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Mental dynamics of performance in racket sports: a systematic review of attention, emotion, cognitive load, and decision-making in tennis and table tennis

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ABSTRACT

Performance in racket sports is shaped by attentional control, perceptual-cognitive processing, emotion regulation, and the availability of cognitive resources. This systematic review examined how attention and perceptual-cognitive processing, emotion and competitive pressure, and cognitive load and mental fatigue relate to performance in tennis and table tennis. Following PRISMA 2020, Scopus, PubMed, and ScienceDirect were searched for peer-reviewed empirical studies published within the 2020–2025 search window. The search identified 283 records; 19 duplicates were removed, 264 records were screened, 58 reports were sought for retrieval, 4 were not retrieved, and 54 were assessed for eligibility. Twenty-nine full-text reports were excluded, leaving 25 studies for qualitative synthesis. Methodological quality was appraised with the MMAT 2018. Because the included evidence differed substantially in study design, constructs, measures, and performance outcomes, no pooled effect size or meta-analysis was conducted; findings were synthesised through deductive thematic analysis. Reviewer-level screening/appraisal decisions were not preserved in the source record in a form that permits valid retrospective calculation of Cohen's kappa, so no coefficient is imputed. Three themes emerged: attention and perceptual-cognitive processing; emotion, anxiety, and pressure; and cognitive load, mental fatigue, and regulation. Overall, external/holistic attentional strategies, perceptual-cognitive training, and selected self-regulation interventions were associated with improved performance, whereas anxiety, pressure, and mental fatigue were commonly associated with performance decrements.



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Introduction

Racket-sport performance depends on more than physical and technical capacity. In tennis and table tennis, players must allocate attention, interpret rapidly changing perceptual information, regulate emotion under competitive pressure, and preserve decision quality when cognitive resources are taxed. Because rallies and stroke-selection decisions unfold within short time windows, these psychological and cognitive processes are directly relevant to accuracy, error control, and match performance (Ding et al., 2024; Starzak et al., 2024). High-performance coaches also increasingly regard mental skills as integral components of preparation rather than peripheral supports (Crespo et al., 2025).

Perceptual-cognitive demands are particularly salient in racket sports. Players infer the likely trajectory of the ball from the opponent's movement, select among competing stroke options, and act under severe temporal constraints. Anticipation and decision-making are influenced by visual information and contextual probabilities (Cañal-Bruland et al., 2022), while expertise is associated with more efficient perceptual-cognitive processing (Schaefer & Scornaienchi, 2022). Attention is therefore operationalised in this review as the allocation of focus during action, anticipation of an opponent's response, and decision-making during performance; within this domain, external and holistic attentional strategies are contrasted with internally directed movement-focused strategies (Starzak et al., 2024).

The second domain concerns emotion, anxiety, and competitive pressure. Break points, deciding sets, ranking implications, and outcome-contingent situations can increase pressure and contribute to performance errors (Harris et al., 2021; Zhang et al., 2024). Competitive anxiety varies with age, gender, and competitive level (Martínez-Gallego et al., 2022; Rodríguez-Cayetano et al., 2022). In this review, the emotion/pressure domain includes competitive anxiety, situational pressure, choking, emotion regulation, and self-talk, with performance outcomes such as shot accuracy, match outcome, and error occurrence. Evidence also indicates that reappraisal and adaptive self-regulation can shape whether emotional responses become disruptive or functional (Fritsch et al., 2022; Robazza et al., 2023).

The third domain concerns cognitive load and mental fatigue. Mental fatigue refers here to a state of reduced cognitive resources following sustained or demanding mental activity that can impair cognitive and motor performance (Ding et al., 2024). In open-skill racket sports, continuous perception, anticipation, and decision-making may make performance sensitive to cognitive load; for example, sleep loss and experimentally induced mental fatigue have been linked to poorer anticipation or stroke accuracy (Dai et al., 2023; Filipas et al., 2024). The cognitive-load/fatigue domain therefore includes experimentally induced or assessed mental fatigue, cognitive load, and regulation strategies such as mindfulness and biofeedback, examined against objective or validated performance outcomes.

Although studies have addressed attention, anxiety, cognitive fatigue, and decision-making, the evidence remains fragmented across constructs, sports, designs, and performance measures. Existing reviews have often focused on a single domain, such as attentional focus or mental fatigue (Ding et al., 2024; Starzak et al., 2024), leaving less explicit integration of how attentional control, emotional pressure, and mental fatigue may converge during racket-sport performance. This fragmentation can obscure mechanism-level interpretation—for example, whether anxiety alters attentional control, or whether fatigue reduces the attentional resources required for effective perception and decision-making.

To address this gap, the present paper is a systematic review rather than a scoping review. It uses an integrative conceptual framework in which controlled attention is treated as a central regulatory process linking three domains: (1) attentional and perceptual-cognitive processing, informed by the constrained-action hypothesis and research on external focus; (2) emotion, anxiety, and pressure, interpreted in part through Attentional Control Theory; and (3) cognitive load and mental fatigue, considered as conditions that can constrain attentional resources. The review objective is to systematically identify, appraise, classify, and thematically synthesise empirical evidence published within the 2020–2025 search window on how these constructs relate to tennis and table-tennis performance. The target population is trained, competitive, or otherwise skill-defined tennis and table-tennis participants with measurable performance outcomes. The review is driven by the following research questions:

RQ1. How do attentional and perceptual-cognitive processes (focus of attention, anticipation, and decision-making) relate to stroke and match performance in tennis and table tennis?

RQ2. What impact do emotional states and anxiety-related pressure have on performance, and which self-regulation strategies may reduce or buffer these effects?

RQ3. How do cognitive load and mental fatigue influence performance in tennis and table tennis, and what regulation strategies have been investigated?

