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RESEARCH ARTICLE

Utilizing Perceptual–Motor Integration and Imagery Training in Enhancing Baseball Batting Accuracy

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ABSTRACT

Batting accuracy is a key skill in baseball that depends on perceptual judgment, timing, and coordinated motor skills. However, many athletes find it difficult to make accurate contact with the ball due to the complex perceptual–motor demands of the task. Grounded in the Perceptual-Action Coupling Theory and Psychoneuromuscular Theory, findings suggest that perceptual-motor training enhances batting accuracy. This study investigated the effectiveness of Perceptual–Motor Integration Training (PMIT) and Imagery Training in improving batting accuracy among junior high school student-athletes. The study used a quasi-experimental pretest–posttest design with 70 male Grade 9 baseball players from a school in Misamis Oriental, Philippines, during the 2025–2026 school year. Participants were divided into two groups, each with 35 students. Batting accuracy was assessed with the Home Run Metrics Test. The interventions lasted six weeks, with the PMIT group performed movement-based perceptual–motor drills, while the Imagery Training group practiced progressive muscle relaxation and visualization exercises. Data were analyzed using descriptive statistics, paired-samples t-tests, and ANCOVA. Results indicated that participants' batting accuracy consistently stayed within the Competent performance level of performance before and after the intervention. However, paired t-test results revealed a significant improvement in the PMIT group with a large effect, while the Imagery Training group showed a significant difference with a moderate effect size. ANCOVA further demonstrated that PMIT was significantly more effective than Imagery Training in enhancing batting accuracy after accounting for pre-test scores. It is also recommended that future researchers examine longer intervention durations, larger sample sizes, and combined effects of perceptual-motor integration and imagery training to further determine their effectiveness in batting accuracy.

KEYWORDS *baseball batting accuracy, perceptual–motor integration, imagery training, sports performance, visuomotor coordination*

INTRODUCTION

Baseball batting accuracy is a defining component of successful performance in interception sports because effective hitting depends on far more than physical strength alone. Batters must rapidly perceive ball trajectory, discriminate pitch location, regulate swing decisions, and execute precise motor responses within fractions of a second, making batting one of the most complex visuomotor tasks in sport (Chen *et al.*, 2021; Gray, 2021; Saijo *et al.*, 2025). Research consistently shows that batting performance is strongly associated with visual tracking, hand–eye coordination, perceptual judgment, and movement timing, all of which shape the batter's ability to achieve accurate and effective bat–ball contact under severe temporal constraints (Aoyama *et al.*, 2022; Morishita *et al.*, 2025). Because of these demands, improving batting accuracy requires interventions that address both perceptual and motor processes rather than relying solely on conventional physical practice.

Contemporary literature emphasizes that batting accuracy is multidimensional, involving decision accuracy, pitch recognition, biomechanical coordination, and contextual adaptability. Successful batting requires players to interpret visual cues, decide whether and when to swing, and coordinate the kinetic chain efficiently to optimize contact precision (Gray, 2021; Laby & Appelbaum, 2021). Studies on batting performance further indicate that the absence of critical visual information can impair strike discrimination and swing adjustments, highlighting the central role of perception–action coupling in batting success (Douglas *et al.*, 2023; Saijo *et al.*, 2025). Although visual and perceptual skills are recognized as important determinants, findings regarding isolated visual training remain inconsistent, suggesting that broader, integrated training approaches may be more effective for improving actual batting performance (Gray, 2021; Tremblay, 2025).

Despite growing international evidence, empirical research addressing baseball batting accuracy in the Philippine setting remains limited. Existing local scholarship has focused more on assessment development than on intervention-based performance enhancement, leaving uncertainty about how global findings translate into school-based or youth baseball contexts in the Philippines (Bandara *et al.*, 2023; Lacson *et al.*, 2023). Recent initiatives such as the Home Run Metrics Test have provided an ecologically valid tool for measuring batting accuracy among Filipino athletes, demonstrating acceptable validity and reliability for skill differentiation (Gomez *et al.*, 2025). However, practical and context-sensitive interventions that improve batting accuracy in realistic educational and sports environments remain underexplored, creating a substantial gap in localized sports performance research.

