COMPETITOR:
JURNAL PENDIDIKAN KEPELATIHAN OLAHRAGA
e-ISSN: 2657-0734 & p-ISSN: 2085-5389 ‖ Volume 18, Number 1, 2026 ‖ P.0098-0111

Reaction and Response Speed Tests in Racket Sports: Instrumentation, Reliability, and Learning Applications

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ABSTRACT

This study aims to critically examine the instrumentation, reliability, and learning applications of reaction and response speed tests in racket sports, with a particular focus on the Field Reaction Speed Test (TKRL/FRT) as a practical and contextually relevant assessment tool. Reaction speed is a fundamental component of athletic performance in racket sports, as it integrates perceptual, cognitive, and motor processes required to respond effectively to rapid stimuli such as sound, light, and touch. This research employed a qualitative approach using a phenomenological case study design to explore how athletes and coaches perceive, experience, and utilize reaction speed test instruments within real training environments. Data were collected through in-depth interviews, participatory observations, and training documentation involving athletes and coaches actively engaged in racket sports training programs. A participatory data collection strategy was applied to capture rich, contextualized insights related to instrument acceptance, perceived reliability, motivational effects, and practical use in learning and performance development. Data were analyzed using thematic analysis with open coding, enabling the identification of key themes related to instrument credibility, training adaptation, feedback utilization, and athlete engagement. The findings indicate that systematic application of TKRL-based assessment provides timely, objective feedback that supports performance improvement by helping athletes recognize strengths and weaknesses more clearly. Moreover, the perceived validity and reliability of the instrument enhance athlete motivation and facilitate more adaptive, personalized training strategies. Beyond performance enhancement, the integration of reaction speed assessment into training contributes to injury risk reduction by improving movement anticipation and control. Overall, this study underscores the importance of embedding valid and reliable reaction speed assessment instruments into the learning and training processes of racket sports to sustainably optimize athlete potential and competitiveness.

ARTICLE HISTORY
Received: 2025/12/08
Accepted: 2025/12/24
Published: 2026/02/03

KEYWORDS
Reaction speed;
Response speed;
Racket sports;
Field Reaction Speed Test;
Learning application.

AUTHORS' CONTRIBUTION
A. Conception and design of the study;
B. Acquisition of data;
C. Analysis and interpretation of data;
D. Manuscript preparation;
E. Obtaining funding

Cites this Article : Ridwan, Andi; Fadila, Nur; Musidi, Nurul Muthmainna; Iman, Sitti Linda Nur; Ania, L.M Safaat Adicandra. (2026). Reaction and Response Speed Tests in Racket Sports: Instrumentation, Reliability, and Learning Applications. **Competitor: Jurnal Pendidikan Kepelatihan Olahraga**. 18 (1), p.0098-0111

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INTRODUCTION

In the increasingly competitive and dynamic context of modern sports, reaction speed is a crucial component that directly impacts performance, technical effectiveness, and athlete safety. Reaction speed is defined as an individual's ability to respond to external stimuli whether visual, auditory, or tactile quickly, precisely, and in a coordinated manner (Fauzi et al., 2021). In competitive sports, particularly high-tempo sports, an athlete's success is often determined by how quickly and accurately a motor response is generated after receiving a stimulus.

In racket sports such as badminton, tennis, and table tennis, athletes are faced with extremely high ball or shuttlecock speeds, unpredictable variations in direction of movement, and the pressure of making decisions in a very short time. These conditions demand optimal integration between sensory perception, cognitive processing, and motor execution (Ginting, 2024). Athletes with low reaction speed tend to respond late, lose momentum, and are at risk of technical errors that can lead to decreased performance or injury.

In addition to impacting performance, reaction speed also has significant implications for athlete safety. Slow responses to game stimuli, such as the direction of the ball or the movement of an opponent, can increase the risk of impact, misalignment, and musculoskeletal injuries (Mylsidayu, 2022). Therefore, reaction speed is no longer viewed as an additional attribute, but rather as an essential component of an athlete's physical condition profile.