Method

This systematic review was conducted and reported in accordance with the PRISMA 2020 statement (Page et al., 2021). It was also informed by the evidence-informed systematic-review principles described by Tranfield et al. (2003). The review was designed as a systematic review with qualitative thematic synthesis; it was not intended to estimate a pooled quantitative effect because the included evidence differed substantially in design, construct operationalisation, instruments, and performance outcomes.

Protocol and Research Questions

The review questions were structured using a PICO-informed framework. The population comprised trained, competitive, or skill-defined tennis and table-tennis participants. The phenomena of interest were attention/perceptual-cognitive processing, emotion/anxiety/pressure, cognitive load/mental fatigue, and decision-making. Where applicable, the comparison involved control conditions, alternative attentional or psychological conditions, or different levels of expertise. Outcomes were objective or validated indicators of sporting performance, including serve speed, stroke accuracy, anticipation performance, decision quality, match outcomes, error occurrence, or related validated performance indices.

Information Sources and Search Strategy

Scopus, PubMed, and ScienceDirect were searched for publications from 2020 through 2025. The search strategy used three blocks-sport, psychological/cognitive construct, and performance outcome-combined with AND and OR operators. The search string was:

("tennis" OR "table tennis" OR "racket sport") AND ("attention*" OR "focus of attention" OR "anticipat*" OR "decision-making" OR "emotion*" OR "anxiet*" OR "mental fatigue" OR "cognitive load" OR "pressure" OR "choking" OR "self-talk" OR "mindfulness") AND ("performance" OR "accuracy" OR "serve" OR "stroke" OR "error" OR "match outcome")*

Eligibility criteria

Studies were eligible when they met all of the following criteria: (1) peer-reviewed empirical research; (2) publication within the 2020–2025 search window; (3) English-language full text; (4) tennis or table tennis as the sport context; (5) at least one focal psychological or cognitive construct specified in the review framework; and (6) at least one objective or validated performance outcome. No minimum sample-size threshold was imposed because the review included multiple empirical designs; instead, sample size, population characteristics, setting, and design were extracted and considered during appraisal. Reviews, protocols, editorials, conference abstracts, and studies focused exclusively on biomechanics, physiology, technology/equipment, nutrition, injury, or other constructs outside the review framework were excluded. Studies without a performance outcome were also excluded.

Table 1. Inclusion and exclusion criteria.

Parameter	Inclusion	Exclusion
Population	Competitive/trained tennis or table-tennis players (any age, sex, level)	Non-racket-sport samples; general population with no racket-sport performance measure
Focus	≥1 focal construct: attention/perceptual-cognition, emotion/anxiety, cognitive load/mental fatigue, decision-making	Constructs outside review focus (e.g., pure biomechanics, injury, nutrition, technology)
Outcome	Objective or validated performance index (serve, accuracy, match outcome, error)	No performance outcome reported
Design	Empirical (experimental, cross-sectional, qualitative, archival)	Reviews, protocols, editorials, conference abstracts
Timeframe	2020–2025	Published before 2020
Language	English	Non-English full text unavailable

Study Selection

Records from the three databases were combined and duplicates were identified primarily by DOI matching. Screening was conducted in two stages: title/abstract screening followed by full-text eligibility assessment against the prespecified criteria. The original manuscript did not retain reviewer-level screening decisions in a form that permits retrospective calculation of an inter-rater coefficient; therefore, a Cohen's kappa statistic cannot be validly reconstructed from the aggregate PRISMA counts and is not reported. This limitation is now stated explicitly rather than replaced by an imputed coefficient.

Data extraction

For each included study, the extraction sheet recorded authorship and year, study design, sample and setting, psychological/emotional/cognitive construct(s), performance outcome(s), and principal conclusions. Coding was deductive and aligned with the three predefined review questions. First, study-level characteristics and findings were coded descriptively; second, those codes were organised into three analytical themes corresponding to RQ1–RQ3. Saturation was not used as a stopping criterion because the corpus was defined by eligibility and the date-bounded search. Triangulation was not claimed as a formal analytic procedure because the review synthesised heterogeneous primary-study designs rather than multiple qualitative data sources.

Quality assessment

Methodological quality was appraised with the Mixed Methods Appraisal Tool (MMAT), Version 2018 (Hong et al., 2018), applied according to study design. The appraisal considered the criteria relevant to each qualitative, quantitative, or mixed-method design. The descriptive 5-point scores shown in Table 2 are treated as indicators of methodological quality, not as validated global cut-offs, and no study was excluded solely because of an arbitrary total score. The assessment was based on information reported in each article, with “Can’t tell” used when necessary information was absent or unclear. Because reviewer-level appraisal decisions were not retained in the source record, a retrospective inter-rater reliability coefficient cannot be calculated.

Table 2. Summary of methodological quality appraisal (MMAT 2018).

