



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

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### ABSTRACT

Reaction time and response speed are critical determinants of performance in racket sports because they influence athletes' ability to perceive stimuli, process information, make decisions, and execute motor actions efficiently. However, the rapid development of assessment technologies has created a need to evaluate the effectiveness, reliability, and educational applicability of various reaction-testing instruments. This study aimed to analyze reaction and response-speed assessment instruments used in racket sports, examine their reliability characteristics, and explore their applications in learning and coaching environments. This study employed a literature review approach by analyzing scientific articles published between 2015 and 2025 from Scopus, Web of Science, PubMed, ScienceDirect, Google Scholar, SINTA, and Garuda databases. A total of 148 articles were initially identified, with 25 studies meeting the inclusion criteria for final analysis. Data were synthesized based on instrument type, reliability indicators, sport context, and educational applications. The results revealed that technology-assisted instruments, including computerized reaction tests, FitLight systems, BlazePod devices, video-based assessments, and mobile applications, demonstrated superior reliability compared with conventional methods. Approximately 84% of the reviewed studies reported Intraclass Correlation Coefficients (ICC) above 0.80, indicating good-to-excellent reliability. FitLight and BlazePod systems exhibited the highest reliability ranges (ICC = 0.86–0.97). Furthermore, reaction-based assessments were found to enhance motor learning, decision-making ability, concentration, and athlete performance monitoring. In conclusion, modern reaction-testing instruments provide reliable, valid, and educationally valuable tools for performance assessment and learning development in racket sports. Their integration into coaching and physical education programs can support evidence-based athlete development and instructional practices.

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- Conception and design of the study;
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## INTRODUCTION

According to the information-processing theory, reaction time represents the interval between the presentation of a stimulus and the initiation of an appropriate motor



response, while response speed reflects the efficiency of executing the selected action after decision-making processes occur. In racket sports such as badminton, tennis, table tennis, and squash, athletes are required to perceive visual information, process environmental cues, make rapid decisions, and execute precise motor actions within fractions of a second. Consequently, reaction ability has become one of the primary determinants of competitive performance (Mann et al., 2019; Kittel et al., 2020).

Ecological dynamics theory further explains that successful performance in racket sports emerges from continuous interactions between athletes and their environment, requiring rapid adaptation to changing task constraints. Players must respond effectively to shuttlecock trajectories, ball spin, racket velocity, opponent positioning, and tactical variations (Davids et al., 2018). Therefore, superior reaction capacity is not merely a physiological attribute but also a perceptual-cognitive skill developed through systematic learning and training processes.

Recent studies indicate that elite racket sport athletes demonstrate significantly faster reaction times and response accuracy than novice players (Faber et al., 2019; Buszard et al., 2021). However, despite the importance of these variables, coaches and physical education practitioners still face challenges in selecting valid, reliable, and practical instruments for measuring reaction and response speed. Traditional tools such as ruler drop tests and manual stopwatch assessments often suffer from measurement bias and limited sensitivity (Horička et al., 2022). Meanwhile, technological developments have introduced computerized reaction systems, mobile applications, wearable sensors, and light-based testing devices, creating a need for comprehensive evaluation of their psychometric quality and educational applicability.

From a learning perspective, reaction assessments are increasingly utilized not only for talent identification but also for monitoring motor learning progress, evaluating training effectiveness, and designing individualized learning interventions in sports education. Nevertheless, evidence regarding the reliability and instructional applications of these instruments remains fragmented across different sports contexts.

Schmidt's Schema Theory posits that repeated exposure to stimuli strengthens motor programs and improves response efficiency through experience-based adaptations. Based on this theoretical framework, researchers have developed numerous reaction-testing instruments to quantify perceptual-motor performance in sport settings (Schmidt et al., 2019). Recent advancements include computerized simple reaction tests, choice reaction tests, FitLight systems, BlazePod technology, Dynavision devices, smartphone-based reaction applications, and sport-specific video simulation assessments (Giesche et al., 2020; Fortes et al., 2021). These instruments provide more accurate measurements than conventional methods because they reduce examiner bias and allow automated data collection.

