

Beyond the Meshing Hypothesis: Self-Efficacy as a Mechanism Linking Preference-Aware Multimodal Coaching, Peer Support, and Collegiate Tennis Performance

*Huang Mofan

Faculty Of Arts, Communication & Education, Kuala Lumpur University of Science and Technology, Malaysia

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ABSTRACT

College tennis involves complex skill development within socially interactive learning environments while requiring athletes to make independent decisions, regulate emotions, and execute technical and tactical actions under pressure. Although previous research has examined instructional approaches, peer support, and self-efficacy in sport learning, these perspectives have rarely been integrated into a coherent theoretical framework. A central challenge concerns the continued influence of fixed visual, auditory, and kinesthetic learning-style assumptions in coaching practice. Existing evidence provides limited support for the meshing hypothesis, which proposes that athletes learn more effectively when instruction is matched to their presumed learning styles. However, rejecting fixed learning categories does not eliminate the importance of responsive and adaptive coaching. This conceptual paper addresses this issue by distinguishing learning-style matching from multimodal coaching and proposing self-efficacy as the key psychological mechanism linking instructional and social environments to tennis performance. Drawing on social cognitive theory and research on motor learning, feedback, and peer support, the paper argues that multimodal coaching and supportive peer interactions enhance mastery experiences, observational learning, verbal encouragement, and adaptive emotional regulation. These experiences strengthen tennis-specific self-efficacy, which contributes to persistence, attentional control, tactical engagement, and performance development. The proposed framework integrates coaching practices and peer support within a self-efficacy-based model and provides a theoretical explanation of why learner-responsive approaches may benefit collegiate tennis development without relying on fixed learner labels. The paper offers implications for evidence-informed coaching and identifies directions for future empirical investigation.

Keywords: tennis performance; self-efficacy; peer support; multimodal coaching; learning preferences; social cognitive theory;

INTRODUCTION

Individualized instruction has become an important consideration in sport coaching because athletes differ in their experiences, preferences, and responses to learning environments. Coaches often attempt to adapt instruction by providing different forms of demonstration, explanation, feedback, and practice opportunities. However, the theoretical basis for such adaptation remains unclear. A widely used approach assumes that athletes possess relatively stable learning styles and that performance improves when instructional methods are matched to these preferred styles. This assumption, commonly referred to as the meshing hypothesis, has received substantial attention in educational and sport contexts, yet empirical evidence has provided limited support for the idea that fixed learning-style matching enhances learning outcomes (Pashler et al., 2008; Rogowsky et al., 2015). The continuing use of individualized coaching practices despite weak evidence for learning-style matching raises an important theoretical question: if performance benefits do not result from matching fixed learning categories, what plausible psychological mechanisms might explain why responsive and adaptive coaching approaches may still be effective?

The collegiate setting adds a distinctive social and educational layer. Students learn with coaches and classmates, observe peers, exchange feedback, and compare progress, yet singles performance remains individually

accountable. University tennis courses can provide autonomy-supportive climates that shape students' emotions and engagement (Simonton et al., 2021), while tennis participation can also cultivate perceived social support and prosocial outcomes among university students (Sun et al., 2025). In China, evidence from an adjacent racket-sport context suggests possible relationships among contextual resources, learning engagement, and self-efficacy (He et al., 2023). However, this cross-sport evidence cannot directly establish the same relationships in collegiate tennis. These findings nevertheless suggest that a useful framework for collegiate tennis performance should connect instructional, social, and psychological processes.

One popular connection has been made through "learning styles." Athletes or students are classified as visual, auditory, reading/writing, or kinesthetic learners, after which instruction is matched to the preferred category. The attraction is understandable. Tennis coaches routinely use demonstrations, verbal cues, video, analogies, guided movement, and physical practice, while learners also differ in what they enjoy and request. Yet the inference that a stable sensory style should determine how an athlete is taught is much stronger than the evidence permits. Reviews and controlled studies have repeatedly failed to establish the crossover pattern required by the meshing hypothesis: visual learners should learn better from visual than verbal instruction, while verbal learners should show the opposite pattern (Pashler et al., 2008; Rogowsky et al., 2015). The same limitation has been identified in motor and sport settings (Fuelscher et al., 2012).

The debate is not completely closed. Clinton-Lisell and Litzinger's (2024) meta-analysis of 21 studies and 101 effect sizes reported a small mean advantage for matched instruction. However, only about one quarter of outcome measures displayed crossover effects for at least two styles, study quality was often low, and heterogeneity was substantial. The authors therefore advised against widespread matching and recommended multimodal instruction as a more defensible alternative. This pattern creates a theoretically useful question: if stable modality matching is not well supported, why can preference-congruent or "matched" conditions sometimes produce a small advantage?

This paper proposes tennis-specific self-efficacy as one plausible candidate mechanism. Being given a preferred mode, meaningful choice, comprehensible demonstration, or affirming label may change an athlete's expectation of success without activating an underlying sensory learning channel. The athlete may attend more closely, practise more willingly, interpret difficulty as less threatening, and persist longer. In Bandura's (1977) terms, coaching and peer interaction may shape efficacy through mastery experiences, vicarious experience, verbal persuasion, and physiological or affective states. In motor-learning terms, enhanced expectancies and learner autonomy may support goal-action coupling, although the motivational mechanisms proposed in the OPTIMAL theory require more direct testing than the field has typically provided (Parma et al., 2024; Wulf & Lewthwaite, 2016). Self-efficacy is therefore not treated as an established or exclusive mechanism. Autonomy, attention, cognitive load, and self-regulation remain competing or complementary explanations that require empirical comparison.