Study	Design category	Indicative score	Quality
Keller et al. (2021)	Quantitative (experimental)	5/5	High
Niżnikowski et al. (2022)	Quantitative (RCT)	5/5	High
Łuba-Arnista et al. (2025)	Quantitative (RCT)	5/5	High
Carboch et al. (2023)	Qualitative	4/5	High
Carboch et al. (2025)	Quantitative (experimental)	4/5	High
Shangguan and Zha (2025)	Quantitative (experimental)	5/5	High
Ren et al. (2022)	Quantitative (experimental)	4/5	High
Harris et al. (2021)	Quantitative (observational)	5/5	High
Beckmann et al. (2021)	Quantitative (experimental)	4/5	High
Fuentes-García et al. (2023)	Quantitative (cross-sectional)	4/5	High
Martínez-Gallego et al. (2022)	Quantitative (cross-sectional)	4/5	High
Pa et al. (2024)	Quantitative (cross-sectional)	3/5	Medium
Nakamoto et al. (2024)	Quantitative (experimental)	5/5	High
Soleimani Rad et al. (2022)	Quantitative (experimental)	4/5	High
Vancurik and Callahan (2023)	Quantitative (observational)	3/5	Medium
Fritsch et al. (2022)	Quantitative (observational)	4/5	High
Robazza et al. (2023)	Quantitative (cross-sectional)	4/5	High
Filipas et al. (2024)	Quantitative (RCT)	4/5	High
Habay et al. (2021)	Quantitative (RCT)	5/5	High
Öztürker et al. (2025)	Quantitative (RCT)	5/5	High
Díaz-García et al. (2023)	Quantitative (experimental)	4/5	Medium
O'Connor et al. (2022)	Quantitative (experimental)	4/5	High
Tebourski et al. (2022)	Quantitative (experimental)	4/5	High
Behaein et al. (2025)	Quantitative (RCT)	4/5	High
Robin et al. (2022)	Quantitative (experimental)	4/5	High

Data synthesis

Because the included studies differed in design, sample characteristics, instruments, psychological constructs, and performance outcomes, no quantitative meta-analysis or pooled effect size was calculated. Instead, findings were synthesised narratively through deductive thematic synthesis (Thomas & Harden, 2008). The synthesis proceeded from descriptive study-level coding to three analytical themes: (1) attention and perceptual-cognitive processing; (2) emotion, anxiety, and pressure; and (3) cognitive load, mental fatigue, and regulation. Where primary studies reported effect magnitudes, these were considered qualitatively; no cross-study standardisation was attempted when the underlying measures were not comparable.

Study Selection (PRISMA 2020)

The database search identified 283 records (Scopus, $n = 251$; PubMed, $n = 30$; ScienceDirect, $n = 2$). After removing 19 duplicates, 264 records were screened and 206 were excluded at title/abstract level. Fifty-eight reports were sought for retrieval; four could not be retrieved, leaving 54 reports assessed for full-text eligibility. Twenty-nine full-text reports were excluded because they had no direct performance outcome ($n = 12$), were non-empirical/review/protocol publications ($n = 8$), or addressed constructs outside the review focus ($n = 9$). A total of 25 studies were therefore included in the qualitative synthesis. These counts correspond to the PRISMA 2020 flow diagram in Figure 1.

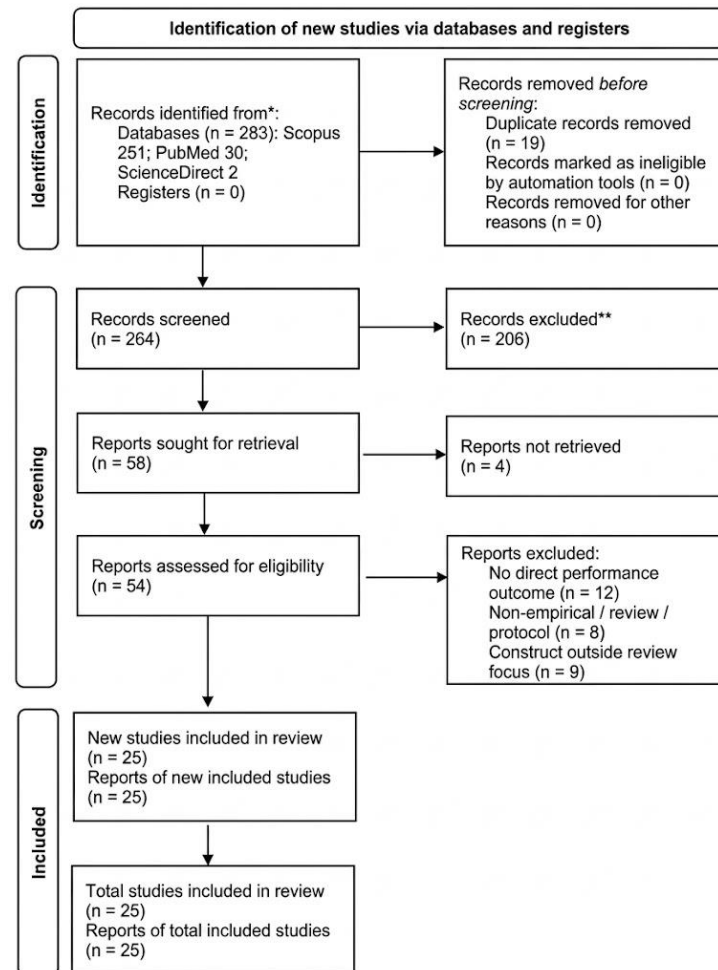


Figure 1. PRISMA 2020 flow diagram of the study selection process. Adapted from Page et al. (2021).

Results and Discussion

Overview of study selection

Twenty-five studies met the eligibility criteria. Although the search window was 2020–2025, the included studies were published from 2021 to 2025. Eleven studies used experimental or randomised crossover designs, 12 used cross-sectional/correlational or observational designs, one used qualitative interviews, and one used archival observational data. The evidence was distributed across three themes: attention and perceptual-cognitive processing ($n = 6$), emotion/anxiety/pressure ($n = 11$), and cognitive load/mental fatigue/regulation ($n = 8$).

Descriptive characteristics of included studies

Table 3 summarises the 25 included studies, including design, sample/setting, thematic classification, and principal findings. Figure 2 shows the temporal distribution of the included studies, with 2022 contributing the largest number of publications. Figure 3 shows that experimental designs were prominent in the attention and fatigue domains, whereas the emotion/anxiety domain combined experimental, cross-sectional, and archival evidence.

Table 3. Summary of the 25 included studies (full titles; ordered by theme).

