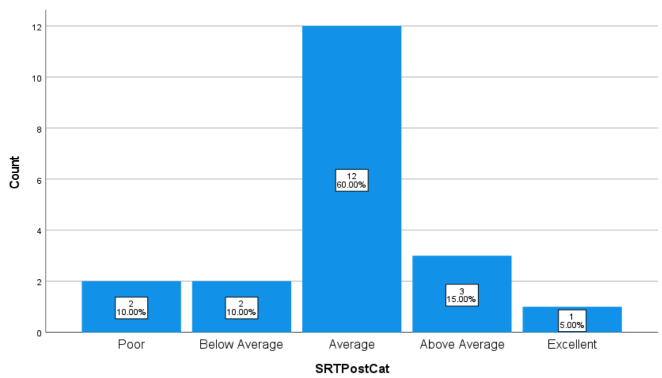
Figure 2

Not Normality Test Results Wilcoxon Signed Rank Test

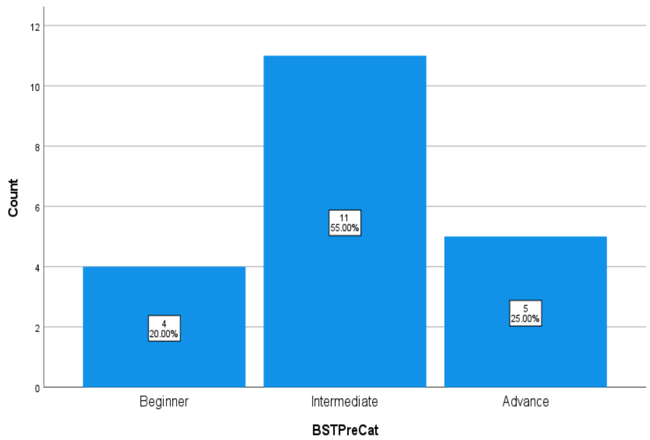
Shuttle Run Pre Test



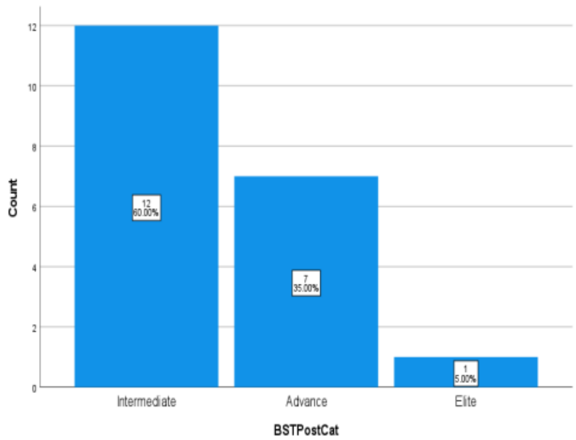
Shuttle Run Post Test



Badminton Specific Pre Test



Badminton Specific Post Test



Note: The provided histograms graphically depict the shuttle run and badminton specific test (both pre and post). Both histograms also exhibited not normal distributions, aligning with the results of normality testing for the

Wilcoxon signed rank test on shuttle run Pre-Test and Post-Test. The badminton specific Pre-Test and Post-Wilcoxon signed rank test also show not normal distributions in line with their respective normality tests.

Table 2

Wall Toss Pre and Post Test

Group	Pre-Test		Post-Test		t (19)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Wall Toss Test	27.86	7.09	30.71	7.22	-24.324	.000	0.52

Note: A paired-samples t-test was undertaken to compare pre-test and post-test scores on the Wall Toss Test. Results showed that post-test performance (M difference = –2.85, SD = 0.52) was substantially higher than pre-test performance. The 95% confidence interval of the difference varied from –3.10 to –2.60. This difference was statistically significant (t(19) = –24.32, p <.001). These findings show that the training session had generated a significant improvement in the eye-hand coordination through the Wall Toss Test.

Table 3

Coin Catch Pre and Post Test

Group	Pre-Test		Post-Test		t (19)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Coin Catch Test	4.16	1.38	5.28	1.37	20.105	<.001	0.52

Note: A paired-samples t-test was used to compare the results of Coin Catch Test pre-test and post-test. The findings indicated that the participants performed much better in the post-test (M = 5.28, SD = 1.37) than during the pre-test (M = 4.16, SD = 1.38). This was also statistically significant t(19) = -20.11, p < .001. The intervention also produced a moderate effect size (Cohen d = 0.52), meaning that there was significant positive effect of the training program on the eye-hand coordination of the participants based on the Coin Catch Test.