Research in badminton demonstrated that visual reaction tests using light stimulus systems exhibit excellent test-retest reliability, with intraclass correlation coefficients exceeding 0.80 (Abdelmoula et al., 2021). Similar findings were reported in tennis and table tennis, where digital reaction assessments showed high sensitivity in differentiating

athletes according to skill level (Le Runigo et al., 2021; Kondrič et al., 2022). Perceptual-cognitive theory suggests that expert performers possess superior anticipation skills, enabling faster response initiation before complete stimulus information becomes available. Consequently, modern reaction assessments increasingly incorporate sport-specific scenarios, video-based decision-making tasks, and virtual reality simulations to capture authentic performance demands (Roca et al., 2020). Within educational contexts, reaction testing has also been integrated into physical education learning. Studies indicate that reaction-based activities enhance students' concentration, motor coordination, attention control, and decision-making capabilities (Pesce et al., 2021; Lubans et al., 2022). Furthermore, digital assessment tools provide immediate feedback, supporting formative evaluation and learner-centered instruction.

Despite substantial progress in reaction assessment technologies, several limitations remain. First, existing studies predominantly focus on elite athletes and high-performance environments, while evidence regarding educational applications in school and university settings remains limited (Fortes et al., 2021). Second, previous reviews generally examine reaction time as an isolated physiological variable without comprehensively discussing instrument validity, reliability, practicality, and pedagogical usefulness simultaneously (Horička et al., 2022). Consequently, practitioners often lack clear guidelines regarding instrument selection for both performance assessment and learning evaluation. Third, technological innovations such as mobile applications, wearable sensors, and light-based systems have expanded rapidly over the last decade, yet comparative evidence concerning their psychometric properties remains inconsistent. Some studies report excellent reliability, whereas others highlight issues related to calibration procedures, environmental influences, and user familiarity (Giesche et al., 2020; Kondrič et al., 2022). Fourth, literature specifically synthesizing reaction and response-speed assessment in racket sports remains scarce. Most investigations focus on a single sport discipline, limiting the transferability of findings across badminton, tennis, table tennis, and squash. As a result, a comprehensive understanding of assessment instruments suitable for racket sports learning and training has not been fully established.

Based on the identified gaps, this article aims to critically analyze reaction and response-speed testing instruments used in racket sports by examining their measurement characteristics, reliability evidence, and educational applications. The study seeks to identify the strengths and limitations of conventional and technology-based assessment tools while evaluating their suitability for athlete development and physical education learning. The novelty of this article lies in its integrated perspective combining three dimensions that are rarely discussed simultaneously: (1) measurement instruments for reaction and response speed, (2) psychometric evidence related to reliability and validity, and (3) pedagogical applications within sports learning environments. Unlike previous studies that focus primarily on performance evaluation, this review positions reaction assessment as both a performance-monitoring tool and a learning-support mechanism.

In conclusion, reaction time and response speed constitute fundamental performance determinants in racket sports due to their direct influence on perceptual-cognitive processing and motor execution. Although numerous assessment instruments have been developed during the past decade, comprehensive understanding regarding their reliability and educational applicability remains limited. Therefore, synthesizing contemporary evidence on reaction-testing instruments, psychometric quality, and learning applications is essential for supporting evidence-based coaching and physical education practices. This review is expected to provide practical guidance for coaches, teachers, researchers, and sports practitioners in selecting appropriate assessment tools while promoting more effective learning and athlete development processes.

## METHODS

This study employed a literature review design to systematically examine reaction tests and response-speed assessment instruments used in racket sports, focusing on their measurement characteristics, reliability, validity, and educational applications. The review was grounded in information-processing theory, which explains that reaction performance results from a sequence of perceptual, cognitive, and motor processes that transform environmental stimuli into purposeful actions. Furthermore, ecological dynamics theory emphasizes the interaction between athletes and task constraints, suggesting that reaction ability should be evaluated within sport-specific contexts that closely resemble competitive situations.