Authors (Year) -Full Title	Design	Sample & Setting	Theme	Key Finding
Keller et al. (2021). How to Serve Faster in Tennis: The Influence of an Altered Focus of Attention and Augmented Feedback on Service Speed in Elite Players	Experimental (within-subject)	Elite tennis players; service-speed protocol	T1	Combining an external focus of attention with augmented feedback produced the fastest service speeds, exceeding an internal focus and either strategy applied alone.
Niżnikowski et al. (2022). An external focus of attention	Experimental (randomised groups)	51 physical-education	T1	An external focus-particularly a distal focus on the target-

Authors (Year) -Full Title	Design	Sample & Setting	Theme	Key Finding
enhances table tennis backhand stroke accuracy in low-skilled players Łuba-Arnista et al. (2025). Is holistic focus of attention equally effective to external focus in performing accuracy of table tennis forehand stroke in low-skilled players?	Experimental (randomised groups)	undergraduates (low-skilled) 80 physical-education undergraduates (low-skilled)	T1	yielded greater table-tennis backhand accuracy than an internal, hand-directed focus. A holistic focus of attention was as effective as an external focus for forehand accuracy, and both outperformed an internal focus condition.
Carboch et al. (2023). Anticipatory information sources of serve and returning of elite professional tennis players: A qualitative approach	Qualitative (interviews)	9 professional players/coaches (Europe)	T1	Elite players draw on kinematic and contextual anticipatory cues-ball toss, body orientation, and opponent tendencies-when reading and returning serve.
Carboch et al. (2025). Perceptual-cognitive training effect on the development of anticipation skills in tennis serve return	Experimental (pre-post, intervention/control)	32 players (high-performance and beginners)	T1	A three-week video-based temporal-occlusion program improved serve-return anticipation, with larger gains among beginners.
Shangguan and Zha (2025). The impact of framing effects, competitive state, and time pressure on risk-taking decisions in tennis players of different skill levels	Experimental (two experiments)	120 players (expert, skilled, novice)	T1	Framing, competitive state (leading/trailing) and time pressure jointly shaped risk decisions, and skill level moderated susceptibility to framing.
Ren et al. (2022). The Adverse Effect of Anxiety on Dynamic Anticipation Performance	Experimental	Skilled participants; dynamic anticipation task	T2	High anxiety impaired dynamic anticipation, reducing processing efficiency and shifting attentional control toward stimulus-driven processing, consistent with Attentional Control Theory.
Harris et al. (2021). Psychological pressure and compounded errors during elite-level tennis	Archival observational (retrospective)	/ >650,000 points across 12 Grand Slam tournaments (2016–2019)	T2	Situational pressure and a preceding error each raised the probability of a subsequent unforced error or double fault, evidencing pressure-linked error compounding at elite level.
Beckmann et al. (2021). Preventing a loss of accuracy of the tennis serve under pressure	Experimental (pre-post, two groups)	20 right-handed highly-skilled junior athletes	T2	A pre-performance left-hand dynamic handgrip preserved serve accuracy under pressure, mitigating choking relative to a right-hand control condition.
Fuentes-García et al. (2023). Pre- and post-competitive anxiety and match outcome in elite international junior tennis players	Cross-sectional	18 U-16 elite boys (ITF Junior Davis Cup)	T2	Pre-competitive anxiety and self-confidence were related to match outcome in elite international junior players at an ITF team event.
Martínez-Gallego et al. (2022). Gender and Age Influence in Pre-Competitive and Post-Competitive Anxiety in Young Tennis Players	Cross-sectional	42 U-12 to U-18 players (12 F, 30 M)	T2	Younger players reported lower trait and pre-match state anxiety; age and gender shaped competitive anxiety and self-confidence profiles.
Pa et al. (2024). The Effect of Pre-Competition Anxiety on Tennis Accuracy Shot Performance Among Malaysian Varsity Tennis Players	Cross-sectional survey	60 Malaysian varsity tennis players	T2	Higher pre-competition anxiety was associated with reduced forehand and backhand shot accuracy among varsity players.

Authors (Year) -Full Title	Design	Sample & Setting	Theme	Key Finding
Nakamoto et al. (2024). Inhibition of Ironic Errors and Facilitation of Overcompensation Errors Under Pressure: An Investigation Including Perceived Weakness	Experimental	Participants performing a tennis-stroke aiming task	T2	Under pressure, prohibiting a specific outcome elicited overcompensation rather than ironic errors, with perceived weakness shaping the error pattern.
Soleimani Rad et al. (2022). Performance and decision making of a complex skill under monitoring and outcome pressure conditions: Which of them can reinvestment predict?	Experimental (within-group)	20 expert table-tennis athletes	T2	Outcome and monitoring pressure differentially affected performance and decision-making, and decision-specific reinvestment predicted decision-making decrements.
Vancurik and Callahan (2023). Detection and Identification of Choking Under Pressure in College Tennis Based Upon Physiological Parameters, Performance Patterns, and Game Statistics	Observational / predictive modelling	College tennis matches (wearable sensors + video)	T2	Choking moments could be detected from physiological, performance and game-statistic variables (e.g., swing speed), supporting an objective choking-detection model.
Fritsch et al. (2022). Self-talk and emotions in tennis players during competitive matches	Cross-sectional / observational	20 video-recorded competitive matches	T2	Both goal-directed and spontaneous self-talk were associated with the intensity of experienced emotions and outward emotional reactions during matches.
Robazza et al. (2023). Athletes' basic psychological needs and emotions: the role of cognitive reappraisal	Cross-sectional	Competitive athletes	T2	Cognitive reappraisal (rather than expressive suppression) mediated the link between basic psychological-need satisfaction and pleasant, functional performance-related emotions.
Filipas et al. (2024). Mental Fatigue Impairs Second Serve Accuracy in Tennis Players	Randomised crossover (RCT)	10 male tennis players	T3	Acute mental fatigue induced by a Stroop task impaired second-serve accuracy, while first-serve speed was comparatively preserved.
Habay et al. (2021). Mental fatigue-associated decrease in table tennis performance: is there an electrophysiological signature?	Randomised counterbalanced crossover	11 experienced table-tennis players	T3	Mental fatigue reduced table-tennis performance, with concurrent EEG changes pointing to an electrophysiological signature of the decrement.
Öztürker et al. (2025). Impact of mental fatigue on tennis players' attention and groundstroke performance	Randomised placebo-controlled crossover	66 young male tennis players	T3	Mental fatigue lowered attention scores and impaired groundstroke depth and accuracy relative to placebo and control conditions.
Díaz-García et al. (2023). Combining HIIT Plus Cognitive Task Increased Mental Fatigue but Not Physical Workload in Tennis Players	Cross-sectional (experimental comparison)	32 tennis players (25 M, 7 F)	T3	Adding an incongruent Stroop task to HIIT increased mental-fatigue indicators without raising physical workload, isolating a cognitive-load effect.
O'Connor et al. (2022). Instantaneous effects of mindfulness meditation on tennis return performance in elite junior athletes completing an implicitly sequenced serve return task	Experimental (single-session, conditions)	Elite junior tennis athletes	T3	A single mindfulness-meditation session-focused-attention or open-monitoring-actively modulated performance on an implicitly-sequenced serve-return task versus a control condition.