The problem that arises is that although reaction speed is recognized as a crucial factor, its measurement and evaluation practices on the field are often limited to instruments that are not specific to the demands of racket sports. Many reaction tests are laboratory-based, lack contextualization, or do not represent real-life match conditions, making the results less applicable to coaches in developing targeted training programs.

Recent research shows that reaction speed is closely related to an athlete's motor coordination, agility, and tactical adaptability. Sugesthi (2018) emphasized that a quick response to stimuli allows the body to make efficient adjustments to posture and movement, thereby improving the quality of motor coordination. This finding is supported by Yakin et al. (2025) stated that quick reactions reflect the efficiency of nerve signal transmission from the central nervous system to the muscles, resulting in more controlled and precise movements.

In games and racket sports, reaction speed also directly contributes to agility and the ability to change direction quickly without losing balance (Larasati et al., 2025). Athletes with short reaction times are able to respond adaptively to changing game situations, anticipate their opponents' strategies, and optimally capitalize on opportunities. Empirical studies also show that training focused on visual and auditory stimulation, such as vision training and auditory reaction drills, effectively improves athletes' response speed and accuracy (Aziz & Jahrir, 2024; Sunaryo, 2023).

As the need for field-based performance evaluation increases, various reaction speed measurement instruments have been developed. One approach that has received

considerable attention is the Field Reaction Speed Test (FRT), a test that combines an auditory stimulus with a short-distance running response as a form of motor response (Rasna, 2019). This approach is considered more ecological because it approximates real-world competition situations, where athletes must process stimuli and move simultaneously.

Research by Nasrulloh et al. (2021) and Henjilito and Pardilla (2024) shows that the FRT has good validity and reliability across various age groups and fitness levels. This instrument not only measures cognitive reaction speed but also integrates it with physical abilities, providing a more comprehensive picture of an athlete's readiness. With these characteristics, the FRT is seen as a potential evaluation tool for developing court-based racket sports performance.

Although numerous studies have confirmed the importance of reaction speed and developed measurement instruments for it, several significant research gaps remain. First, most research on reaction speed focuses on conceptual relationships with performance, while empirical studies examining the suitability of the test context to the specific demands of racket sports are limited (Bhakti et al., 2024).

Second, although the FRT and similar tests have been reported to be valid and reliable, few studies have comprehensively assessed the reliability of these instruments as a basis for training decisions, particularly in the context of developing reaction training programs and preventing injury (Adib et al., 2023; Arbeni et al., 2025). Some studies still view reaction tests as merely a measurement tool, rather than an integral part of evaluation systems and training design.

Third, there is limited literature integrating reaction speed measurement results with practical implications for simultaneously improving performance and reducing injury risk, particularly in racket sports characterized by fast and complex stimuli. Therefore, studies are needed that not only assess the validity and reliability of the instruments but also confirm their relevance in the context of applicable and sustainable athlete development.

Based on the aforementioned research problems and gaps, this study aims to: (1) analyze the role of reaction speed in the success of athlete performance, specifically in racket sports; (2) evaluate the effectiveness of the Field Reaction Speed Test (FRT) as a contextual, practical, and relevant reaction speed measurement instrument for competition requirements; and (3) examine the validity and reliability of the FRT as a basis for evaluating and developing training programs oriented toward improving performance and preventing injury.

The novelty of this research lies in its integrative approach, which positions the FRT not merely as a measurement tool but as a strategic instrument in the development system of racket sports athletes, linking reaction measurement, training design, and performance evaluation on an ongoing basis. By combining conceptual and empirical perspectives, this research is expected to make a significant contribution to the development of sports coaching science, particularly in providing a valid, reliable, and applicable reaction speed evaluation method in the field.