Table 4

Shuttle Run Wilcoxon Signed Ranks Test results

Ranks	N Sum of Rank	Mean Rank
Negative Rank	20[a] 210.00	10.50
Positive Rank	0[b] .00	.00
Ties	0[c]	
Total	20	

Note: The comparison between pre-test and post-test results on the Shuttle Run Test was conducted using Wilcoxon Signed Ranks Test. This was indicated by 20 negative scores and no positive ranks which indicated that all the participants had lower (better) post-test-timings compared to their pre-test-timings. Mean rank of the negative ranks was 10.50 having a sum of ranks of 210.00. The trend indicates that there is an incessant agility performance improvement after the training program.

Table 5

Wilcoxon Signed Ranks Test outcomes of Badminton Specific Test

Ranks	N Sum of Rank	Mean Rank
Negative Rank	20[a] 210.00	10.50
Positive Rank	0[b] .00	.00
Ties	0[c]	
Total	20	

Note: A Wilcoxon Signed Ranks Test was used to compare the results of the Badminton-Specific Test pre-test and post-test. The data had 20 negative ranks, 0 positive ranks, and no ties, which proved that all people had better results on the post-test.

Following the training intervention, all participants showed a consistent and uniform improvement, with a mean rank of 10.50 for the negative ranks and a sum of ranks of 210.00.

Discussion

The results of the present study provide strong evidence that the training intervention has led to significant improvement in several performance domains such as agility, eye-hand coordination, reaction time and badminton-specific performance. According to the results of the normality analysis based on Shapiro-Wilk test, some of the variables (Wall Toss Test and Coin Catch Test) were normally distributed, whereas others (Simple Reaction Time, Shuttle Run, and Badminton-Specific Test) were not. The use of parametric and non-parametric statistical tests was informed by this variation in patterns of distribution, which ensured that the methodology used was rigorous and that the results were interpreted correctly. The general effectiveness of the training program to enhance performance-related neuromata and physical qualities in badminton players can be illustrated by the direction and magnitude of improvements in all the variables. The paired-samples t-test confirmed the fact that the results of the Wall Toss Test revealed statistically significant changes in the result of the pre-test and post-test. The enhancement in the mean scores is implied by the better eye-hand coordination of the participants that is required of badminton players who need to respond quickly to the change in the direction of the shuttle trajectories. Research by Ustuner et al. (2019) indicates that visual tracking and concentrated attention are the keys to good racket play that directly affects the accuracy and consistency of strokes.

Also, it has been proved that special visual training can enhance the level of perceptions, which will enhance performance levels in decision-making and reaction times on the court (Baker et al., 2020).This improvement is complementary to the other previous studies indicating that repetitive sport-specific training and exercises based on the coordination of neuromuscular integration and sensorimotor integration can significantly improve perceptual abilities. To illustrate this, it was found that the training based on the coordination enhances the speed of visual-motor processing, which is essential in interceptive sports such as badminton. The relatively small effect size of the study (Cohens d = 0.52) supports these findings indicating that it is possible to gain significantly even in relatively short training period. These patterns were observed in the Coin Catch Test when the subjects had a substantial improvement between the pre-test and post-test; these results were supported with a moderate effect size and paired samples t-test. Eye-hand coordination and in particular reactive catch skill is important in fast-paced athletic performance. The inherent neuromata processing speed, high hand movement speed, and attentional control mechanisms can be transferable even in the event the activity in question is not badminton playing. These findings can be correlated with the general enhancement observed in this study that demonstrates that the intensive training can enhance rapid upper-limb responses. Because of the non-normal distribution, Wilcoxon Signed Ranks Test was applied to compare the results of the Shuttle Run Test and Badminton-Specific Test where there were uniform and identical increases in all the participants. The post scores of all participants on both tests were lower (improved) than the pre-test scores, which confirmed the improvement in the speed, agility, and sport-related movement efficiency. The agility is a basic physical requirement in badminton because players have to move variously fast to catch the shuttle. The agility performance improvements observed here are aligned with the new research findings that agility training leads to dramatic change in the multidirectional movement control and accelerates the onset of movement. As an example, the performance of racquet-sport athletes regarding directional change was improved more effectively when using agility-oriented training as compared to traditional conditioning programs. Likewise, a longitudinal study by Rohman and Saputra (2022) showed that agility-specific workouts really improved the speed of court covering and reduced reaction time when playing the game on the field. Irrespective of the level of previous performance, the training intervention seems to have taken the same effect, as is observed by the fact that all people in this study have improved uniformly.

The indicated improvement in badminton-specific performance is yet another indicator of the effectiveness of the training intervention. The general skill, movement accuracy, and energy economy of badminton-specific tasks were all shown to have significant post-test improvements by all athletes in this test. These benefits demonstrate the potential neuromotor improvements as well as the physical benefit of the training program. The role of improved anticipatory skills, cognition related movement selection and training induced modifications in muscle activation patterns all play an important part in ensuring improved badminton performance. This is confirmed by the existing results where it was observed that the on court productivity of all participants improved upon the training session. Also, it has been demonstrated that introducing agility, response, and coordination-based training to the badminton training may increase various performance indicators, including the endurance, footwork response speed and stroke accuracy.