Authors (Year) -Full Title	Design	Sample & Setting	Theme	Key Finding
Tebourski et al. (2022). Effects of Mindfulness for Performance Programme on Actual Performance in Ecological Sport Context: Two Studies in Basketball and Table Tennis	Experimental (programme evaluation)	Athletes in basketball and table-tennis contexts	T3	A structured Mindfulness-for-Performance programme improved actual performance in ecological table-tennis (and basketball) settings.
Behaein et al. (2025). Effects of Biofeedback and Mindfulness on the Psychological Skills and Forehand Flick Accuracy in Adolescent Table Tennis Players	Randomised controlled trial	40 adolescent semi-professional TT players	T3	Biofeedback, mindfulness and their combination improved psychological skills and forehand-flick accuracy relative to a control group.
Robin et al. (2022). Tennis Service Performance in Beginners: The Effect of Instructional Self-Talk Combined With Motor Imagery	Experimental (three groups, pre-post)	Young novice tennis players	T3	Instructional self-talk combined with motor imagery enhanced tennis service performance beyond motor imagery alone or a control condition.

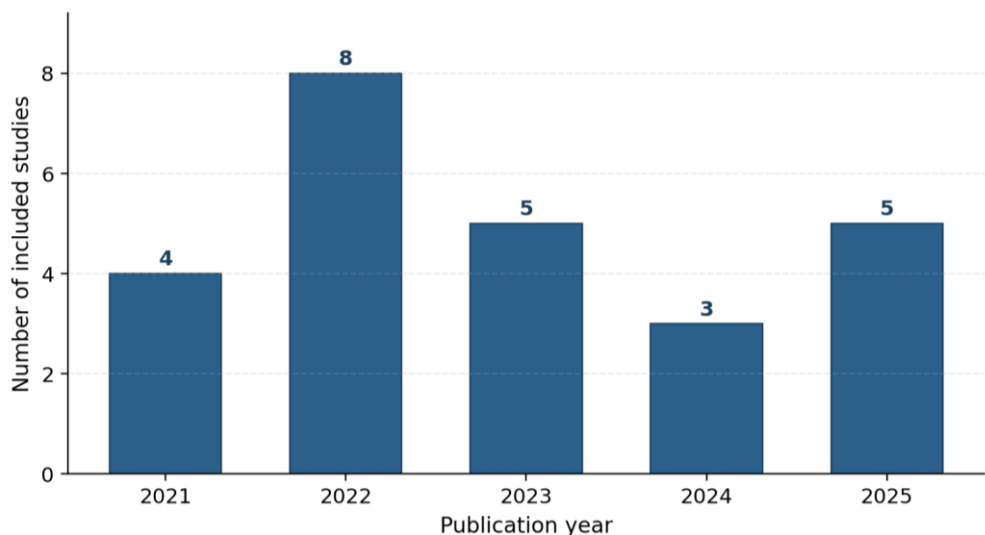


Figure 2. Temporal distribution of included studies (2021-2025).

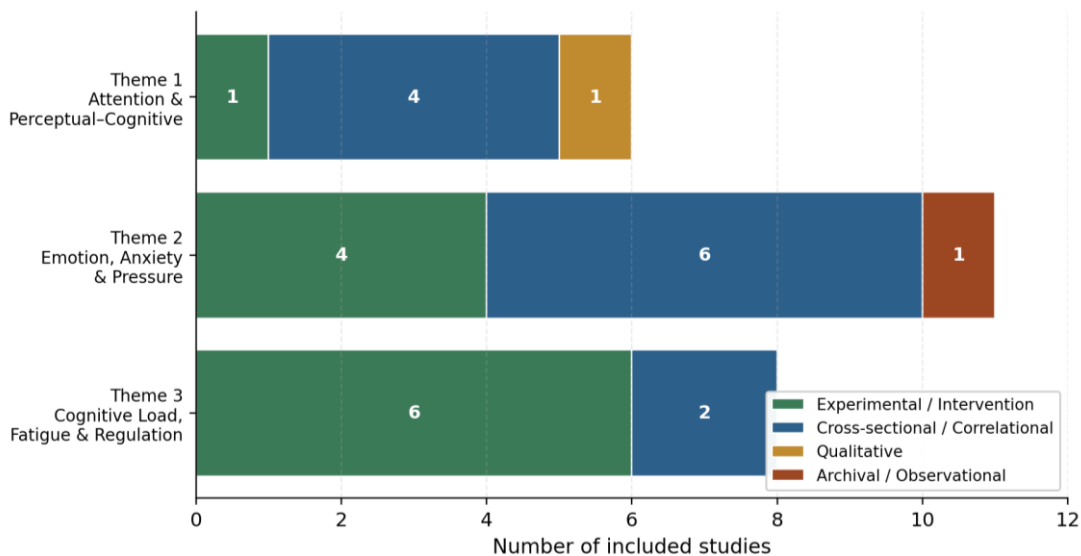


Figure 3. Distribution of included studies by thematic focus and research design.