One promising direction involves Perceptual–Motor Integration Training (PMIT), which is grounded in Perception–Action Coupling Theory and emphasizes the development of visuomotor coordination through dynamic, movement-based drills. PMIT directly targets reaction time, spatial awareness, eye–hand coordination, and the athlete's capacity to transform visual stimuli into immediate and coordinated action (Chen *et al.*, 2022; Thieschäfer & Büsch, 2022). Unlike isolated sports vision exercises, PMIT may better replicate the real-time perceptual and motor demands of baseball by combining visual processing with physical execution. Dynamic drills such as evasive-response tasks, shuttle-target striking, and reaction-ball activities may therefore provide more representative learning conditions for improving batting accuracy in youth athletes.

In parallel, imagery training offers a complementary psychological approach based on Psychoneuromuscular Theory, which proposes that mentally rehearsing movements activates neural pathways similar to those involved in physical performance (Jacobson, 1931; Sinha *et al.*, 2021). Techniques such as progressive muscle relaxation and guided visualization may enhance concentration, confidence, motor planning, and psychological readiness by allowing athletes to mentally simulate batting scenarios before execution (Toussaint *et al.*, 2021; Zisopoulou & Varvogili, 2022). Although imagery training has demonstrated benefits across sport psychology, its direct application to baseball batting accuracy remains less established, particularly among junior high school athletes. This suggests the need to compare physical-perceptual and psychological interventions to determine their relative effectiveness in practical batting development.

In response to these theoretical and contextual gaps, the present study examines the effectiveness of Perceptual–Motor Integration Training and Imagery Training in enhancing baseball batting accuracy among Grade 9 student-athletes in the Philippine school setting. By comparing these interventions through a quasi-experimental framework, the study contributes to evidence-based physical education and sports training practices while aligning with DepEd Order No. 21, s. 2019 and broader educational goals promoting holistic learner development. Furthermore, the investigation supports Sustainable Development Goals 3 (Good Health and Well-being) and 4 (Quality Education) by exploring accessible, school-based strategies that strengthen both physical competence and cognitive readiness in youth sports performance.

Statement of the Problem

This study aimed to determine the effectiveness of perceptual–motor integration and imagery training in enhancing baseball batting accuracy. Specifically, this study answered the following questions:

1. What is the baseball batting accuracy of the participants before and after the interventions?
2. Within each group, do the participants' baseball batting accuracy scores significantly differ before and after the interventions?
3. Which of the two interventions was more effective at improving baseball batting accuracy?

Hypotheses

The study's hypotheses are presented below to guide the researcher in analyzing problems 2 and 3. The significance level was set at α=0.05 in analyzing the data gathered using appropriate statistical tools:

Ho_1: There is no significant difference in participants' baseball batting accuracy before and after the interventions.

Ho_2: Neither of the two interventions was more effective at improving baseball batting accuracy.

METHODS

This study employed a quasi-experimental pretest–posttest research design to determine the effectiveness of Perceptual–Motor Integration Training (PMIT) and Imagery Training in enhancing baseball batting accuracy. A quasi-experimental design was appropriate because it allows researchers to examine intervention effects in real-world settings where random assignment may not be feasible (Ravalihasy *et al.*, 2023). The pretest–posttest structure enabled the researcher to measure participants' batting accuracy before and after the intervention period and determine whether measurable performance changes occurred after exposure to the training programs (Azak & Gözen, 2024; Park *et al.*, 2023).

The study was conducted among 70 male Grade 9 junior high school students who were members of a baseball team during the 2025–2026 school year in a school in Jasaan, Misamis Oriental, Philippines. The participants were between 12 and 16 years old and were selected because they were already engaged in baseball training under the supervision of the researcher. They were divided into two intervention groups, with 35 participants assigned to the Perceptual–Motor Integration Training group and 35 participants assigned to the Imagery Training group.

Before participation, parental consent and student assent were secured. A health screening procedure was also conducted to determine the participants' readiness for physical activity. Students who disclosed medical concerns were required to obtain clearance from a licensed healthcare provider before joining the intervention. These procedures helped ensure that participation was voluntary, safe, and appropriate for the physical demands of the study.

The main instrument used to assess batting accuracy was the Home Run Metrics Test developed and validated by Gomez *et al.* (2025). This test measures batting accuracy in a dynamic and game-like setting by requiring each participant to respond to 10 fastpitch pitches delivered within the strike zone by a skilled pitcher. Scores are based on the quality and placement of batting outcomes, ranging from called strikes to home runs. The test also reflects related performance components such as reaction time, consistency, power, pitch recognition, plate discipline, and adaptability.

