Indonesian Journal for Physical Education and Sport
https://journal.unnes.ac.id/sju/index.php/inapes
e-ISSN 2774-4434 | inapes@mail.unnes.ac.id
https://doi.org/10.15294/inapes.xxxx

Development and Effectiveness of a Reaction Light-Based Eye-Foot Coordination Training Module in Badminton Athletes

Krisna Anggana[a], Adi S[b]
[ab]Universitas Negeri Semarang, Indonesia

Correspondence: krisnaanggana7@students.unnes.ac.id
Received: 15 April 2026 **Accepted:** 28 April 2026 **Published:** 13 May 2026

Abstract
Badminton is a fast-paced sport requiring athletes to integrate visual perception with rapid and precise footwork to respond effectively to shuttlecock movements. However, training practices remain largely conventional, with limited visual stimulus variation that may hinder optimal coordination development. Therefore, improving eye-foot coordination and reaction speed is essential to enhance performance in real-game situations. This study aimed to determine the effectiveness of a reaction light-based eye-foot coordination training module in badminton athletes. A mixed methods approach with an embedded design and One Group Pretest-Posttest Design was employed. The sample consisted of 12 athletes selected through total sampling. Training was conducted through structured sessions using reaction light as a visual stimulus. Data were collected using the Badminton Reactive Footwork Speed Test (BRFST) and a questionnaire. Data analysis included normality, homogeneity, and paired sample t-test ($\alpha = 0.05$). The results showed a significant decrease in mean scores from pretest (30.57) to posttest (23.15) ($t = 12.006$; $p < 0.05$), indicating improved footwork speed, as lower time scores reflect faster performance. It can be concluded that the training module is effective in improving eye-foot coordination in badminton athletes.

Keywords: eye-foot coordination; reaction light; badminton; training modul

1. Introduction

Badminton is a high-speed sport characterized by dynamic gameplay that requires athletes to respond quickly to shuttlecock trajectories through rapid and precise footwork (Darisman et al., 2025). To perform effectively, athletes must possess integrated physical and technical abilities that support efficient movement on the court (Pramudya & Adi, 2026). The ability to reach optimal positions before executing strokes is essential in maintaining performance during competition. In the context of achievement sport, this capability is developed through structured, systematic, and continuous training processes (Azzahra & Hafidz, 2025; Jiddan & Adi, 2025). Optimal badminton performance is closely associated with efficient footwork and the integration of physical and technical abilities developed through structured training.

Physical fitness plays an important role in supporting footwork performance and movement efficiency (Mahapatra & Pradhan, 2025). In addition, coordination between the visual system and lower limb movement, known as eye-foot coordination, is a key factor in badminton performance, enabling athletes to process visual information and execute accurate movement responses (Fauzan et al., 2026; Ardhi & Adi, 2025). This ability allows athletes to process visual information, estimate shuttlecock trajectory, and execute appropriate footwork movements accurately and efficiently.

Advances in sports science have introduced innovative training methods using visual stimulus-based technology such as reaction light, which provides random visual cues that require quick motor responses (Steff & Bădău, 2024; Adi et al., 2023). Previous studies have shown that this type of training can improve reaction speed, coordination, and decision-making in sports (Mashari & Adi, 2021). These findings indicate that integrating visual stimuli into training programs has strong potential to enhance athletes' performance.

However, most existing studies primarily focus on analyzing visuomotor abilities or utilizing specific technological systems, rather than developing structured and practical training modules that can be directly implemented in daily training programs (Azzaria et al., 2023). Previous studies also tend to emphasize the relationship between visual coordination and performance without developing applicable training models for athletes (Adi & Soegiyanto, 2023). In addition, training practices in the field are still predominantly conventional, with limited variation in visual stimuli that may hinder the optimal development of athletes' reaction and coordination abilities (Bhakti et al., 2024). Therefore, it can be concluded that there is a need for the development of a structured, practical, and technology-based training module that integrates visual stimuli with coordinated movement patterns to improve badminton athletes' performance.