In this paper, preference-aware multimodal coaching refers to the coordinated and task-appropriate use of two or more complementary instructional modes that are informed, but not determined, by athletes' expressed preferences. These modes may include demonstration, verbal explanation, visual representation, video, and guided physical practice. The construct has three defining features: coordinated multimodality, alignment between instructional modes and tennis tasks, and responsiveness to expressed learner preferences. It does not classify athletes into fixed learning-style categories. Learner choice, feedback quality, and mastery progression are treated as related instructional conditions rather than defining components of the construct.

The purpose of this conceptual review is therefore not to rehabilitate fixed learning styles. It is to replace a category-based explanation with a testable mechanism-based framework. The paper makes four contributions. First, it clarifies the distinction among fixed learning-style labels, expressed modality preferences, and preference-aware multimodal coaching. Second, it integrates social cognitive theory with evidence from motor learning, peer support, and tennis-related research to develop a framework connecting instructional and social conditions with subsequent performance. Third, it proposes tennis-specific self-efficacy as a candidate mediating mechanism and distinguishes it from competing or complementary explanations involving autonomy, attention, cognitive load, and self-regulation. Fourth, it develops propositions that distinguish direct effects, mediation, moderation, and proposed moderated mediation, together with a research design agenda for collegiate tennis in

Chinese higher education, including Hebei Province. The framework does not claim to establish these relationships empirically. Instead, it identifies theoretically grounded relationships that require direct longitudinal and experimental testing in collegiate tennis.

Review Approach And Conceptual Scope

This paper follows a theory-synthesis and model-building approach to conceptual research (Jaakkola, 2020). It is an integrative conceptual review rather than a systematic review or meta-analysis. Accordingly, it does not claim exhaustive coverage or report a PRISMA flow. The synthesis gives priority to four evidence classes: foundational social cognitive theory; systematic reviews and meta-analyses concerning learning styles, self-efficacy, physical education, and tennis performance; peer-reviewed studies directly addressing motor learning, sport support, and university tennis; and recent Chinese evidence relevant to sport self-efficacy and social support. Evidence drawn directly from tennis is distinguished from evidence from adjacent racket sports and broader educational or sport contexts. The latter is used to support theoretical reasoning rather than to establish relationships in collegiate tennis. This approach is appropriate when fragmented literature must be reorganized around a proposed explanatory mechanism rather than simply catalogued (Snyder, 2019).

The unit of explanation is the collegiate tennis learning episode and its accumulation across a course or training program. The focal antecedents are preference-aware multimodal coaching and perceived peer support. Preference-aware multimodal coaching is defined by coordinated multimodality, task-mode alignment, and responsiveness to expressed learner preferences. Tennis-specific self-efficacy is examined as a candidate mediator and is defined at a level aligned with the performance tasks being predicted. The principal outcome is tennis performance, conceptualized as a multidimensional set of technical, tactical, physical, and competitive behaviors rather than a single self-reported impression. Chinese higher education is treated as an important context for empirical testing rather than a uniform cultural cause. Institutional setting, coaching climate, prior experience, gender, competitive level, and local peer norms should be measured rather than inferred from nationality.

The synthesis is guided by one question: Through what theoretically defensible psychological mechanisms might learner-sensitive coaching and peer support be associated with subsequent tennis performance when fixed learning-style matching is not an adequate explanation? The framework proposes that instructional variety and social support may create efficacy-relevant experiences. Tennis-specific self-efficacy is therefore examined as one plausible mechanism rather than an empirically established or exclusive explanation. Alternative or complementary mechanisms, including autonomy, attention, cognitive load, and self-regulation, are also considered. The proposed self-efficacy pathway is sufficiently specific for empirical testing while accommodating the embodied, observational, verbal, and social characteristics of tennis learning.

Construct Clarification

Learning styles, learning preferences, and multimodal coaching

The term learning style is used inconsistently. It can refer to a preference, a strategy, a cognitive tendency, a personality-like type, or a claimed sensory channel. The strongest and most problematic claim is the meshing hypothesis: learners possess stable modality-specific styles and learn more when instruction is matched to the identified style. A valid test requires a crossover interaction, not merely higher scores in a matched group or a correlation between preference and outcome (Pashler et al., 2008). Many studies cited in favor of learning styles do not meet that criterion.

Controlled evidence has generally been unfavorable. Rogowsky et al. (2015) found no support for matching auditory or visual word preferences to listening or reading instruction. In anatomy education, students' reported VARK categories did not align consistently with study behavior or achievement (Husmann & O'Loughlin, 2019). In sport, Fuelscher et al. (2012) similarly concluded that coaching practice had moved ahead of empirical support. Despite these limitations, belief in matching remains widespread among educators (Newton & Salvi, 2020), and instructional decisions can be shaped by that belief (Bresnahan et al., 2024).

Recent evidence requires a nuanced interpretation. Clinton-Lisell and Litzinger (2024) reported a small pooled matched-instruction effect, but most measures did not show the crossover interaction necessary to validate style-specific matching. The result may reflect expectation, choice, interest, study quality, or general benefits of a more carefully designed lesson. It does not demonstrate that each learner has a fixed sensory route through which motor skill is best acquired. Indeed, assigning a style label can create expectations that become self-reinforcing, restrict willingness to use other strategies, and encourage psychological essentialism.

Rejecting the meshing hypothesis does not imply that every athlete should receive identical instruction. Preferences are real as subjective experiences. Task demands also differ. A serve can be supported through live demonstration and video; a grip adjustment may require concise verbal information and guided practice; tactical patterns may benefit from court diagrams, questioning, and representative play. The evidence-based alternative is preference-aware multimodal coaching: the deliberate use of complementary demonstrations, verbal cues, visual representations, guided practice, feedback, and learner choice without assigning athletes to fixed categories.