The Home Run Metrics Test has demonstrated known-group validity and internal consistency reliability (Gomez *et al.*, 2025). In the present study, the researcher conducted an additional pilot test to strengthen reliability evidence. Based on 10 trials, the computed Cronbach's alpha was 0.750, indicating acceptable reliability for research use. Although the Spearman–Brown Prophecy Formula projected that increasing the number of trials from 10 to 20 would raise reliability to approximately 0.857, the 10-trial format was retained because it already provided acceptable reliability while remaining practical for field implementation.

Data gathering followed a structured pretest–intervention–posttest procedure. Prior to the intervention, participants completed a pretest assessment using the Home Run Metrics Test to determine their baseline batting accuracy. An orientation was then conducted to explain the study objectives, procedures, safety rules, and participation expectations. After the intervention period, the same testing procedures were used in the posttest to determine changes in batting accuracy.

The PMIT group underwent drills designed to improve perception–action coupling, reaction time, visuomotor coordination, and spatial awareness. These drills included the Dodgeball Evasive Response Drill, Arnis Shuttle-Target Strike Drill, and Reaction Ball Catch Drill. Sessions lasted approximately 45 to 50 minutes and were conducted three times per week for six weeks. The program progressed from basic execution and controlled responses during the early weeks to faster, more complex, and less predictable movement patterns during the later weeks.

The Imagery Training group participated in sessions lasting approximately 30 to 45 minutes, conducted three times per week for six weeks in a quiet and controlled setting. This intervention was grounded in Psychoneuromuscular Theory and included Progressive Muscle Relaxation and Basic Visualization or Guided Imagery. Participants mentally rehearsed batting actions such as tracking the pitch, timing the swing, and achieving accurate bat–ball contact. Data were analyzed using descriptive statistics for batting accuracy levels, paired-samples t-tests with Cohen's d for within-group changes, and ANCOVA with partial eta squared to compare posttest scores between groups while controlling for pretest performance. All analyses were conducted at the 0.05 level of significance.

RESULTS

Problem 1. What is the baseball batting accuracy of the participants before and after the interventions?

Table 1 presents the frequency, percentage, mean, and standard deviation of participants' baseball batting accuracy before and after the interventions for both perceptual–motor integration and imagery training.

Table 1. *Descriptive Statistics of the Participants' Baseball Batting Accuracy Before and After the Interventions*

Range	Interpretation	Perceptual–Motor Integration Training				Imagery Training			
		PRETEST		POSTTEST		PRETEST		POSTTEST	
		f	%	f	%	F	%	F	%
91 - 100	Expert	0	0	0	0	0	0	0	0
71 - 90	Proficient	3	8.571	6	17.14	3	8.571	4	11.43
51 - 70	Competent	16	45.71	28	80	28	80	29	82.86
31 - 50	Basic	16	45.71	1	2.857	4	11.43	2	5.714
10 - 30	Novice	0	0	0	0	0	0	0	0
TOTAL		**35**	**100**	**35**	**100**	**35**	**100**	**35**	**100**
MEAN		54.14		62.83		60.63		62.91	
INTERPRETATION		Competent		Competent		Competent		Competent	
SD		11.56		8.89		8.35		6.73	

For the Perceptual–Motor Integration Training group, the pretest mean score was 54.14 (*SD* = 11.56), interpreted as Competent. In terms of distribution, 16 participants (45.71%) were classified under the Competent level, while another 16 participants (45.71%) were in the Basic level. A smaller proportion, 3 participants (8.57%), fell under the Proficient level, and no participants were classified as Novice or Expert. For the posttest, the mean score of the Perceptual–Motor Integration Training group was 62.83 (SD = 8.89), also interpreted as Competent. The majority of participants, 28 (80%), were categorized under the Competent level. Six participants (17.14%) were in the Proficient level, while 1 participant (2.86%) was classified under the Basic level. No participants were categorized as Novice or Expert.

For the Imagery Training group, the pretest mean score was 60.63 (*SD* = 8.35), interpreted as Competent. Most participants, 28 (80%), were classified under the Competent level. Four participants (11.43%) were in the *Basic* level, while 3 participants (8.57%) were categorized under the Proficient level. No participants were classified as Novice or Expert. For the posttest, the Imagery Training group obtained a mean score of 62.91 (*SD* = 6.73), interpreted as Competent. A total of 29 participants (82.86%) were categorized under the Competent level. Four participants (11.43%) were classified as Proficient, while 2 participants (5.71%) were in the Basic level. No participants were categorized as Novice or Expert.