In practice, training at PB ALTREC badminton club still relies on conventional methods such as cone drills and manual reaction exercises guided by coaches (Lengga et al., 2020). Although these methods can improve basic coordination abilities, the limited variation of visual stimuli may restrict the development of athletes' reaction and coordination capabilities (Febrianto et al., 2026; Yuwono et al., 2025). This condition highlights the urgency of developing more innovative, structured, and effective training approaches that better simulate real-game situations.

Therefore, this study aims to develop and evaluate the effectiveness of an eye-foot coordination training module based on reaction light in badminton athletes (Adi et al., 2021). The novelty of this study lies in the development of a structured, practical, and technology-based training module that integrates visual stimuli with coordinated footwork, providing a more applicable and effective approach for improving athletes' coordination and overall performance

2. Method

This study employed a Research and Development (R&D) approach adapted from the Borg and Gall model to develop and evaluate a reaction light-based eye-foot coordination training module. The research procedure consisted of several stages: (1) needs analysis, (2) product design, (3) expert validation, (4) product revision, (5) product trial, and (6) final product development. The study was conducted at PB ALTREC badminton club, Semarang, involving 12 athletes selected using a total sampling technique (Indarwan & Adi, 2025). The developed product was validated by experts using a Likert-scale questionnaire covering aspects of content feasibility, presentation, and training suitability. The validation data were analyzed descriptively to determine the level of product validity.

The product trial stage was conducted to evaluate the effectiveness of the developed training module as part of the R&D process. A pretest-posttest approach was used to measure athletes' performance before and after the implementation of the training program (Riaz & Shamim, 2026).

The training intervention was carried out over 6 sessions, with each session lasting approximately 120 minutes, using reaction light as a visual stimulus tool.

The training program consisted of structured exercises aimed at improving eye-foot coordination, reaction speed, agility, and balance. The activities included directional change drills using four reaction lights, swap leg drills over a line, reactive wall sit foot taps, single-leg balance exercises, six-point shadow footwork, ladder drills, four-point reaction drills using a tennis ball, reaction and shuttlecock hitting drills, plyometric reaction exercises, reactive jumps from a kneeling position, and resistance band-based reaction training. These exercises were progressively implemented to simulate game-like situations and enhance athletes' perceptual-motor responses.

Data were collected using the Badminton Reactive Footwork Speed Test (BRFST) to measure eye-foot coordination ability and a questionnaire based on the Training Evaluation and Learning Acceptance Scale (TERLAS) to evaluate athletes' acceptance of the training module, supported by documentation of the training process. Data were analyzed using normality testing (Shapiro-Wilk), homogeneity testing (Levene's test), and a paired sample t-test with a significance level of 0.05. The final product of this study is a validated, structured, and practically applicable training module that can be directly implemented in badminton training practice.

3. Result

The product developed in this study is a reaction light-based eye-foot coordination training module specifically designed for badminton athletes. The module combines structured training principles with dynamic visual stimuli to enhance coordination, reaction speed, and movement accuracy of the lower limbs. It consists of several systematically organized training variations, each equipped with clear implementation procedures, training objectives, and evaluation indicators, making it practical for application in real training environments. The visual representation of the developed module is shown in Figure 1.

Figure 1. Cover of the reaction light-based eye-foot coordination training module

The results of this study present the outcomes of statistical analyses conducted to evaluate the effectiveness of the reaction light-based training module on athletes' eye-foot coordination ability.

The findings are organized into normality testing, homogeneity testing, hypothesis testing, and instrument testing.

Normality test

The normality test was conducted using the Shapiro-Wilk test to determine whether the data were normally distributed prior to further statistical analysis. The results are presented in Table 1.

Table 1. Normality test results

Variable	Test Method	Statistic	df	Sig.	Interpretation
Selisih Pretest-Posttest	Shapiro-Wilk	0.952	12	0.661	Normally distributed

The normality test using the Shapiro-Wilk method showed a significance value of 0.661 (> 0.05), indicating that the data were normally distributed. This result confirms that parametric statistical analysis can be applied in subsequent testing.