Multimodality serves at least three functions. First, complementary representations can highlight different features of the same skill. Second, choice can increase perceived autonomy and readiness to engage. Third, varied instruction gives coaches more opportunities to diagnose misunderstanding and provide task-appropriate correction. The value lies in instructional design and learner agency, not in a presumed match between a sensory identity and a single mode. This distinction is summarized in Table 1.

Table 1. Construct distinctions underlying the conceptual framework

Construct	Meaning	Evidence status	Coaching implication
Fixed learning style	A stable visual, auditory, reading/writing, or kinesthetic learner type.	Not established as a reliable basis for assigning instruction.	Do not label or permanently track athletes by type.
Modality preference	A learner's reported liking or comfort for receiving information in a particular way.	Preferences exist, but preference does not demonstrate superior learning in that mode.	Ask and observe preferences, but retain task-appropriate instruction.
Meshing hypothesis	The claim that matching instruction to a diagnosed style produces superior learning through a crossover interaction.	Crossover evidence is infrequent; recent pooled effects are small and heterogeneous.	Do not build separate curricula around presumed sensory identities.
Preference-aware multimodal coaching	Coordinated use of demonstration, verbal cues, visual representation, guided practice, and bounded choice.	Consistent with motor-learning, autonomy, and feedback principles when modes are complementary.	Vary representation while keeping the learning goal and practice task coherent.
Perceived instructional fit	The learner's appraisal that instruction is understandable, usable, and responsive.	May influence expectancy, engagement, and self-efficacy without a modality-specific mechanism.	Treat fit as a motivational and usability signal, then verify with performance evidence.

Note. The framework distinguishes subjective preference and instructional responsiveness from the stronger claim that learners possess fixed sensory styles.

Peer support in an individually contested, socially learned sport

Peer support is not a unitary construct. Sport research distinguishes emotional support, esteem support, informational support, and tangible assistance (Rees & Hardy, 2000). In collegiate tennis, emotional support can reduce the perceived threat of failure; esteem support communicates confidence in the player's capacity; informational support provides cues, tactical observations, or feedback; and tangible support includes practice time, ball feeding, equipment sharing, or logistical help. The quality and timing of support matter as much as its frequency.

Tennis creates a productive theoretical contrast between social learning and individual accountability. Training is commonly conducted with partners or groups, enabling observation, comparison, feedback, and mutual regulation. Competitive singles play, however, restricts direct peer assistance once a point begins. Support must therefore be internalized into beliefs, routines, and coping resources before or between performance episodes. This structure makes self-efficacy a plausible transmission mechanism.

Evidence across sport supports this view. Perceived support has been associated with performance partly through self-confidence and related psychological processes (Freeman & Rees, 2009). Observing teammates or competitors affects self-efficacy depending on the model's performance and the learner's interpretation of winning and losing (Kwon et al., 2022). Among adolescents, peer support has been linked with exercise adherence through self-efficacy and self-regulation (Zou et al., 2023). Chinese validation work also supports the measurement of exercise-related social support while underscoring the need for culturally and developmentally appropriate instruments (Yao et al., 2024).

Support is not always beneficial. Incorrect technical advice, controlling comparison, ridicule, dependency, and excessive reassurance can undermine learning. Peer feedback requires the ability to judge quality, manage affect, and act on information (Carless & Boud, 2018). Research outside sport likewise shows that providing and receiving feedback have different learning effects (Wu & Schunn, 2021). A conceptual model should therefore focus on perceived high-quality, autonomy-supportive, task-relevant peer support rather than assuming that any peer contact is positive.

Tennis-specific self-efficacy

Self-efficacy refers to beliefs about one's capability to organize and execute actions required to attain specified levels of performance (Bandura, 1997). It is prospective and task-referenced. It differs from self-esteem, general optimism, global confidence, and retrospective satisfaction. Sport-confidence is a related domain construct (Vealey, 1986), but efficacy theory places particular emphasis on correspondence among the capability belief, task, conditions, and criterion.

This specificity is often lost in applied research. A general self-efficacy scale may capture broad coping beliefs, yet it is poorly matched to a tennis outcome such as first-serve placement under pressure, recovery positioning after a wide forehand, or adherence to a tactical pattern when trailing. Bandura (2006) recommended that efficacy items represent graded task demands and be phrased in terms of capability rather than intention. Sport research similarly stresses measurement correspondence (Feltz et al., 2008). If the outcome is coach-rated tennis performance, efficacy should refer to the technical, tactical, and competitive behaviors underlying that rating.

Four sources shape efficacy. Mastery experiences are the most direct: successful execution, improvement, and recovery from errors provide evidence of capability. Vicarious experiences arise when athletes observe credible and sufficiently similar models. Verbal persuasion includes credible coaching cues, peer encouragement, and evaluative feedback. Physiological and affective states matter through interpretation; elevated arousal can be read as readiness or incapacity. Instruction and peer interaction influence all four sources, which explains why efficacy can mediate environmental effects rather than merely accompany performance.

The relationship is also reciprocal. Stronger efficacy may increase practice effort and persistence, producing better performance and new mastery evidence. Performance improvements then strengthen efficacy. Cross-sectional correlations cannot separate these directions. The conceptual model uses efficacy as a mediator because

it specifies how earlier instructional and peer experiences can influence later performance, but empirical studies should test reciprocal and lagged alternatives.