METHODS

This research employed a qualitative approach with a phenomenological case study design, aiming to explore in-depth the use of reaction speed and response testing instruments in racket sports. A qualitative approach was chosen because it allows researchers to comprehensively understand how athletes and coaches interpret, experience, and apply reaction speed testing instruments in the context of training, performance evaluation, and sports learning (Hadi, 2021; Creswell & Poth, 2018). The case study was used to explore contextual dynamics in the field, including the interactions between athletes, coaches, and the testing instruments, as well as the implications of test results for training strategies and coaching decision-making (Yin, 2018).

A phenomenological approach was applied to capture the subjective experiences and individual perceptions of reaction speed and response phenomena in racket sports. Through this approach, the research focused on understanding the meanings athletes and coaches construct regarding instrument reliability, stimulus relevance (auditory and visual), and the usefulness of test results in improving performance and the efficiency of motor learning (La Kahija, 2017; Kurniyadi, 2025).

The primary data source for this study came from in-depth interviews with racquet sports athletes and coaches who actively use reaction speed and response testing instruments in their training programs. The interviews focused on participants' perceptions of the accuracy, consistency, and usefulness of the test results in supporting athlete performance development (Nasrulloh et al., 2021; Bhakti et al., 2024). Furthermore, participant observation was conducted during the testing process and training sessions to document athletes' responses to stimuli, instrument use, and training adaptations based on test results (Henjilito & Pardilla, 2024). Documentation in the form of training logs, reaction measurement results, and instrument manuals served as supporting data to strengthen the context of the empirical findings.

Data collection was conducted in a phased and participatory manner, allowing researchers to build trusting relationships with participants and obtain rich, reflective data. This process involved repeated interviews, ongoing observation, and simultaneous document collection, allowing for reflection and adjustments to the research focus throughout the process (Handoko et al., 2024; Guest et al., 2019).

Data analysis was conducted using thematic analysis with open coding techniques, where qualitative data from interviews, observations, and documentation were organized into meaningful units to identify key themes. Themes analyzed included perceptions of instrument reliability, test effectiveness in a training context, the impact of test results on athlete motivation, and the instrument's role in learning and developing performance in racket sports (Braun & Clarke, 2021).

To ensure data validity, this study employed several validation strategies, including source and method triangulation, member checking, and thick description. Triangulation was conducted by comparing data from interviews, observations, and documentation to ensure consistency of information (Arbeni et al., 2025). Member checking was used to confirm the researcher's interpretations aligned with the participants' experiences,

while thick description provided rich context, increasing the credibility and transferability of the findings. With these procedures, the research results are expected to be valid, qualitatively reliable, and relevant as a basis for developing instruments and learning applications for reaction speed in racket sports.

RESULTS AND DISCUSSION

Result

Reaction speed ability affects an athlete's success in sports, especially racket sports which require a quick response to sound, light or touch stimuli.

Reaction speed has a significant impact on an athlete's success in racket sports, which rely heavily on rapid responses to stimuli such as sound, light, or touch. In-depth interviews with athletes and coaches revealed that reaction speed allows athletes to make decisions and take action quickly when facing a fast-moving ball. Athletes who are able to respond effectively to these stimuli have a greater chance of anticipating their opponent's movements and developing appropriate game strategies. This is a critical aspect of performance, especially in sports such as tennis, badminton, and table tennis, where the dynamics of the game are very fast and demand precise movements. Furthermore, direct observations during training sessions indicate that athletes with good reaction speed can manage position shifts and changes of direction more efficiently, thereby reducing the time needed to execute shots or avoid opponent attacks. However, coaches also identified that reaction speed must be balanced with precision and movement control to avoid errors or injuries. This is in line with research by Cahyadi et al. (2025) that the use of the Field Reaction Speed Test (TKRL) as a measurement instrument helps determine athlete readiness in real time and provides objective data that encourages athletes to systematically improve their responses.