The review process followed established guidelines for evidence synthesis in sports science and physical education research. Scientific articles were identified through comprehensive searches in international and national databases, including Scopus, Web of Science, PubMed, ScienceDirect, Google Scholar, SINTA, and Garuda. The search strategy combined keywords such as "reaction time," "response speed," "racket sports," "badminton," "tennis," "table tennis," "measurement instrument," "reliability," "validity," "motor learning," and "sports education." The search was limited to publications from 2015 to 2025 to ensure contemporary relevance and technological applicability.

The inclusion criteria consisted of: (1) peer-reviewed journal articles; (2) studies investigating reaction-time or response-speed assessments in racket sports; (3) research reporting psychometric properties such as reliability, validity, sensitivity, or responsiveness; and (4) studies discussing learning, coaching, or educational applications of reaction assessment tools. Articles unrelated to sports performance, non-English publications without accessible full texts, conference abstracts, and duplicate records were excluded.

Data extraction focused on several key variables, including instrument type, participant characteristics, sport discipline, testing procedures, reliability coefficients, validity evidence, and educational implications. Consistent with measurement theory, particular attention was given to indicators of instrument quality, including intraclass correlation coefficients (ICC), test-retest reliability, standard error of measurement, and construct validity.

Empirical findings from previous studies were synthesized through thematic analysis. The analysis identified three major themes: conventional reaction-testing instruments, technology-assisted assessment systems, and pedagogical applications in sports learning environments. This analytical approach was selected because previous research has shown that technological innovations such as FitLight systems, BlazePod devices, mobile applications, and video-based decision-making assessments provide increasingly accurate measurements of perceptual-motor performance while simultaneously supporting athlete development and learning evaluation. Therefore, integrating theoretical foundations, empirical evidence, and educational perspectives enables a comprehensive understanding of reaction and response-speed assessment practices in contemporary racket sports.

## RESULTS AND DISCUSSION

### Result

#### Study Selection and Characteristics

A total of 148 articles were initially identified from Scopus, Web of Science, PubMed, ScienceDirect, Google Scholar, SINTA, and Garuda databases. After removing duplicates and screening titles and abstracts, 52 articles remained eligible for full-text review. Following the inclusion and exclusion criteria, 25 studies were included in the final synthesis.

The selected studies involved badminton, tennis, table tennis, and squash athletes ranging from novice to elite levels. Most studies investigated computerized reaction tests, FitLight systems, BlazePod devices, video-based decision-making assessments, and smartphone applications.

**Table 1.**

Characteristics of Reaction and Response-Speed Assessment Instruments in Racket Sports

Instrument Type	Number of Studies (n)	Sport Context	Main Variable Measured	Reliability (ICC)
Ruler Drop Test	3	Tennis, Badminton	Simple Reaction Time	0.65–0.78
Computerized Reaction Test	7	Tennis, Table Tennis	Visual Reaction Time	0.82–0.94
FitLight System	5	Badminton, Tennis	Response Speed	0.86–0.96
BlazePod System	4	Badminton, Squash	Agility & Response Time	0.88–0.97
Video-Based Assessment	4	Tennis, Table Tennis	Decision-Making Speed	0.80–0.92
Mobile Application Test	2	Badminton	Visual-Motor Reaction	0.78–0.89

The results indicate that technology-assisted instruments generally demonstrated higher reliability coefficients than conventional methods. FitLight and BlazePod systems showed the highest consistency across repeated measurements.

## Reliability Analysis of Reaction Instruments

The synthesis revealed that most digital-based reaction tests demonstrated good-to-excellent reliability. Of the 25 reviewed studies, 84% reported ICC values above 0.80, indicating strong measurement stability.

**Table 2.**

Summary of Reliability Findings

Reliability Category	ICC Range	Number of Studies	Percentage
Excellent	>0.90	10	40%
Good	0.80–0.89	11	44%
Moderate	0.70–0.79	3	12%
Low	<0.70	1	4%

The findings suggest that modern reaction assessment technologies provide reliable measurements suitable for both performance monitoring and educational evaluation.

## Distribution of Instrument Usage Across Studies

The chart demonstrates that computerized reaction assessments remain the most frequently utilized instruments, followed by FitLight and BlazePod systems.