Tennis performance

Tennis performance is multidimensional and level-dependent. Physiological reviews emphasize repeated high-intensity movement, recovery, speed, agility, strength, and endurance (Fernandez-Fernandez et al., 2009; Kovacs, 2007). Skill-acquisition research emphasizes representative practice, perception-action coupling, variability, feedback, and the progression from technique to tactical adaptability (Reid et al., 2007). Contemporary performance analysis also uses tracking and machine-learning methods to characterize strokes, movement, and match patterns (Bilić et al., 2023; Sampaio et al., 2024).

A single global self-rating is therefore inadequate. For collegiate research, performance can combine standardized skill tests, serve and return accuracy, rally consistency, movement tests, coach ratings anchored to behavioral criteria, and match-derived indicators. Physical conditioning interventions can improve important tennis outcomes (Deng et al., 2022; Lambrich & Muehlbauer, 2022), but psychological and instructional variables are unlikely to affect all dimensions equally. Self-efficacy should be most strongly related to behaviors that permit strategic control, sustained attention, effort, and persistence, and less strongly related to capacities constrained by physiology or long-term training history.

Theoretical Integration

Social cognitive theory as the primary mechanism

Social cognitive theory explains human functioning through reciprocal interactions among personal factors, behavior, and the environment (Bandura, 1986). Athletes are not passive recipients of coaching or support. They select models, interpret feedback, regulate effort, and help shape their practice environments. Coaches and peers provide opportunities and information, but the meaning of these inputs depends on athletes' appraisals, prior experiences, and current levels of competence.

Self-efficacy occupies a central position in social cognitive theory because it may affect choice, effort, persistence, resilience, thought patterns, and affective reactions (Bandura, 1977, 1997). These processes are relevant to tennis. A player with strong efficacy for completing a second serve under pressure may be more likely to preserve an appropriate swing, whereas a doubtful player may decelerate. Similarly, a player who feels capable of recovering after an error may re-engage more quickly, while another player may continue to focus on the previous point. These examples illustrate how efficacy beliefs might become relevant to tennis performance. They do not establish that self-efficacy causes these behaviors or that belief can substitute for technical competence. Unrealistically high efficacy that is unsupported by skill may contribute to poor decisions. Productive self-efficacy should therefore be calibrated through authentic mastery experiences and diagnostic performance feedback.

Preference-aware multimodal coaching may contribute to the development of efficacy-relevant experiences. Demonstration and video can provide vicarious information, while task-appropriate verbal cues may offer credible persuasion. Coordinating these modes around a common tennis task may also help athletes understand the actions required for successful performance. Related instructional conditions, including graduated practice, learner choice, diagnostic feedback, and progressive challenge, may provide additional mastery evidence and help athletes interpret arousal as manageable. However, these conditions are not treated as defining components of preference-aware multimodal coaching. Peer support may operate through parallel channels. Peers can model coping and technique, affirm capability, normalize setbacks, and make demanding practice more socially manageable. Coaching and peer support are therefore theoretically distinct antecedents that may contribute to the same efficacy system. Nevertheless, the proposed pathways require direct testing in collegiate tennis.

Expectancy, autonomy, and motor learning

The OPTIMAL theory of motor learning proposes that enhanced expectancies, autonomy support, and an external focus of attention may facilitate performance and learning by strengthening goal–action coupling (Wulf & Lewthwaite, 2016). This framework is relevant because it connects motivational and attentional conditions with motor execution. Giving learners some control over feedback timing or practice order may increase perceived autonomy. Positive but credible performance comparisons may enhance expectations of success, while external-focus instructions may direct attention toward the intended movement effect.

However, not all supporting studies have measured motivation or demonstrated that motivational change accounts for retention or transfer. Parma et al. (2024) found insufficient evidence that common expectancy and autonomy manipulations consistently increased motivation or that motivational changes explained motor-learning advantages. These limitations do not require expectancy and autonomy to be rejected. Instead, the proposed mediating processes should be specified and tested directly. Tennis-specific self-efficacy provides one measurable candidate, but perceived autonomy, attentional focus, information quality, cognitive load, and self-regulation remain plausible competing or complementary mechanisms.

This distinction changes how apparent learning-style effects can be interpreted. A preferred video, demonstration, or practice option may be associated with stronger efficacy because the athlete expects the material to be understandable, perceives the instruction as responsive, or experiences greater control. It may also provide information that is better suited to the task, direct attention toward relevant movement features, or reduce unnecessary cognitive load. These explanations are empirically testable and do not require a modality-specific cognitive match. Future studies should therefore compare changes in self-efficacy with changes in autonomy, attention, cognitive load, self-regulation, and practice behavior. Such comparisons can determine whether self-efficacy explains unique variance or operates alongside other mechanisms.

Peer support as a social amplifier

Peer support may have an independent association with self-efficacy and may also condition how athletes respond to coaching. A demonstration may be more persuasive when a similar peer successfully performs the skill and explains how an error was corrected. A challenging progression may appear more attainable when practice partners provide esteem support and nonjudgmental feedback. Conversely, the potential benefits of a well-designed coaching activity may be weakened when peers mock errors, create threatening comparisons, or communicate technically inconsistent advice. Peer support is therefore proposed both as an independent social resource and as a possible moderator of the relationship between coaching and self-efficacy.

This proposed amplifying role requires a clear distinction between informational value and social approval. Evidence from general educational research suggests that task-specific feedback identifying the gap between current and desired performance is more useful than nonspecific praise (Hattie & Timperley, 2007). Its direct applicability to collegiate tennis, however, requires empirical examination. From a self-efficacy perspective, verbal persuasion may be more influential when it is credible, behaviorally grounded, and followed by opportunities to attempt the task. A peer climate that provides only positive reassurance may temporarily increase reported confidence without improving efficacy calibration or subsequent performance. High-quality peer support is therefore conceptualized as combining emotional safety, task-relevant information, technical credibility, and opportunities for action. Whether it strengthens the proposed coaching-to-efficacy pathway remains an empirical question.