Classification of evidence by theme, construct, and outcome

Table 4 classifies the included evidence by focal construct and performance outcome. Figure 4 provides a descriptive author-keyword co-occurrence map, illustrating the concentration of the literature around attention, decision-making, anxiety, choking, mental fatigue, mindfulness, accuracy, and stroke performance. The map is descriptive and is used to contextualise, rather than quantitatively weight, the evidence base.

Table 4. Classification of included studies by theme, construct, and performance outcome.

Theme	Focal construct(s)	Performance outcome(s)	Studies
T1. Attention & Perceptual–Cognitive	Focus of attention; anticipation; decision-making	Serve speed; stroke accuracy; anticipation; risk decisions	Keller et al. (2021), Niżnikowski et al. (2022), Łuba-Arnista et al. (2025), Carboch et al. (2023), Carboch et al. (2025), Shangguan and Zha (2025)
T2. Emotion, Anxiety & Pressure	Competitive anxiety; situational pressure; choking; emotion regulation; self-talk	Shot accuracy; match outcome; error compounding; functional emotions	Ren et al. (2022), Harris et al. (2021), Beckmann et al. (2021), Fuentes-García et al. (2023), Martínez-Gallego et al. (2022), Pa et al. (2024), Nakamoto et al. (2024), Soleimani Rad et al. (2022), Vancurik and Callahan (2023), Fritsch et al. (2022), Robazza et al. (2023)
T3. Cognitive Load, Mental Fatigue & Regulation	Mental fatigue; cognitive load; mindfulness; biofeedback	Serve/groundstroke accuracy; psychological skills	Filipas et al. (2024), Habay et al. (2021), Öztürker et al. (2025), Díaz-García et al. (2023), O'Connor et al. (2022), Tebourski et al. (2022), Behaen et al. (2025), Robin et al. (2022)

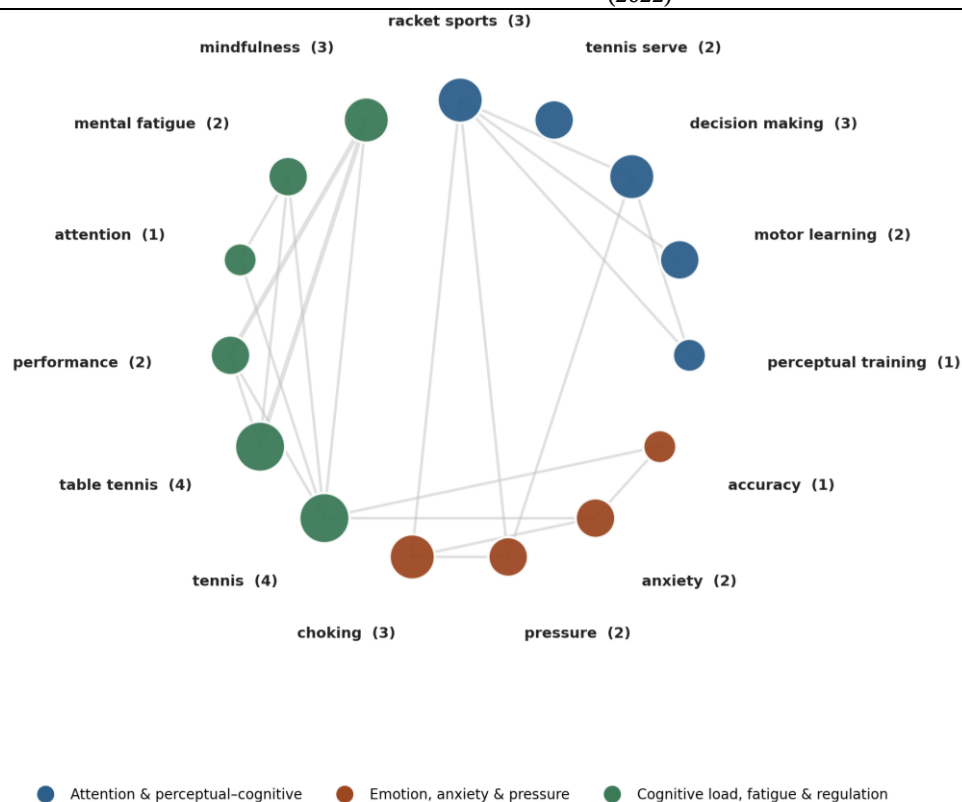


Figure 4. Author-keyword co-occurrence map of the 25 included studies.

Thematic synthesis

RQ1 - Attention and perceptual-cognitive processing

Attentional focus was consistently associated with performance across tennis and table tennis. Keller et al. (2021) reported faster tennis serves when an external focus was combined with augmented feedback, while Niżnikowski et al. (2022) found greater table-tennis backhand accuracy under an external target-focused instruction than an internal movement focus. Łuba-Arnista et al. (2025) further showed that holistic focus could perform comparably to external focus for forehand accuracy and both outperformed an internal focus. Taken together, these findings support a constrained-action interpretation in which directing attention toward task-relevant environmental effects can reduce disruptive conscious control of movement. The broader contextual literature also supports the

importance of cognition in racket sports: Haryanto et al. (2024) found associations between self-confidence, cognitive processing speed, and topspin accuracy in table tennis.