## Learning Applications in Racket Sports

The reviewed studies consistently reported positive educational outcomes associated with reaction-based learning interventions. Three major learning applications emerged from the literature.

**Table 3.**

Educational Applications of Reaction Assessments

Learning Domain	Number of Studies	Main Findings
Motor Skill Development	10	Improved movement execution and coordination
Decision-Making Training	7	Faster tactical choices during play
Attention and Concentration	5	Increased focus and cognitive engagement
Performance Monitoring	3	Effective tracking of athlete progress

Reaction-based learning activities contributed to improvements in perceptual-motor integration, anticipation ability, and sport-specific decision-making. Several studies reported that integrating light-based reaction systems into badminton and tennis training improved athletes' response speed by 8–15% after 6–8 weeks of intervention.

## Comparative Effectiveness of Conventional and Technology-Based Instruments

**Table 4.**

Comparison Between Conventional and Technology-Assisted Assessments

Aspect	Conventional Tests	Technology-Based Tests
Measurement Accuracy	Moderate	High
Objectivity	Moderate	High
Data Recording	Manual	Automatic
Sensitivity to Change	Low–Moderate	High
Educational Feedback	Limited	Immediate
Learning Integration	Moderate	High

The evidence indicates that technology-assisted assessments offer superior measurement precision, greater objectivity, and enhanced educational value. Immediate

feedback provided by digital systems supports formative assessment and individualized learning strategies in racket sports education.

Overall, the literature synthesis revealed that reaction and response-speed assessments constitute essential components of athlete evaluation and learning in racket sports. Technology-assisted instruments such as computerized reaction systems, FitLight, BlazePod, and video-based assessments demonstrated excellent reliability and practical applicability. Furthermore, these tools not only measure performance outcomes but also facilitate motor learning, decision-making development, and continuous monitoring of athlete progress within educational and coaching environments.

## **Discussion**

The Information Processing Theory explains that reaction time and response speed are outcomes of a sequential process involving stimulus detection, information processing, decision making, and motor execution (Schmidt et al., 2019; Mann et al., 2019). In racket sports, these processes occur within milliseconds because athletes must continuously interpret visual cues and execute appropriate motor responses under dynamic conditions. The present review demonstrates that reaction and response-speed assessments constitute essential indicators of perceptual-cognitive and motor performance in badminton, tennis, table tennis, and squash. This finding supports previous research emphasizing that superior reaction capability differentiates elite athletes from novice performers (Kittel et al., 2020; Buszard et al., 2021).

From a conceptual perspective, reaction time and response speed are closely associated but represent different constructs. Reaction time refers to the interval between stimulus presentation and movement initiation, whereas response speed encompasses the complete process from perception to movement completion (Fortes et al., 2021). Ecological Dynamics Theory further suggests that successful performance depends on athletes' ability to perceive affordances and adapt actions according to environmental constraints (Davids et al., 2018; Woods et al., 2020). Consequently, assessment instruments should not only measure isolated motor responses but also evaluate perceptual-cognitive performance within sport-specific contexts.

The findings of this review reveal that technology-assisted instruments, including computerized reaction tests, FitLight systems, BlazePod devices, and video-based assessments, demonstrated superior reliability compared with conventional tools. Most reviewed studies reported intraclass correlation coefficients exceeding 0.80, indicating good to excellent measurement consistency. Similar findings were reported by Giesche et al. (2020), Abdelmoula et al. (2021), Le Runigo et al. (2021), and Kondrič et al. (2022), who observed that digital assessment systems reduced measurement error and enhanced test sensitivity. These results indicate that modern technological devices provide more objective and reproducible data than traditional ruler-drop tests or manual stopwatch measurements.

The superiority of technology-based assessments can be explained through measurement theory. Reliable instruments minimize random error and improve score

stability across repeated measurements (Hopkins et al., 2021). In racket sports, where performance differences may be measured in milliseconds, even minor measurement inaccuracies can significantly affect interpretation. Therefore, the high reliability coefficients reported in FitLight and BlazePod systems suggest their suitability for athlete monitoring, talent identification, and performance evaluation. Similar conclusions have been reported in studies involving badminton athletes (Faber et al., 2019), tennis players (Roca et al., 2020), and table tennis athletes (Kondrič et al., 2022).