Homogenity test

The homogeneity of variance test in this study was conducted using the Levene's test (Test of Homogeneity of Variance) to determine the similarity of variances among the analyzed data.

Table 2. Homogenity test results

		Levene Statistic	df1	df2
Kuesioner dan Tes Fisik	Based on Mean	12,137	1	22
	Based on Median	11,595	1	22
	Based on Median an witgh adjusted df	11,595	1	11,003

Based on the test results, a significance value of 0.002 was obtained for the Based on Mean criterion. This value is lower than the 0.05 significance level (0.002 < 0.05), thus concluding that the data variance is not homogeneous.

Therefore, the assumption of homogeneity of variance in this study was not met. However, given that the data used were paired (pretest and posttest on the same subject), further analysis continued using the appropriate statistical test, the Paired Sample t-test.

Hypothesis testing

Hypothesis testing in this study was conducted using a paired sample t-test to determine differences between pretest and posttest results.

Tabel 3. Hypothesis test results

Paired Differences									
					95% Confidence interval of the difference				
		Mean	**Std. Deviation**	**Std. Error Mean**	**Lower**	**Upper**	**t**	**df**	**Std. Deviation**
Pair 1	Pretest-Posttest	7,42000	2,14095	,61804	6,05970	8,78030	12,006	11	2,14095

The paired sample t-test showed a significant difference between pretest and posttest scores (t = 12.006, df = 11, p = 0.000 < 0.05). The mean difference was 7.42, with a 95% confidence interval ranging from 6.06 to 8.78. This The paired sample t-test showed a significant difference between pretest and posttest scores (t = 12.006, df = 11, p < 0.05). The mean difference was 7.42, with a 95% confidence interval ranging from 6.06 to 8.78. The average score decreased from 30.57 (pretest) to 23.15 (posttest), indicating an improvement in footwork speed, as lower time scores in the BRFST reflect faster movement performance. This finding demonstrates that the reaction light-based training module effectively enhances athletes' eye-foot coordination.

Validity test

The validity test is carried out to determine the extent to which the statement items in the instrument are able to measure the construct to be studied. The validity test in this study uses the Pearson Product Moment correlation technique, which is by correlating the score of each statement item with the total score.

Tabel 4. Validity test results

Criteria	Result	Interpretation
r count > r table	All items fulfilled	Valid
Sig. < 0.05	All items fulfilled	Valid

The results showed that all questionnaire items had correlation values higher than the r-table value (0.576) and significance values below 0.05. This indicates that all items were valid and appropriate for measuring the research variables.

Reability test

The reliability test was conducted to determine the consistency of the questionnaire instrument in measuring the research variables. Reliability was assessed using Cronbach's Alpha coefficient. An instrument is considered reliable if the Cronbach's Alpha value exceeds 0.70, indicating acceptable internal consistency.

Table 5. Reliability test results

Instrument	Number of items	Cronbach's Alpha	Interpretation
Selisih Pretest - Posttest	Shapiro-Wilk	0.857	Normally distributed

The results showed that the questionnaire obtained a Cronbach's Alpha value of 0.857, which indicates high reliability. This means that the instrument has good internal consistency and is suitable for use in data collection.

4. Discussion

The results of this study indicate that the reaction light-based training module significantly improves athletes' eye-foot coordination ability. This improvement is evidenced by the decrease in BRFST scores from pretest to posttest, which indicates faster footwork performance, as lower time scores reflect better speed and coordination. This finding answers the research objective, confirming that the implemented training intervention contributes positively to athletes' performance.

From a scientific perspective, the improvement in coordination ability can be explained by the integration of visual stimuli and motor responses during training (Artazila & S, 2024). Reaction light training provides dynamic and unpredictable visual cues, requiring athletes to process information quickly and respond appropriately. This process enhances perceptual-motor integration and neuromuscular coordination. Previous research shows that visual training can improve athletes' ability to process visual information and respond more efficiently, leading to better performance outcomes.