Anticipation and decision-making also appear trainable rather than fixed. Carboch et al. (2023) described the kinematic and contextual cues used by elite tennis players to anticipate serves, and Carboch et al. (2025) found that a short temporal-occlusion programme improved serve-return anticipation, with larger gains among less experienced players. Complementary evidence from Wang et al. (2023) demonstrated the value of analysing anticipation in real match contexts rather than relying only on laboratory tasks, while Ji et al. (2024) showed that action anticipation differentiates experts from novices at the neural-processing level. Shangguan and Zha (2025) further indicated that framing, score state, and time pressure jointly shape risk-taking, with skill level moderating susceptibility. Thus, the answer to RQ1 is not simply that “more attention” improves performance; rather, the quality, direction, and contextual adaptation of attentional control appear to matter.

RQ2, Emotion, anxiety and psychological pressure

Emotion, anxiety, and pressure formed the largest thematic group. In elite tennis, Harris et al. (2021) showed that situational pressure and preceding errors increased the probability of subsequent unforced errors or double faults. Among younger and collegiate players, higher pre-competitive anxiety was associated with poorer shot accuracy or match outcomes (Fuentes-García et al., 2023; Pa et al., 2024), while age and gender were associated with differences in anxiety profiles (Martínez-Gallego et al., 2022). The mechanistic evidence from Ren et al. (2022) is important because it links anxiety with reduced processing efficiency and altered attentional control during anticipation.

Additional peer-reviewed work strengthens this interpretation while also widening the context beyond tennis and table tennis. Conde-Ripoll et al. (2023) found meaningful variation in pre-competitive anxiety among high-level padel players as a function of competitive status and round, and Conde-Ripoll et al. (2024) linked pre- and post-competitive anxiety and self-confidence with technical-tactical performance. Mizuno and Masaki (2024) reported that left-hand contraction could improve selected aspects of tennis-serve performance under pressure. Thiessen et al. (2024) further showed that mental toughness and coping-related characteristics are relevant to choking susceptibility. These studies support the present review’s conclusion that pressure effects are contingent on athlete characteristics, situational demands, and regulation processes rather than being uniform across all performers.

The included intervention studies also identify potentially useful buffers against performance deterioration. Beckmann et al. (2021) found that a pre-performance left-hand dynamic handgrip preserved serve accuracy under pressure, while Nakamoto et al. (2024) showed that pressure can produce overcompensation errors rather than a single uniform error pattern. Soleimani Rad et al. (2022) linked decision-specific reinvestment to decrements under monitoring and outcome pressure. These findings caution against treating “choking” as one homogeneous mechanism and instead support task- and athlete-specific regulation strategies.

Emotion regulation is equally important. Robazza et al. (2023) found cognitive reappraisal to be more functionally related to performance-related emotions than expressive suppression, and Fritsch et al. (2022) showed that both goal-directed and spontaneous self-talk were associated with emotional experiences during competitive tennis. Nicolas et al. (2025) additionally reported beneficial effects of imagining successful actions after errors in young non-expert tennis players, suggesting a role for post-error regulation. A data-driven approach has also been proposed for identifying choking from physiological and performance variables (Vancurik & Callahan, 2023). Collectively, these findings answer RQ2 by indicating that anxiety and pressure can impair accuracy, anticipation, and decision quality, but the magnitude and expression of those effects depend on regulation strategies, coping resources, and the competitive context.

RQ3, Cognitive load, mental fatigue and regulation

Mental fatigue was a recurring challenge to performance. Filipas et al. (2024) found that experimentally induced mental fatigue impaired second-serve accuracy, while Öztürker et al. (2025) reported reductions in attention, groundstroke depth, and accuracy. In table tennis, Habay et al. (2021) linked performance decline to concurrent electrophysiological changes, and Díaz-García et al. (2023) showed that adding a cognitive task to high-intensity exercise increased mental-fatigue indicators without increasing physical workload. Together, these studies strengthen the interpretation that some performance decrements are specifically cognitive rather than merely physical.

Regulation strategies were promising but should not be treated as interchangeable or uniformly effective. O’Connor et al. (2022) showed acute modulation of elite-junior tennis return performance following mindfulness meditation, whereas Tebourski et al. (2022) reported improved ecological table-tennis performance after a Mindfulness-for-Performance programme. Behaein et al. (2025) found benefits from biofeedback and mindfulness for psychological skills and forehand-flick accuracy, and Robin et al. (2022b) found that

instructional self-talk combined with motor imagery enhanced tennis-service performance. Outside the formal 25-study evidence base, Liao (2025) reported associations among mindfulness meditation, recovery, burnout, and psychological resilience in elite tennis players, and Hijah et al. (2025) reported reduced stress following mindfulness meditation in junior volleyball athletes in an Indonesian Sinta-2 journal. These contextual studies support the plausibility of regulation-based interventions while also highlighting that the present evidence base remains heterogeneous.

Comparative and critical analysis

Contextual comparative evidence

To strengthen comparative interpretation without changing the formal systematic-review corpus, 15 recent peer-reviewed studies were added only as contextual literature in the Discussion. Eleven are international studies addressing racket-sport cognition, anxiety, pressure, imagery, or mindfulness, and four are Indonesian studies published in nationally accredited Sinta-2 journals. These sources are explicitly contextual and do not alter the PRISMA denominator, the $n = 25$ included-study count, or the MMAT appraisal set.