Another important finding concerns the growing use of sport-specific reaction assessments. Traditional reaction tests primarily measure simple responses to generic stimuli. However, recent studies emphasize the importance of contextualized testing that reflects actual game situations (Mann et al., 2019; Roca et al., 2020). Video-based anticipation tests and virtual reality simulations require athletes to interpret opponent movements, predict ball trajectories, and select tactical responses. Such assessments align with ecological validity principles because they replicate real competitive demands. As a result, they provide a more accurate representation of perceptual expertise than isolated laboratory measurements.

The educational application of reaction assessments represents another significant contribution identified in this review. Motor Learning Theory argues that repeated exposure to task-relevant stimuli strengthens neural pathways and enhances movement efficiency (Schmidt et al., 2019; Magill & Anderson, 2021). The reviewed studies demonstrated that reaction-based learning activities improved attention, concentration, coordination, and decision-making skills among students and athletes. Similar findings were reported by Pesce et al. (2021), Lubans et al. (2022), and Barnett et al. (2023), who found that perceptual-motor training positively influences both cognitive and physical performance outcomes.

Furthermore, technology-enhanced learning environments provide immediate feedback, which is considered a critical factor in motor skill acquisition. Feedback allows learners to recognize performance errors and adjust subsequent responses more effectively (Wulf & Lewthwaite, 2016; Button et al., 2020). The implementation of FitLight and BlazePod systems in training sessions has been shown to increase learner engagement, motivation, and task-specific adaptability. Consequently, reaction assessments function not only as evaluation tools but also as instructional resources that facilitate active learning processes.

The present findings also highlight the importance of integrating reaction assessment into long-term athlete development programs. According to contemporary talent development models, perceptual-cognitive abilities are fundamental determinants of future sporting success (Vaeyens et al., 2021; Baker et al., 2022). Reliable reaction measurements enable coaches to monitor developmental progress and design individualized training interventions. Therefore, reaction assessment should be considered an integral component of athlete profiling alongside physical, technical, and psychological evaluations.

Based on the theoretical framework and empirical evidence synthesized in this review, it can be argued that the evolution of reaction-testing technology has transformed

assessment practices in racket sports. Modern instruments offer higher reliability, greater ecological validity, and broader educational utility than conventional methods. Their implementation supports evidence-based coaching, athlete monitoring, and student-centered learning. Consequently, coaches, teachers, and sports scientists are encouraged to adopt technology-assisted reaction assessments to enhance both performance evaluation and learning outcomes in contemporary racket sport environments.

## CONCLUSION

This literature review confirms that reaction time and response speed are fundamental performance components in racket sports because they directly influence perceptual-cognitive processing, decision-making, and motor execution. Conceptually, reaction ability is not limited to physiological responsiveness but also reflects athletes' capacity to perceive environmental information, process stimuli efficiently, and execute appropriate actions under dynamic competitive conditions. Therefore, reaction and response-speed assessments represent important indicators of both athletic performance and learning development. Empirically, the review synthesized 25 studies involving badminton, tennis, table tennis, and squash athletes. The findings revealed that technology-assisted instruments, including computerized reaction tests, FitLight systems, BlazePod devices, video-based assessments, and mobile applications, demonstrated superior reliability compared with conventional methods. Approximately 84% of the reviewed studies reported Intraclass Correlation Coefficients (ICC) above 0.80, indicating good-to-excellent measurement consistency. FitLight and BlazePod systems showed the highest reliability ranges (ICC = 0.86–0.97), while conventional ruler-drop tests exhibited lower reliability (ICC = 0.65–0.78). Furthermore, reaction-based assessments were found to have significant educational applications. Beyond measuring performance, these instruments support motor learning, improve attention and concentration, enhance decision-making skills, and facilitate continuous monitoring of athlete development. Consequently, modern reaction-testing technologies should be integrated into coaching and physical education programs as reliable, valid, and pedagogically valuable tools. Future research should focus on developing sport-specific, ecologically valid assessment systems that better represent real-game situations and learning environments in contemporary racket sports.

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