Furthermore, vision plays a central role in guiding movement and controlling performance in sports (Laby & Appelbaum, 2021). Studies have demonstrated that improvements in visual function are closely related to enhanced athletic performance, as visual input is essential for decision-making and movement execution (Widhiya et al., 2023). This supports the findings of this study, where athletes showed improved coordination after undergoing visual stimulus-based training.

From a neuromotor perspective, visual training stimulates adaptations in the nervous system, particularly in processing speed and coordination efficiency (Miswangga et al., 2025). Training programs that involve repeated exposure to visual stimuli can improve visuomotor abilities and reaction time, which are critical components in fast-paced sports such as badminton (Adi, Soenyoto, et al., 2023). Empirical evidence shows that sports vision training significantly enhances visuomotor skills and reaction performance in athletes.

In addition, the effectiveness of this training approach can be explained by the concept of perception-action coupling, where athletes continuously adjust their movements based on visual input (Cahyati et al., 2025). Training methods that incorporate reactive and game-like stimuli are more effective in improving agility and coordination compared to conventional drills (Zhao et al., 2026). Recent research also highlights that agility and reaction performance are strongly influenced by perceptual and cognitive training components.

The findings of this study are consistent with previous research indicating that visual stimulus-based training improves reaction ability and movement efficiency. However, this study extends previous findings by emphasizing the development of a structured and practical training module that can be directly applied in training sessions (Adi et al., 2025). Unlike many previous studies

that focus on theoretical analysis or isolated training tools, this study integrates technology into a comprehensive and applicable training model.

The novelty of this study lies in the development of a structured, practical, and technology-based training module that integrates visual stimuli with coordinated footwork patterns. This approach provides a more applicable solution for coaches and contributes to both theoretical and practical aspects of sports training. The use of technology also allows for more interactive and varied training, which better simulates real-game conditions.

Despite the positive findings, this study has several limitations (Usman & Adi, 2025). The sample size was relatively small and limited to athletes from a single badminton club, which may affect the generalizability of the results. Future research is recommended to involve larger samples, different levels of athletes, and comparative training methods to further validate the effectiveness of the developed module. Overall, this study confirms that the reaction light-based training module is an effective and innovative approach to improving eye-foot coordination in badminton athletes. The findings support the hypothesis that integrating visual stimuli into structured training programs can significantly enhance athletes' performance.

5. Conclusion and Recommendation

This study demonstrates that the development of a reaction light-based eye-foot coordination training module provides an effective and innovative approach to improving badminton athletes' performance. The findings contribute to the advancement of sports training methods by integrating visual stimulus technology with structured movement patterns, offering a more practical and applicable model compared to conventional training approaches (Apriyanto & Adi, 2022). This study strengthens the understanding that coordination training is more effective when it involves perceptual-motor integration rather than relying solely on repetitive physical drills. In practical terms, the developed training module can be utilized by coaches as an alternative training strategy to enhance athletes' reaction ability, movement efficiency, and adaptability in real-game situations. Furthermore, this study opens opportunities for future research to explore the application of similar technology-based training models in different sports, age groups, and performance levels, as well as to compare their effectiveness with other training methods in broader contexts.

Acknowledgement

The authors would like to express their sincere gratitude to the athletes and coaches of PB ALTREC badminton club for their active participation and cooperation in this study. The authors also extend their deepest appreciation to Dr. Adi S, M. Pd., for his guidance, valuable suggestions, and continuous support throughout the research process. The authors would also like to express their gratitude to their parents for their endless support and encouragement. Special thanks are also given to Nadiya Munika Putri for her support and assistance during the completion of this study. In addition, the authors would like to thank all parties who have contributed both technically and morally to this research.