The rationale in this research is derived out of research and practice. On their part, previous research has focused on the significance of agility and eye coordination in badminton. As Ochor and Amasiatu (2025) report, significantly higher scores on eye-hand coordination test were also significantly associated with much better shuttle control, reaction time and shot placement in collegiate badminton players. Nevertheless, Mangun and Subarkah (2024) discovered that athletes with larger agility scores succeeded more in smashes under stress and fatigue. These studies have however not assessed the effects of taking these characteristics collectively on overall performance. The findings of the current study tend to support these conclusions as it states that the training program had a positive effect on the relationship between the technical performance and physical capabilities. The normality plots and the histograms that were employed to graphically analyze the distributions of all the variables were also found to support the statistical results. The Q-Q plots were used to realize that the variables such as the Wall Toss Test and Coin Catch Test approximate normality, which is consistent with the Shapiro-Wilk test. However, the Shuttle Run and Badminton-Specific Tests' Q-Q graphs showed distinct departures from normalcy, indicating that non-parametric tests were suitable. In order to prevent analytical bias, statistical research such as that which highlighted the significance of combining graphical and computational normality assessments supports the practice of visually verifying the behavior of data before choosing statistical techniques. The participants' demographics offer more information on the study's implications and generalizability. Gender-related bias was lessened by the sample's equal representation of male and female athletes. The participants were young adults, who are often thought to be in the ideal age range for neuromuscular adaptation and the development of physical performance, as indicated by the age distribution's concentration between 20 and 23 years. According to recent research athletes in this age range show quick gains in coordination and speed when they participate in training regimens that are methodically designed.

Participants demonstrated significant gains in every assessed variable, including eye-hand coordination tests that were statistically significant and agility and skill-based tests that consistently yielded favorable scores. . This means that the fundamental motor skills associated with the performance of the badminton were positively developed through the training program. The results are consistent with the recent studies indicating that multi-component knowledge such as coordination, agility, response time, and perceptual speed contribute significantly to badminton performance (Phomsoupha & Laffaye, 2015).

Moreover, there is a variety of the experience of playing (less than two years and over five years) which proves that the training intervention proved to be effective at each level of ability. Among the interesting features of the present research is that both the direction of growth has been statistically significant and statistically consistent above the participants in both physical and sport-specific measures. This consistency implies that the training program has covered the basic neuromotor and physical systems that are related to badminton play. The implications of these findings on the training program design and coaching practice are presented. Such exercises as agility, coordination, and sport-specific drills on a regular basis, particularly on fast directional shifts, visual-motor processing, and accuracy of timing, can turn out to be useful to coaches.

Research has indicated that training treatments that emphasize on both physical and perceptual-cognitive features are essential since they produce the most substantial improvements on the indicators of racquet-sport performance. The findings of the study justify such recommendations by showing that inclusive training measures yield more successful outcomes. In recent studies, agility includes perceptual and decision-making abilities besides the physical ones. Badminton players need to quickly adapt to the actions of their opponents, and this requires them to move quickly and efficiently. As the research done over the last decade shows, the efficiency of court movement goes up drastically, and the shuttle-to-contact time decreases as a result of training on agility (Phomsoupha & Laffaye, 2015). The current research supports these observations by indicating that a relatively long period of time can bring substantial gains to organized agility exercises.

It is worth noting, as well, that even though the changes were statistically significant, the magnitude of some of the tests (the Wall Toss Test and the Coin Catch Test) was moderate, meaning that maybe more time spent on the intervention or more training variety is required to make even more significant changes**.** This finding is in agreement with the research findings that, unless training loads or increase of drill complexity is progressively altered, coordination-based improvements level off once increased. To sum up, the research results indicate that the training program produced an enormous effect on the performance levels in badminton-specific skills and ability, coordination, agility, and reaction time. These developments are supported by recent academic studies based on the positive effects of special physical and neuromotor training in the racquet sports. The statistical strength, the confirmation of the results graphically, and the correspondence to the recent studies are considered to be the features that make the conclusions of the study reliable and applicable. Altogether, the study provides strong evidence that structured training programs can lead to the substantial and credible increases in the performance of athletes in a variety of aspects that are essential to badminton.

Conclusion

The researchers discovered that combined eye coordination and agility training is very helpful in enhancing the performance of badminton, reaction-time, and efficiency in movements. The interdependence of perception and motor skills as the focus of the synergistic training approach was more effective than the traditional ones. Although the sample was small and the time was short, significant positive changes were observed, which means that holistic and sport-specific exercises should be used. The future studies are to use bigger samples and extended intervention to further confirm and streamline the training protocols.

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