Problem 2. Within each group, do the participants' baseball batting accuracy scores significantly differ before and after the interventions?

Ho_1: There is no significant difference in participants' baseball batting accuracy before and after the interventions.

Table 2 presents the results of the paired-samples t-test comparing the pre-test and post-test batting accuracy scores of the participants in the Perceptual–Motor Integration Training group and the Imagery Training group.

Table 2. *Paired Samples t-test for Pre-Test and Post-Test Scores in Perceptual-Motor Integration and Imagery Trainings*

Group	Test	M	Interpretation	SD	T	p	Cohen's d
Perceptual-motor Integration (n = 35)	Pre-test	54.14	Competent	11.56	-6.323*	<0.001	- 1.069
	Post-test	62.83	Competent	8.890			
Imagery Training (n = 35)	Pre-test	60.63	Competent	8.353			
	Post-test	62.91	Competent	6.727	-3.441*	0.002	- 0.582

**Significant at 0.05 two-tailed alpha level. M = mean, SD = standard deviation, t = t statistic, p = probability value, Cohen's d = effect size*

As shown in *Table* 2, the Perceptual–Motor Integration Training group obtained a pre-test mean score of 54.14 (*SD* = 11.56) and a post-test mean score of 62.83 (*SD* = 8.890), both interpreted as competent levels of batting accuracy. The paired-samples t-test revealed a statistically significant improvement in batting accuracy after the intervention, $t(34) = -6.323$, $p < .001$. The computed Cohen's $d = -1.069$ indicates a large effect size, suggesting that the perceptual–motor integration training produced a substantial improvement in participants' batting accuracy.

In contrast, the Imagery Training group recorded a pre-test mean score of 60.63 (*SD* = 8.353) and a post-test mean score of 62.91 (*SD* = 6.727), both interpreted as competent levels of performance. The paired-samples t-test also showed a statistically significant difference, $t(34) = -3.441$, $p = .002$, although the magnitude of the effect was smaller, with Cohen's $d = -0.582$, indicating a moderate effect size.

Based on these findings, the null hypothesis can be rejected. The results indicate significant differences between participants' pre- and post-test batting accuracy scores, suggesting that their batting performance improved after the intervention period. During the training sessions, the researcher directly observed that participants demonstrated improved swing timing, better bat control, and more consistent contact with the ball during the post-test sessions compared with the pre-test, indicating improvements in batting execution following the training period.

Problem 3. Which of the two interventions was more effective at improving baseball batting accuracy?

Ho_2: Neither of the two interventions was more effective at improving baseball batting accuracy.

Table 3 presents the results of the ANCOVA comparing post-test batting accuracy scores of participants in the Perceptual–Motor Integration group and the Imagery Training group, while controlling for pre-test scores.

Table 3. ANCOVA *Summary Table for Posttest Scores with Pretest Scores as Covariate*

GROUPS	Adjusted Mean	Interpretation	F(1,67)	p	Partial η^2
Perceptual–Motor Integration Training	64.79	Competent	9.227*	0.003*	0.121
Imagery Training	60.95	Competent			

*Significant at the 0.05 alpha level. Adjusted Mean = estimated marginal mean controlling for the pretest covariate; F = F statistic; p = probability value; partial η^2 = effect size.

Prior to the ANCOVA, assumptions were examined: residual normality was supported by Q–Q inspection, and the homogeneity of regression slopes was confirmed, supporting the suitability of the model. Levene's test indicated unequal variances, $F(1, 68) = 10.75$, $p = .002$; with equal group sizes ($n = 35$ each), the ANCOVA remained robust to this violation. After adjusting for the influence of the pre-test scores, the ANCOVA results revealed a statistically significant effect of group on post-test batting accuracy, $F(1,67) = 9.227$, $p = .003$. Thus, the null hypothesis can be rejected. The partial eta squared ($\eta^2 p$) value of 0.121 indicates a moderate effect size, suggesting that approximately 12.1% of the variance in post-test batting accuracy is attributable to the intervention type after controlling for pre-test performance. After adjusting for pretest scores, the estimated marginal mean was higher for the Perceptual–Motor Integration Training group (M = 65.28, SE = 1.115, 95% CI [63.06, 67.50]) than for the Imagery Training group (M = 61.30, SE = 1.115, 95% CI [59.08, 63.52]). This adjusted difference confirms that, once the initial baseline gap was controlled, the PMIT group attained higher batting accuracy than the Imagery Training group.