References

Ade Rahayu. (2025). Metode Penelitian dan Pengembangan (R&D) : Pengertian, Jenis dan

Tahapan. *DIAJAR: Jurnal Pendidikan Dan Pembelajaran*, *4*(3), 459–470. https://doi.org/10.54259/diajar.v4i3.5092

Adi, S., Arbanisa, W., & Winoto, A. (2023). Program Latihan Beban Pada Olahraga Bulutangkis: Sebuah Tinjauan Pustaka. *Citius: Jurnal Pendidikan Jasmani, Olahraga, Dan Kesehatan*, *3*(2), 146–154.

Adi, S., Da'i, M., & Cahyani, O. D. (2021). Level of Physical Activity and Mass Body Index of Students in the Pandemic Period. *Juara*, *6*(1), 30–38.

Adi, S., & Soegiyanto, K. S. (2023). Digital literacy of physical education teachers in the 5.0 era. *Sport TK: Revista Euroamericana de Ciencias Del Deporte*, *12*, 13.

Adi, S., Soenyoto, T., & Ramadhan, I. (2023). Latihan Kelentukan Terhadap Performa Olahraga: Sebuah Tinjauan Pustaka Sepak Bola, Futsal, Bulutangkis Dan Renang. *Bajra: Jurnal Keolahragaan*, *2*(2), 40–47.

Adi, S., Soenyoto, T., Yuwono, C., Ihsani, S. I., Utama, M. B. R., & Supriyono, S. (2025). Strengthening Evaluation of Physical Fitness, Health, and Movement Competency. *Jurnal Panjar: Pengabdian Bidang Pembelajaran*, *5*(1), 21–26.

Apriyanto, R., & Adi, S. (2022). Analisis Keterampilan Teknik Bermain Tenis Meja dalam Mewujudkan Konsep Kurikulum Merdeka Belajar. *Physical Activity Journal (PAJU)*, *4*(1), 87–98.

Artazila, S. Z. N., & S, A. (2024). Analysis of Badminton Techniques Smash Using a Biomechanical Approach: Systematic Literature Review. *Jurnal Moderasi Olahraga*, *4*(2 SE-Articles), 232–241. https://doi.org/10.53863/mor.v4i2.1474

Azzahra, S. F., & Hafidz, A. (2025). *JPO : Jurnal Prestasi Olahraga*. *8*, 1124–1131.

Azzaria, A. A., Oktafiya, A. D., Munir, M., & Adi, S. (2023). Pengukuran Latihan Push Up Dan Daya Ledak Otot Lengan Terhadap Hasil Smash Atlet Bola Volly. *Citius: Jurnal Pendidikan Jasmani, Olahraga, Dan Kesehatan*, *3*(1), 129–135.

Bhakti, Y. H., Rahayu, T., Kristiyanto, A., Azam, M., & Aliriad, H. (2024). Analyzing Handball Techniques Using A Biomechanical Approach: A Systematic Literature Review. *Physical Education Theory and Methodology*, *24*(2), 338–343.

Cahyati, W. H., Adi, S., Armini, L. N., & Mara, U. T. (2025). *Developing the Indonesian Student Health Index as an Instrument for Monitoring and Evaluating Student Health in Physical Education*. *7989*, 1062–1069. https://doi.org/10.17309/tmfv.2025.5.05

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Darisman, E. K., Utomo, G. M., & Rosmi, Y. F. (2025). *Improving Badminton Technical and Tactical Skills through Structured and Targeted Training Peningkatan Kemampuan Teknik dan Taktik Bulutangkis melalui Pelatihan yang Terstruktur dan Terarah*. *3*(1), 207–213.

Fauzan, A. T., Adi, S., Jasmani, P., Keolahragaan, F. I., & Negeri, U. (2026). *Journal of Physical Education , Sport , Health and Recreations*. *15*(1), 86–94.

Febrianto, R. A., Adi, S., Jasmani, P., Keolahragaan, F. I., & Negeri, U. (2026). *Journal of Physical Education , Sport , Health and Recreations*. *15*(1), 180–186.

Indarwan, R. T., & Adi, S. (2025). *Analysis of Endurance Training in Volleyball : A Systematic Literature Review*. *6*(2013), 295–305.