Conceptual Model And Propositions

Figure 1 presents the proposed model. Preference-aware multimodal coaching and peer support are positioned as environmental antecedents of tennis-specific self-efficacy. Self-efficacy predicts later tennis performance and mediates both antecedent relationships. Peer support also moderates the coaching-to-efficacy path because peer behavior can validate, extend, or undermine instructional experiences. Prior tennis experience and task difficulty are boundary conditions rather than universal controls: they can change which efficacy source is most informative and how strongly beliefs translate into performance.

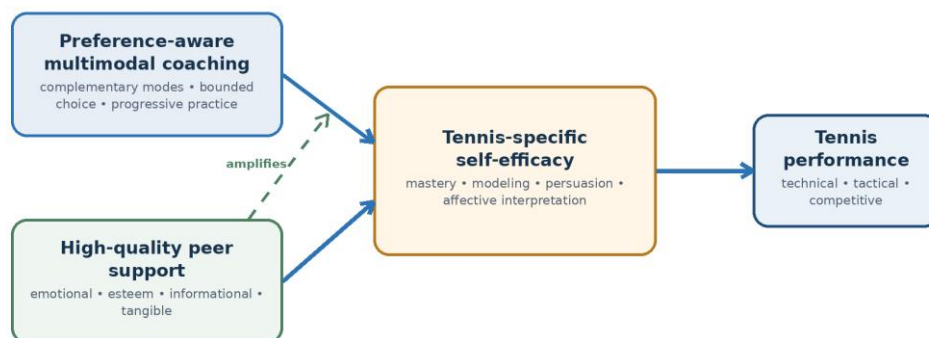


Figure 1 Conceptual framework linking coaching and peer support to tennis performance

Preference-aware multimodal coaching and self-efficacy

Preference-aware multimodal coaching does not allocate learners permanently to visual, auditory, or kinesthetic tracks. It provides task-appropriate representations, lets learners express preferences or make bounded choices, and requires embodied practice. The expected efficacy benefit arises through several routes. Clear demonstrations make successful execution imaginable. Video and external cues help athletes identify controllable features of performance. Graduated tasks generate early mastery evidence. Choice can strengthen ownership and reduce defensiveness. Feedback linked to observable behaviors enables athletes to attribute improvement to controllable action.

The effect should depend on instructional quality. Redundant or contradictory modalities can overload attention, and excessive choice can become burdensome. Multimodality is not inherently superior; it is valuable when complementary modes are coordinated around the same learning goal. Likewise, preferences should inform communication but not override task requirements. An athlete who prefers verbal explanation must still observe and physically practice a serve.

Proposition 1. Preference-aware multimodal coaching is positively associated with tennis-specific self-efficacy when instructional modes are complementary, task-appropriate, and paired with opportunities for successful practice.

Peer support and self-efficacy

Peers provide efficacy information that coaches cannot fully duplicate. Similarity makes peer models diagnostically meaningful: if a classmate at a comparable level masters a movement, the observer may revise beliefs about attainability. Peers also witness effort and improvement across sessions, enabling specific esteem support. Informational support can help learners notice cues between coach contacts, while emotional support can reduce shame after visible errors.

The predicted relationship concerns support quality, not social contact. Unsolicited technical advice from an unqualified peer may create confusion. Comparison with a much more advanced player may lower efficacy. Support that is controlling, sarcastic, or conditional may increase threat. Effective peer support is autonomy-supportive, credible, and aligned with the coach's learning objective.

Proposition 2. Perceived high-quality peer support is positively associated with tennis-specific self-efficacy through vicarious experience, credible esteem and informational support, and more adaptive interpretations of error and arousal.

Self-efficacy and tennis performance

Self-efficacy affects performance through effort, persistence, attentional control, and commitment to selected actions. In training, efficacious learners are more likely to attempt challenging drills, use feedback, and persist

after errors. In competition, they are more likely to execute a chosen pattern decisively and recover psychologically between points. The association should be strongest when efficacy and performance refer to the same task and conditions (Moritz et al., 2000).

Self-efficacy is not expected to dominate all predictors. Physical capacity, technical history, opponent strength, injury, coaching quality, and chance remain important. Efficacy should explain incremental variance and the conversion of available skill into behavior, particularly under challenge. Calibration is crucial: beliefs grounded in mastery and accurate feedback should predict performance more consistently than unsupported confidence.

Proposition 3. Tennis-specific self-efficacy is positively associated with subsequent tennis performance, with stronger effects when efficacy and performance measures are matched in task, difficulty, and temporal proximity.

The mediating role of self-efficacy

Instructional variety does not improve match performance simply because more media are used. It must change what athletes understand, do, and believe they can do. Similarly, peer support is not carried onto the court as a material resource during each point; it becomes consequential through internalized expectations, coping routines, and self-regulation. These observations support mediation.

The expected mediation is partial. Coaching may affect performance directly by improving technique and tactical knowledge. Peer feedback may directly correct an error. Physical practice may create physiological adaptation independent of confidence. Self-efficacy represents the motivational-regulatory pathway within this larger system.

Proposition 4. Tennis-specific self-efficacy partially mediates the positive relationship between preference-aware multimodal coaching and subsequent tennis performance.

Proposition 5. Tennis-specific self-efficacy partially mediates the positive relationship between high-quality peer support and subsequent tennis performance.