Based on ANCOVA results, the null hypothesis stating that neither of the interventions is more effective than the other is rejected. PMIT is more effective for improving baseball batting accuracy. Although the Imagery Training group started higher (pretest M = 60.63 vs. 54.14 for PMIT), ANCOVA controlled for this baseline difference. After adjustment, a significant group effect indicated that improvements in batting accuracy differed between interventions. The PMIT group improved, while Imagery Training showed minimal improvement. This indicates PMIT yields greater gains when initial scores are controlled, making it the more effective intervention. These results should nonetheless be interpreted with caution: because the groups were intact rather than randomly assigned and the PMIT group began at a lower level with more room to improve, part of the adjusted between-group difference may reflect regression to the mean and a possible ceiling effect in the higher-starting Imagery group.

DISCUSSION

The findings indicate that both groups generally demonstrated Competent baseball batting accuracy before and after the interventions, suggesting that the participants already possessed functional batting skills prior to the study. This may be attributed to their prior exposure to baseball training as student-athletes, which likely developed their basic swing mechanics, timing, hand–eye coordination, and familiarity with batting situations. Previous research supports this interpretation, showing that athletes with regular sport-specific practice tend to demonstrate stronger perceptual–motor coordination and sport-related performance than non-athletes (Chen *et al.*, 2021). In batting, repeated exposure to pitched balls strengthens visual tracking, reaction timing, and coordinated movement execution, all of which are necessary for successful bat–ball contact (Gray, 2021).

Although both groups remained within the Competent level, the distribution of scores showed meaningful improvement, particularly in the Perceptual–Motor Integration Training group. The PMIT group shifted from a larger proportion of participants in the Basic level during the pretest to a higher concentration in the Competent and Proficient levels during the posttest. This suggests that PMIT helped improve the participants' batting execution, especially in terms of timing, movement control, and accuracy. Such improvement is consistent with the nature of batting as a complex interceptive skill that requires athletes to rapidly perceive ball speed, trajectory, and location and translate this information into coordinated motor responses (Gray, 2021; Morishita, 2025). The observed improvement supports the view that batting accuracy is shaped by the interaction of perceptual judgment, visuomotor coordination, biomechanical execution, and situational demands.

The significant pretest–posttest improvement in the PMIT group further suggests that movement-based perceptual–motor drills can effectively enhance batting accuracy. PMIT directly trains perception–action coupling by requiring athletes to respond to moving stimuli while executing coordinated body movements. In the present study, drills such as dodgeball evasive response, Arnis shuttle-target striking, and reaction-ball catching likely strengthened the participants' visual tracking, reaction time, spatial awareness, and eye–hand coordination. This aligns with studies showing that perceptual–motor training improves visual tracking, response accuracy, and coordination in sport-related tasks (Chen *et al.*, 2022; Laby & Appelbaum, 2021). Because these drills involve real-time movement responses, they approximate the demands of batting more closely than isolated visual or technical drills (Thieschäfer & Büsch, 2022).

The results are also theoretically consistent with Perception–Action Coupling Theory, which explains that skilled motor performance improves when athletes learn to coordinate their actions with relevant environmental cues. In baseball, hitters must quickly interpret visual information from the incoming ball and convert it into an accurate swing within a limited time window. PMIT may have enhanced this process by repeatedly exposing participants to dynamic visual stimuli that required immediate motor adjustment. This supports the argument that representative training conditions, where perception and movement are practiced together, are important for improving performance in time-constrained interceptive sports such as baseball (Gray, 2021; Thieschäfer & Büsch, 2022).

The Imagery Training group also showed a significant improvement from pretest to posttest, although the magnitude of change was smaller than that of the PMIT group. This finding indicates that imagery training may still contribute to batting performance by improving focus, composure, mental rehearsal, and consistency in movement preparation. Imagery allows athletes to mentally simulate sport actions, strengthen motor planning, and improve attentional control before actual execution (Danon *et al.*, 2021; Sinha *et al.*, 2021). The use of progressive muscle relaxation may have further supported performance by reducing physical tension and preparing participants for more focused visualization (Toussaint *et al.*, 2021). Thus, while imagery training may not directly reproduce the perceptual and physical demands of batting, it appears useful as a psychological strategy for stabilizing performance and enhancing readiness.