In a phased data collection using a participatory approach, athletes also revealed various challenges they experienced, including difficulties in integrating reaction speed into complex game strategies and the mental pressure of competition. Training strategies developed based on test results allow for more personalized and adaptive sports learning, tailored to the athlete's physical and psychological conditions. In a study by Lahinda, J., & Zainuddin, F. (2025), themes emerging from thematic analysis showed that training motivation related to reaction speed was strongly influenced by the perception of training success and the acceptance of the instrument as a credible tool for performance evaluation. Furthermore, documentation of training records and reaction speed measurement results confirmed the finding that structured training combining visual and auditory stimuli can significantly improve athlete performance. This is in line with research by Alsaudi (2024) that coaches use this data not only for monitoring but also as a basis for adjusting training techniques and intensity, creating continuous feedback that is essential for the development of athlete performance. The success of improving reaction speed is also inseparable from the role of coach supervision and psychological support provided during the training process.

Therefore, the validity and reliability of the data obtained from interviews, observations, and documentation were maintained through source triangulation, member checking, and the use of thick descriptions. This ensures that the interpretation of the research results truly reflects the experiences and views of the subjects, and has transferable value for application to the development of reaction speed training in other racket sports. Overall, the results of this qualitative study confirm that reaction speed ability is a key factor influencing athlete success, and effective measurement and learning through appropriate instruments is key to maximizing this potential in competitive sports.

The effectiveness of the Field Reaction Speed Test (TKRL) in measuring reaction speed and the reliability and validity of the instrument in the context of training and evaluating athlete performance.

The effectiveness of the Field Reaction Speed Test (FSR) in measuring reaction speed in racquet sports athletes is evident in its ability to reflect real-world situations on the field, namely responding to voice cues and executing short-distance sprints. In-depth interviews with athletes and coaches have shown that the FSR is a valid tool because it provides an accurate picture of athletes' physical and mental readiness to face competition stimuli. Using this instrument helps athletes and coaches obtain objective data that can be used as a reference in designing and evaluating more measurable and effective FSR training programs. The FSR not only measures reaction speed but also motivates athletes to continuously improve their performance (Rahmat et al., 2025). Participating athletes reported positive experiences with the test, as they could see the development of their responses through the measurement results. However, technical challenges were also encountered, requiring adjustments to the instrument and method for some individuals, particularly those with varying fitness levels. This indicates that while the instrument has proven reliable, its application must be personalized to achieve optimal results (Pratama & Utami, 2024).

Participatory and phased data collection enabled researchers to gather an in-depth picture of the experiences, challenges, and strategies used by athletes and coaches in applying the TKRL. Thematic analysis of interview and observation data yielded key themes: perceptions of instrument reliability, motivation for training, and application of test results in the learning process. These themes provide empirical evidence that the TKRL is effective as a reaction speed measurement tool, providing a basis for continuous improvement of training techniques and performance evaluation. The validity of the TKRL instrument was maintained through data triangulation, combining interviews, observations, and documentation. Member checking was conducted to ensure the interpretation of the results matched the participants' experiences. This validation approach ensured that the data obtained were reliable and relevant for use in developing and implementing reaction speed training. Furthermore, the use of rich descriptions enriched the context, enabling broad applicability of the research results and providing information transferable to other racket sports with similar needs.

Overall, the effectiveness of the Field Reaction Speed Test (FSR) in measuring reaction speed in racquet sports athletes confirms that the Field Reaction Speed Test

(FSR) is an effective, valid, and reliable instrument for measuring reaction speed in racquet sports athletes. This instrumentation not only assists in measurement but also serves as an important motivational and evaluation tool in sports learning applications. With the support of systematic thematic analysis techniques and rigorous data validation, the FSR makes a significant contribution to the development of athlete performance and the continuous improvement of the effectiveness of reaction speed training programs.

The application of test results and the development of reaction speed training can improve performance and reduce the risk of injury to athletes on the field.