Peer support as a boundary condition

Coaching occurs in a peer climate. When peers reinforce task goals, model constructive responses to failure, and exchange accurate feedback, the same instructional design should produce stronger efficacy gains. When peers create ridicule, status threat, or inconsistent technical messages, instructional benefits may be weakened. This moderation is especially plausible in group university courses where coach attention per student is limited and much practice occurs in pairs.

The moderation can be tested at individual and group levels. Individual perceived support may interact with perceived coaching. Group-level norms can be aggregated when within-group agreement is adequate. A multilevel design can distinguish whether an athlete's personal support perception or the broader class climate explains the cross-level amplification.

Proposition 6. High-quality peer support strengthens the positive association between preference-aware multimodal coaching and tennis-specific self-efficacy; low-quality or threatening peer interaction weakens that association.

Table 2. Summary of conceptual propositions

ID	Relationship	Core mechanism	Key boundary or test
P1	Multimodal coaching → tennis-specific self-efficacy	Complementary information, bounded choice, mastery progression, and credible feedback.	Modes must be coherent and task-appropriate; compare

			with fixed matching and standard instruction.
P2	Peer support → tennis-specific self-efficacy	Vicarious experience, esteem and informational support, and adaptive error interpretation.	Support quality, model similarity, and technical credibility.
P3	Self-efficacy → tennis performance	Effort, persistence, attentional control, tactical commitment, and recovery after error.	Match efficacy and performance in task, difficulty, and time.
P4	Multimodal coaching → self-efficacy → performance	Instructional experiences are translated into motivated, persistent execution.	Partial mediation; retain direct technical-learning pathways.
P5	Peer support → self-efficacy → performance	Social resources are internalized into expectations and coping routines.	Partial mediation; distinguish support functions and sources.
P6	Peer support × multimodal coaching → self-efficacy	Peers validate, extend, or undermine instructional experiences.	Test individual and group-level climate using multilevel models.

Note. Arrows indicate proposed temporal influence, not conclusions from existing cross-sectional evidence.

Boundary Conditions And Competing Explanations

Prior experience and model similarity

Novices often have unstable performance representations and limited criteria for judging feedback. Demonstrations, simple external cues, and successful approximations may therefore have a stronger association with their efficacy beliefs. Experienced players possess richer knowledge and may respond more to diagnostic video, tactical information, and performance data. Evidence from Chinese adolescent table tennis, an adjacent racket-sport context, suggests that the relationship between learning engagement and self-efficacy may vary according to training experience (He et al., 2023). However, this cross-sport evidence does not directly establish the same relationship in collegiate tennis. Prior tennis experience should therefore be examined as a potential moderator rather than treated only as demographic background.

Model similarity may also influence the interpretation of observational information. A highly advanced peer may demonstrate what is possible but not necessarily what the learner can attain next. By contrast, a similar peer who demonstrates the process of identifying and correcting an error may provide more relevant vicarious information than a flawless expert. Future studies should measure perceived similarity and perceived competence rather than assuming that all peer models have equivalent effects.

Task difficulty and efficacy calibration

Easy tasks can produce ceiling effects in both self-efficacy and performance, whereas extremely difficult tasks may result in unstable or unrealistic efficacy judgments. Graded tasks are necessary to assess efficacy calibration, which refers to the correspondence between perceived capability and actual success across different levels of difficulty. The proposed self-efficacy pathway may be more evident in challenging but attainable tasks where effort, strategy, attention, and persistence are relevant to performance.

Calibration also helps distinguish performance-relevant efficacy from positive self-report bias. If coaching is associated with higher efficacy ratings but not with better retention, transfer, or match behavior, it may have generated temporary reassurance rather than meaningful learning. Objective performance indicators and delayed

assessments are therefore needed to determine whether changes in efficacy correspond with subsequent changes in tennis performance.

Autonomy, attention, and information quality

Self-efficacy is not the only plausible mediator. Preference-aware multimodal coaching may also be associated with perceived autonomy, situational interest, comprehension, attentional focus, information quality, cognitive load, and self-regulation. Peer support may influence belonging, enjoyment, stress appraisal, feedback use, and emotional regulation. These mechanisms may operate independently, in parallel, or in sequence. A rigorous empirical test should therefore compare alternative and parallel mediators rather than assume that self-efficacy provides an exclusive explanation.

The conceptual claim advanced in this paper is deliberately limited. Tennis-specific self-efficacy is proposed as one theoretically specified candidate mechanism linking instructional and social experiences with subsequent tennis behavior. It is not assumed to be the strongest or only mediator. If its indirect association becomes negligible after autonomy, information quality, attention, cognitive load, or self-regulation is included, the framework should be revised accordingly. The theoretical value of the framework lies in specifying a falsifiable pathway and comparing it with credible alternatives.

Reciprocal causality and selection

Better tennis players may receive more positive attention, perceive greater peer support, and report stronger self-efficacy. Students with higher self-efficacy may also express their learning preferences more confidently or select preferred instructional modes more assertively. Cross-sectional mediation cannot distinguish these alternative directions and may produce misleading estimates of indirect relationships. Longitudinal ordering, experimental manipulation, and within-person analysis are therefore required to examine the proposed temporal sequence.

Selection may also occur at the class and programme levels. Students who voluntarily join tennis clubs may differ systematically from those enrolled in compulsory physical education courses. Competitive squads may differ from recreational classes in coaching intensity, skill distribution, peer climate, and performance expectations. Sampling procedures and theoretical inferences should therefore correspond closely to the population and instructional context under investigation.