The ANCOVA results showed that after controlling for pretest scores, PMIT was significantly more effective than Imagery Training in improving baseball batting accuracy. This finding suggests that batting accuracy may improve more substantially when training directly engages both perceptual and motor processes rather than relying mainly on mental rehearsal. Although imagery training can support confidence, concentration, and motor planning, PMIT provides actual movement practice under dynamic conditions that require athletes to respond to visual information in real time. This distinction is important because batting requires not only cognitive preparation but also immediate perception-based motor execution. Therefore, PMIT may have produced greater gains because it more closely replicated the demands of actual batting situations (Chen *et al.*, 2022; Gray, 2021; Thieschäfer & Büsch, 2022).

With these, the findings support the value of integrating perceptual–motor training into school-based baseball instruction and athletic development programs. The results suggest that PMIT can be used by coaches and Physical Education teachers to improve batting accuracy through drills that develop reaction time, visual tracking, coordination, and perception–action coupling. Imagery training, meanwhile, may serve as a complementary strategy for improving focus, confidence, relaxation, and mental preparation. Together, the findings reinforce the idea that batting accuracy is both a physical and cognitive-motor skill, but greater performance gains may occur when interventions are task-representative and require athletes to coordinate perception and movement during actual practice conditions.

LIMITATIONS OF THE STUDY

Several limitations should be considered when interpreting these findings. First, the study used a quasi-experimental design with intact, non-randomly assigned groups, and the two groups were not equivalent at baseline—the PMIT group began at a lower batting-accuracy level (M = 54.14) than the Imagery Training group (M = 60.63). Although ANCOVA statistically adjusted for pretest differences, the lower starting point of the PMIT group leaves open the possibility that part of its larger adjusted gain reflects regression to the mean or a ceiling effect in the higher-starting group rather than a pure intervention advantage. Second, the sample was limited to 70 male Grade 9 student-athletes from a single school, which constrains generalizability to other ages, sexes, skill levels, and settings. Third, the six-week intervention period was relatively short, so the durability of the improvements is unknown. Fourth, batting accuracy was assessed with a single instrument, and some performance observations were made by the researcher, which may introduce measurement and observer effects. Future research should employ randomized assignment, larger and more diverse samples, longer intervention and follow-up periods, and, where possible, blinded assessment to confirm and extend these results.

CONCLUSION

This study examined the effectiveness of Perceptual–Motor Integration Training (PMIT) and Imagery Training in enhancing baseball batting accuracy among Grade 9 student-athletes. Using a quasi-experimental pretest–posttest design, the study found that participants in both groups were generally within the Competent level before and after the interventions. Both groups showed significant pretest–posttest improvements; however, the PMIT group demonstrated a larger performance gain and stronger effect size than the Imagery Training group.

Based on the findings, the study concludes that both PMIT and Imagery Training can contribute to improved baseball batting accuracy, but PMIT is more effective when pretest performance is controlled. The stronger effect of PMIT supports the Perception–Action Coupling Theory, as batting accuracy improved more when athletes practiced responding to visual cues through coordinated movement. Imagery Training also supported batting performance by enhancing focus, mental rehearsal, and consistency, consistent with Psychoneuromuscular Theory.

It is recommended that baseball coaches, sports trainers, and Physical Education teachers integrate PMIT drills such as reaction-based ball activities, evasive-response drills, and shuttle-target striking tasks into regular training sessions to improve visual tracking, reaction time, coordination, and batting accuracy. Imagery training, including progressive muscle relaxation and visualization, may also be used as a complementary strategy to strengthen confidence, concentration, and performance consistency. Future researchers may replicate the study with larger samples, different age groups, longer intervention periods, and other sports to further examine the effects of perceptual–motor and imagery-based training on athletic performance.

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AI Declaration: *This study utilized artificial intelligence tools to assist in preparing this article. Specifically, AI assistance was used to help condense the full thesis manuscript into a reduced journal-article format and to refine language quality, clarity, and tone, with human supervision and editing throughout. All statistical results were checked against the author's thesis and its JASP output, and the author carefully reviewed and edited all outputs to maintain academic rigor and integrity.*

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