Comparatively, the three themes converge on controlled attention as a plausible integrative mechanism. Anxiety can disrupt attentional control during anticipation (Ren et al., 2022), whereas mental fatigue may reduce the resources needed to sustain effective attention and precision (Öztürker et al., 2025). Regulation strategies can therefore be interpreted as attempts to stabilise attentional control across different stressors. Evidence from Haryanto et al. (2024) on cognitive speed and topspin accuracy, Wang et al. (2024) on coping and brain activity following prediction-error discrepancies, and Robin et al. (2022a) on self-talk and motor imagery further suggests that cognitive preparation, emotion regulation, and action execution are interdependent rather than isolated processes.

The cross-study comparisons nevertheless require caution. Experimental studies generally provide stronger internal validity for attentional and fatigue manipulations, whereas many anxiety findings are cross-sectional and therefore do not establish causality. Sample sizes are often small, several studies use laboratory proxies or closed-skill tasks, and the instruments used to measure anxiety, fatigue, attention, and performance are not standardised across the corpus. Accordingly, the present synthesis supports consistent patterns of association and experimental effect in selected contexts, but it does not justify a single universal effect estimate across racket sports.

The review integrates evidence from 25 eligible studies into a single account of mental processes underpinning tennis and table-tennis performance. The central interpretation is that performance is shaped by the regulation of attention under changing cognitive and emotional conditions. Attentional direction influences stroke execution and anticipation; pressure and anxiety can disrupt control of attention and increase errors; and mental fatigue can reduce the resources required for accurate perception and action. The additional contextual literature, including studies from padel and Indonesian sport-science journals, supports the broader relevance of these mechanisms without changing the formally included evidence base of 25 studies.

Theoretical implications

The findings are compatible with an attention-centred theory of performance under pressure. Ren et al. (2022) provide evidence consistent with Attentional Control Theory, in which anxiety can shift the balance between goal-directed and stimulus-driven control. The external-focus findings (Keller et al., 2021; Niżnikowski et al., 2022) are consistent with the constrained-action hypothesis. The convergence of mindfulness, self-talk, reappraisal, and imagery across the evidence further suggests that maintaining controlled attention may be a common mechanism through which different psychological strategies support performance. The review therefore contributes an integrative interpretation rather than proposing that one psychological construct independently determines performance.

Practical implications

For coaches and practitioners, three practical implications are supported by the synthesis. First, training should include external or holistic attentional cues and perceptual-cognitive drills that require anticipation under realistic temporal constraints. Second, emotional-regulation routines should be practised deliberately, including cognitive reappraisal, structured self-talk, and brief pre-performance routines for pressure situations. Third, cognitive fatigue should be treated as a performance constraint that can be managed through task design, recovery, mindfulness, biofeedback, and strategically controlled cognitive load. These recommendations should be adapted to athlete level and task context rather than applied as universal protocols.

Gaps in the evidence

Four evidence gaps are especially clear. First, few studies manipulate attention, anxiety, and fatigue within the same experimental framework, limiting direct tests of their interaction. Second, much of the evidence still relies on laboratory or closed-skill tasks rather than authentic match environments. Third, women, para-athletes,

recreational athletes, and more geographically diverse samples remain underrepresented. Fourth, heterogeneity in psychological instruments and performance outcomes restricts quantitative aggregation. Future studies should therefore prioritise preregistered multi-factor designs, ecologically valid performance metrics, standardised outcome definitions, and transparent reporting of sample characteristics and context.

Limitations

Several limitations should temper interpretation. The search covered only three databases and English-language peer-reviewed literature from 2020–2025; consequently, relevant regional studies, non-English evidence, and grey literature may have been missed. Search sensitivity is also constrained by the chosen keywords, and no formal publication-bias test was undertaken because the review did not conduct a meta-analysis. The included studies vary substantially in sample size, age, expertise, measurement instruments, and performance outcomes. Cross-sectional and observational designs limit causal inference, while several interventions involve small samples or laboratory proxies. In addition, the original review record did not preserve reviewer-level screening/appraisal decisions sufficiently to calculate Cohen's kappa retrospectively. The MMAT ratings are therefore descriptive judgements rather than precise estimates of certainty or absence of bias.

Future directions

Future research should (1) use multi-factor designs that simultaneously manipulate or measure attention, anxiety, and fatigue; (2) prioritise authentic match situations and standardised performance outcomes so that quantitative synthesis becomes feasible; (3) include more women, para-athletes, amateur participants, and non-Western samples; (4) preregister screening and extraction procedures and retain reviewer-level decisions so inter-rater reliability can be reported; and (5) examine whether psychological interventions transfer from laboratory tasks to competitive performance. Studies should also report sufficient contextual and methodological detail to support international comparisons and replication.

Conclusions

This systematic review searched Scopus, PubMed, and ScienceDirect for English-language, peer-reviewed empirical studies published within the 2020–2025 search window and applied predefined eligibility criteria to 283 records, yielding 25 included studies after duplicate removal, screening, retrieval, and full-text assessment. Study quality was appraised with the MMAT 2018, and because methodological and outcome heterogeneity precluded valid pooling, findings were synthesised through deductive thematic analysis rather than meta-analysis. Across the 25 studies, attentional direction and perceptual-cognitive preparation were associated with better performance, whereas anxiety and competitive pressure commonly increased error risk and mental fatigue impaired accuracy and attentional performance. Evidence also indicates that reappraisal, self-talk, mindfulness, biofeedback, and related strategies may buffer these effects. Overall, the most defensible integrative interpretation is that controlled attention is a trainable but limited performance resource. Future research should test the interaction of attention, anxiety, and fatigue in authentic competitive settings using standardised outcomes and more diverse athlete populations.

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