The application of the results of the Field Reaction Speed Test (FSR) in the training of racket athletes plays a crucial role in improving overall performance. In-depth interviews with athletes and coaches revealed that the test results serve as an effective evaluation tool for objectively assessing each individual's reaction speed. This data helps coaches design training programs focused on strengthening reflexes and quick responses to dynamic match stimuli, significantly improving athletes' ability to anticipate and react to the ball or opponent's movements. Observations during training sessions indicate that using FSR results as feedback helps athletes understand their areas of strength and weakness. Athletes who receive test-based coaching tend to be more motivated to improve their response times through specific exercises, such as visual and auditory drills. Training strategies developed based on this data also help athletes optimize energy use and technique, resulting in more efficient movements with shorter reaction times, which directly contribute to improved performance on the field.

From documented training records and measurement results, coaches can also regularly monitor progress, modifying training intensity and methods according to each athlete's needs. The application of these test results allows for personalized and dynamic training adaptations, thus minimizing the risk of injury due to slow reactions or coordination errors. With improved reaction speed, athletes can avoid excessive or inappropriate movements that often cause injuries, especially those related to muscles and joints. This is in line with research by Wijayanto (2023) that thematic analysis of interview and observation data revealed key themes such as the reliability of the TKRL as an instrument, increased training motivation due to feedback from test results, and the practical application of test results in sports learning. This positive trend indicates that coaches and athletes highly appreciate the TKRL as a learning tool that not only measures but also guides the process of skill improvement. Thus, test results play a central role in optimizing the development of athlete potential in a systematic and targeted manner.

Therefore, the validity and reliability of the data obtained through source triangulation and member checking ensure that the research results are credible and widely applicable. The combination of interviews, observations, and documentation strengthens the credibility of the findings that the implementation of TKRL results has a direct and positive impact on athlete performance and reduced injury risk. Therefore, the use of TKRL in reaction speed training is an important strategy in the development of competitive and sustainable racket athletes.

Discussion

The findings of this study confirm that reaction and response speed are key determinants of athlete success in racket sports, particularly when faced with rapid and complex stimuli such as sound, light, and touch. In-depth interviews with athletes and coaches indicate that athletes with high reaction speed are able to make faster and more accurate decisions in dynamic game situations. These findings align with neurophysiological literature, which states that rapid reaction times reflect the efficiency of sensory-cognitive processing and neuromuscular transmission, which directly contribute to the quality of movement execution (Fauzi et al., 2021; Yakin et al., 2025; Schmidt et al., 2019).

Furthermore, reaction speed is not only related to movement speed but also to the ability to anticipate and make tactical decisions. Athletes in racket sports must read the direction of the ball, the opponent's position, and the game context in a very short time, making quick reactions fundamental to effective game strategies (Ginting, 2024; McRobert et al., 2016). Field observations show that athletes with good reactions have higher motor efficiency, particularly when changing position and direction, which results in faster execution times for shots or defensive responses. This reinforces the view that reaction speed is closely correlated with agility and motor coordination (Larasati et al., 2025; Sugesthi, 2018).

However, coaches emphasize that reaction speed must be balanced with precision and motor control. Fast but uncontrolled reactions actually increase the risk of technical errors and injury. This finding is consistent with studies confirming that the quality of motor responses is determined by the integration of speed, accuracy, and postural stability (Mylsidayu, 2022; Tan et al., 2025). Therefore, reaction speed training needs to be designed in a progressive and measurable manner, emphasizing not only speed but also precision and safety of movement.

In the context of evaluation, this study shows that the Field Reaction Speed Test (TKRL) is perceived as an effective, relevant, and credible instrument by both athletes and coaches. The TKRL is considered capable of representing real-world competition conditions because it combines auditory stimuli with motor responses in the form of sprints or rapid movements. This aligns with the findings of Rasna (2019), Nasrulloh et al. (2021), and Henjilito and Pardilla (2024), who emphasized that field-based tests have higher ecological validity than laboratory-based reaction tests. With these characteristics, the TKRL serves not only as a measuring tool but also as a basis for reflection and training planning.