Figure 2 contrasts the traditional learning-style matching explanation with the proposed self-efficacy-based account. It illustrates that any potential benefit of preference-aware multimodal coaching may be better explained by efficacy-relevant instructional and social experiences than by assignment to fixed learner categories. However, this contrast remains a theoretical proposition. Direct empirical comparisons are required to determine whether self-efficacy, competing psychological mechanisms, or modality-specific matching better accounts for subsequent tennis performance.

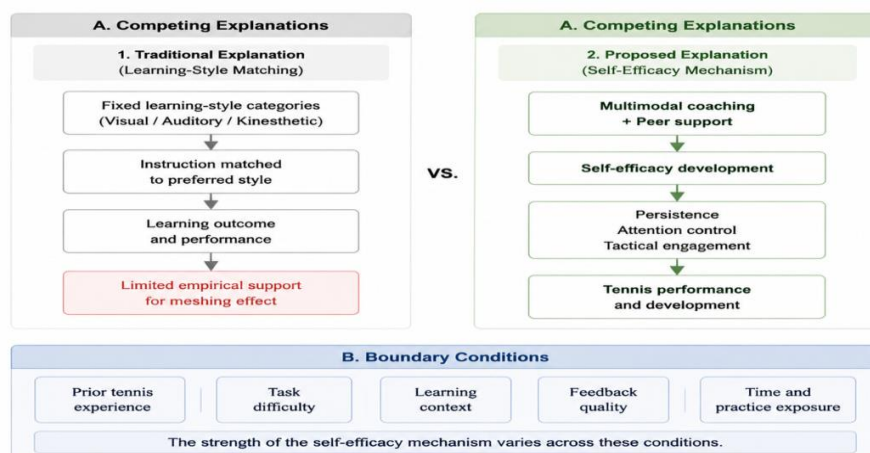


Figure 2. Boundary Conditions and Competing Explanations of the Self-Efficacy Mechanism

Future Research Directions

Measurement and Empirical Testing

Future research should first address construct validity. Learning-style inventories should not be used to classify athletes into fixed learner categories. Instead, modality preferences should be measured as continuous characteristics. Researchers should also distinguish athletes' expressed preferences from instructional delivery and perceived instructional fit. Preference-aware multimodal coaching should be assessed through its three defining features: coordinated multimodality, task–mode alignment, and responsiveness to expressed learner preferences. Learner choice, feedback quality, and mastery progression should be measured separately as related instructional conditions. Questionnaires may be combined with lesson-plan analysis, classroom observation, video coding, and implementation-fidelity checks to distinguish intended coaching from athletes' perceptions and actual coaching practices.

Self-efficacy measurement should be specific to tennis learning and performance. Future studies should assess athletes' beliefs about their capability to perform representative tennis tasks across different levels of difficulty. These tasks may include technical execution, tactical decision-making, recovery after errors, and performance under pressure. Items should be phrased in terms of perceived capability rather than intention, motivation, or general confidence. Developing a tennis-specific measure through expert review, pilot testing, confirmatory factor analysis, and validity assessment would improve the accuracy of examining the proposed relationship between self-efficacy and subsequent tennis performance.

Peer support also requires careful measurement. Future research should distinguish emotional, esteem, informational, and tangible support and assess the quality, technical credibility, and task relevance of each form. Support from training partners may operate differently from support provided by classmates, friends, or general social relationships. Researchers should also distinguish individual perceptions of peer support from the broader peer climate within a class or training group. This distinction would allow peer support to be examined both as an independent social resource and as a proposed moderator of the relationship between coaching and self-efficacy.

Performance outcomes should be evaluated through multiple indicators. Standardized skill tests, serve and return accuracy, rally consistency, tactical decision-making, match-based performance records, and coach evaluations can provide complementary evidence of tennis performance. Retention and transfer tests should also be included to distinguish temporary practice effects from sustained learning. Combining objective, observational, and match-based measures can reduce the limitations associated with relying only on self-reported performance.

Empirical studies should compare the proposed self-efficacy pathway with alternative explanations. Perceived autonomy, attentional focus, information quality, cognitive load, and self-regulation can be assessed as parallel or sequential mediators. Direct effects, indirect effects, moderation, and conditional indirect effects should be estimated separately. In particular, researchers should examine whether peer support moderates the association between preference-aware multimodal coaching and tennis-specific self-efficacy and whether this moderation produces a conditional indirect association with subsequent tennis performance.

Longitudinal and Comparative Research

Future studies should move beyond cross-sectional and short-term investigations to examine how coaching experiences, peer support, self-efficacy, and tennis performance develop over time. A multiwave design could assess baseline tennis experience and performance before measuring coaching and peer support during the instructional period. Self-efficacy and competing psychological mechanisms could then be assessed before subsequent performance, retention, and transfer outcomes. This temporal ordering would help determine whether changes in self-efficacy precede changes in performance, although longitudinal evidence alone would not establish causality.

Experimental and quasi-experimental research could provide stronger tests of the proposed framework. Studies may compare fixed learning-style matching, general multimodal instruction, and preference-aware multimodal

coaching. Such designs should ensure that instructional content, task difficulty, practice duration, and coach contact remain comparable across conditions. They should also assess whether any advantage associated with preference-responsive instruction is explained by self-efficacy, autonomy, attention, cognitive load, self-regulation, or improved task information.

Comparative research is also needed to examine whether the proposed relationships vary across groups and learning environments. Studies involving novices and experienced players, compulsory physical education classes, recreational tennis courses, and competitive university squads may reveal important boundary conditions. Within Chinese higher education, institutional setting, class size, coaching climate, prior experience, competitive level, and peer norms should be measured directly rather than inferred from nationality. Multilevel analysis may be appropriate when students are nested within classes, coaches, or universities.