Jiddan, F., & Adi, S. (2025). *Indonesian Journal for Physical Education and Sport Analysis Of Plyometric Training In Basketball : Systematic Literatur Review*. *6*(1), 165–173.

Laby, D. M., & Appelbaum, L. G. (2021). Vision and on-field performance: a critical review of visual assessment and training studies with athletes. *Optometry and Vision Science*, *98*(7), 723–731.

Lengga, S. W., Adi, S., & Fadhli, N. R. (2020). Metode latihan drill untuk meningkatkan keterampilan backhand overhead clear pada atlet bulutangkis usia 8-12 tahun. *Indonesia Performance Journal*, *4*(2), 20–30.

Mahapatra, C., & Pradhan, K. C. (2025). Correlation between racquet conversion speed with hand–eye coordination and reaction in amateur badminton players—an observational study. *Bulletin of Faculty of Physical Therapy*, *30*(1), 17. https://doi.org/10.1186/s43161-025-00281-3

Mashari, M., & Adi, S. (2021). Improving learning outcomes of physical education using multimedia technology in 4.0 Era. *Acitya: Journal of Teaching and Education*, *3*(1), 27–33.

Miswangga, E., Agata, B., & Adi, S. (2025). *Bridging the Gap in Physical Literacy : Differences in Competency , Motivation , and Knowledge Between Grades 5 and 6*. *6*, 379–393.

N, M. A. D., & Adi, S. (2025). *Agility Training For Futsal Players : A Systematic Literature Review*. *17*(2), 1830–1841.

Nuraryati, A. D. (2025). *Physical Literacy Development of Elementary Students in Physical Education Classes*. *6*, 422–432.

Pramudya, A., & Adi, S. (2026). Efikasi Diri Dan Kesiapan Berolahraga Siswa Sekolah Dasar: Tinjauan Terhadap Respon Denyut Nadi dalam Pembelajaran Pendidikan Jasmani. *Jurnal MensSana*, *11*(1 SE-Articles). https://doi.org/10.24036/MensSana.110126.02

Riaz, N., & Shamim, A. (2026). *Synergizing Eye Coordination and Agility in Mastering Badminton Skills*. https://doi.org/10.55737/trt/v-i.201

Steff, N., & Bădău, D. (2024). *A pilot study regarding the development of reaction time through the implementation of Fitlight technology in the training of basketball players aged 13-14 years*. *25*(1), 17–22.

Usman, M. T., & Adi, S. (2025). Analysis of Squat Training In The Sport Of Football: Systematic Literature Review. *COMPETITOR: Jurnal Pendidikan Kepelatihan Olahraga*, *17*(1), 48–55.

Widhiya, A., Utomo, B., Wulandari, B., Wahyudi, A. N., Ngawi, M., & Footwork, L. (2023). *Jurnal Kejaora : Jurnal Kesehatan Jasmani dan Olah Raga PENGARUH LATIHAN FOOTWORK TERHADAP KELINCAHAN DAN KECEPATAN PADA ATLET BULU TANGKIS PB . KUSUMA NGAWI*. *8*(November), 207–215.

Yuwono, C., Adi, S., Soenyoto, T., Ihsani, S. I., Utama, M. B. R., Aliriad, H., Anam, K., Cahyati, W. H., Andriana, L. M., & Appukutty, M. (2025). The Development and Educational Evaluation of a Smart IoT Relay Baton with Accelerometer Technology. *Physical Education Theory and Methodology*, *25*(6), 1389–1397.

Zhao, Z., Liu, Y., & Xu, K. (2026). Optimizing Agility Training in Team Sport Players-The Role of Perception- Action Coupling: A Systematic Review with Multi-Level Meta-Analysis. *Journalof Sports Science & Medicine*, *25*(1), 84–111. https://doi.org/10.52082/jssm.2026.84

Zulhendri, Z., & Sukoco, P. (2021). *ketepatan drive pada ekstrakurikuler bulutangkis The effects of exercise and coordination of precision eye-hand drive in extracurricular badminton*. *2*(1), 1–13.