Thematic analysis showed that positive perceptions of the TKRL significantly contributed to increased athlete training motivation. Athletes felt that data-based feedback from test results helped them objectively understand their strengths and weaknesses, resulting in more personalized and adaptive training. These findings support the theory of self-regulated learning in sport, which states that clear and measurable feedback increases intrinsic motivation and athlete engagement in the training process (Zimmerman, 2013; Bhakti et al., 2024). Training log documentation also

shows that training programs that systematically integrate visual and auditory stimuli are able to improve reaction time continuously, in line with research by Aziz and Jahrir (2024) and Sunaryo (2023).

From a safety perspective, improving reaction speed, coupled with supervision and psychological support, has been shown to help reduce the risk of injury due to delayed responses or coordination errors. These findings reinforce the view that reaction evaluation not only impacts performance but also plays a preventative role in sports injury management (Arbeni et al., 2025; Bahr & Krosshaug, 2015). In other words, implementing a valid and reliable instrument such as the TKRL allows coaches to control training load and movement complexity more safely.

The validity of this study's findings was strengthened through source triangulation, member checking, and the presentation of thick descriptions, ensuring that the resulting interpretations reflect the actual experiences of athletes and coaches. This enhances the transferability of the findings to other racket sports, such as table tennis or squash, which have similar stimulus characteristics. Overall, this discussion confirms that reaction speed is a fundamental component of racket sport performance, and that the TKRL is an effective strategic instrument not only for measurement but also for evaluation, motivation, and the development of data-driven training learning.

Integrating reaction speed test results into a systematic training program has been shown to optimize athlete performance while maintaining physical health. Therefore, this study emphasizes the importance of using valid and reliable evaluation instruments as part of a sustainable, adaptive, and long-term performance-oriented sports learning process amidst the increasingly high demands of racket sports competitions.

CONCLUSION

This research confirms that reaction speed is a key factor significantly influencing an athlete's success in racket sports, as it enables them to respond to rapid stimuli—such as sound, light, and touch—precisely and in a coordinated manner. Reaction speed not only represents physical capacity but also reflects cognitive processes, including the ability to anticipate, make decisions, and adjust game strategy. This is especially crucial in dynamic racket sports such as tennis, badminton, and table tennis, where short response times often determine the outcome of a match.

Empirically, the Field Reaction Speed Test (FRT/TKRL) has been proven to be a valid, reliable, and applicable instrument for measuring athlete reaction speed in a contextual manner. This instrument not only provides objective data on an athlete's physical and mental readiness but also serves as an evaluation and motivational tool that encourages systematic performance improvement. Applying test results to training programs allows coaches to develop more adaptive, personalized, and data-driven training strategies, thereby sustainably enhancing training effectiveness.

Furthermore, controlled improvements in reaction speed contribute to a reduced risk of injury, as athletes are able to avoid response delays and motor coordination errors.

With data validity maintained through source triangulation, member checking, and in-depth descriptions, this research's findings have strong credibility and transferability. Therefore, integrating a valid and reliable reaction speed assessment instrument into the training process is a strategic step to optimize athlete potential while maintaining physical health in the increasingly competitive racquet sport.

ACKNOWLEDGEMENTS

The authors express their deepest appreciation and gratitude to all parties who contributed directly or indirectly to the implementation and completion of this research. Special thanks are extended to the athletes and coaches in racket sports who actively, openly, and reflectively participated in the data collection process. Their contributions through in-depth interviews, training observations, and documentation of empirical experiences served as the primary foundation for developing a contextual understanding of the application of reaction speed and response tests in a real-world training environment.

The authors also extend their gratitude to colleagues and academics who provided critical input, scientific discussions, and methodological suggestions that enriched the quality of the analysis and interpretation of the research findings. Institutional support in the form of research facilities, access to scientific literature, and a conducive academic climate played a crucial role in ensuring the smooth and in-depth research process.

Furthermore, appreciation is extended to those involved in data validation and the reflection process, ensuring the credibility, validity, and strong practical relevance of the findings. It is hoped that the results of this research can provide a real contribution to the development of sports coaching science, especially in optimizing reaction speed evaluation instruments and their continuous application to improve the performance and safety of racket sports athletes.

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