Future empirical research should also directly compare the explanatory value of the meshing hypothesis with the proposed self-efficacy-based account. Such comparisons should test whether preference matching produces the crossover interaction required by the meshing hypothesis. They should then examine whether any observed advantage is better accounted for by tennis-specific self-efficacy or by competing mechanisms involving autonomy, attention, information quality, cognitive load, and self-regulation. This approach would determine which explanation receives stronger empirical support without treating any proposed mechanism as established in advance.

Practical Implications

The framework suggests that collegiate tennis coaches should stop diagnosing students as fixed visual, auditory, or kinesthetic learners. Such labels offer false precision and can narrow learners' willingness to use effective strategies. Coaches can still ask students what helps them understand, offer bounded choices, and vary representation. The practical shift is from matching identities to designing experiences.

A preference-aware multimodal sequence can be simple. The coach identifies the performance goal, demonstrates the movement at normal speed, highlights one or two external effects, provides a concise verbal cue, and allows immediate guided practice. Video or diagrams are added when they reveal information not easily seen live. Learners may choose the order of two practice tasks or the timing of selected feedback, but choices remain aligned with the learning objective. Difficulty is progressed to produce authentic mastery rather than easy success.

Peer support should also be designed rather than left to chance. Practice partners can use shared observation criteria, distinguish observation from advice, and provide one specific feed-forward statement. Coaches should model how to acknowledge effort without concealing errors, how to ask before offering feedback, and how to respond constructively after mistakes. Rotating partners may broaden modeling opportunities, while stable pairs may support trust; the choice should reflect the course goal.

Efficacy monitoring can be embedded into instruction. Before a graded task, students can rate confidence for a clearly specified criterion. After performance, coach and athlete compare expectation with evidence and select the next challenge. The goal is calibrated efficacy: confidence supported by skill and an accurate understanding of current limits. This process turns confidence from a motivational slogan into actionable performance information.

Universities can support implementation through coach development. Training should cover the limits of learning-style matching, principles of multimodal instruction, feedback literacy, peer-climate management, and task-specific efficacy assessment. Resource constraints do not require multiple individualized curricula. A coherent multimodal lesson with bounded choice is more scalable than separate tracks for presumed learner types.

Theoretical Contributions

The first contribution is conceptual precision. The paper separates three ideas that are often conflated: learners can express preferences; instruction can use multiple modes; and matching a fixed learner type to one mode can improve learning. The first two claims are compatible with evidence-informed coaching, while the third requires a crossover effect that is rarely demonstrated. This distinction allows sport pedagogy to respect individual difference without reproducing a neuromyth.

The second contribution is a motivational reinterpretation of apparent matching effects. The small pooled effect reported by Clinton-Lisell and Litzinger (2024) need not imply modality-specific cognitive architecture. Perceived fit, labeling, or choice may change expectancies and self-efficacy. By making this mechanism explicit, the paper converts a polarized debate into competing testable explanations.

The third contribution is the integration of instructional and social environments. Coaching and peer support are typically studied in separate literatures, yet both shape the same four efficacy sources. Their convergence explains why peer climate can amplify or undermine coaching. This is especially important in tennis, where learning is social but performance is often individually executed.

The fourth contribution is the specification of self-efficacy as task-specific and calibrated. Generic self-efficacy scales may produce associations that are difficult to translate into coaching. Aligning efficacy items with tennis behaviors and difficulty levels strengthens theoretical correspondence and produces more useful intervention evidence.

Finally, the model positions Chinese collegiate tennis as a context for theory testing rather than a token population. It identifies measurable contextual features and rejects essentialist assumptions. This approach can reveal which mechanisms travel across settings and which depend on institutional or social conditions.

Limitations of the Conceptual Review

This paper is an integrative conceptual review and does not estimate a pooled effect or claim exhaustive literature coverage. Its propositions require empirical testing. The model emphasizes self-efficacy, but autonomy, attention, belonging, feedback uptake, and self-regulation may operate in parallel or sequence. The proposed moderation by peer support is theoretically plausible yet may vary by support function and performance level. The framework also focuses on psychological and pedagogical mechanisms and does not model physical conditioning, injury, equipment, or opponent quality in detail. These factors remain central to tennis performance. Future work should integrate them when the research question concerns comprehensive performance prediction. Finally, the model assumes that preference-aware multimodal coaching can be measured reliably. Researchers must distinguish intended instruction from students' perceptions and actual coaching behavior. Observation, video coding, and fidelity checks will be necessary alongside questionnaires.

CONCLUSION

Collegiate tennis coaching needs a learner-sensitive framework, but fixed learning-style matching is not a defensible foundation. The better question is not whether a student is a visual, auditory, or kinesthetic learner. It is whether coaching and peer interaction create clear information, meaningful choice, authentic mastery, credible models, constructive persuasion, and manageable challenge. Social cognitive theory explains how these experiences become performance-relevant. Preference-aware multimodal coaching and high-quality peer support shape tennis-specific self-efficacy; efficacy then supports persistence, attentional control, tactical commitment, and recovery from errors. Peer climate can strengthen or weaken the instructional pathway. This mechanism-based account preserves the practical appeal of individualized coaching while replacing fixed categories with testable processes. For Chinese higher education, the framework provides a focused program of research: measure preference without labeling, assess tennis-specific efficacy, use objective and delayed performance outcomes, separate within-person change from stable differences, and test context rather than assuming it. Such work can produce coaching guidance that is both more humane and more scientifically credible.

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