Mental Imagery and Tennis: A Review, Applied Recommendations and New Research

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Abstract

Mental Imagery (MI), which can be defined as the brain's ability to recreate motor experiences in the absence of actual actions, is a mental strategy commonly used by tennis players and coaches in the context of learning and performance. The purpose of this review was to examine the MI use, interventions and effects on the performance of tennis players. Preferred reporting items for reviews and meta-analyses guidelines were employed and research studies were collected via SCOPUS, PubMed, PsycINFO, Science Direct and Google Scholar, in English and French, from the earliest record up to August 2021. Forty-one studies met the inclusion criteria. This review (number 2020-05-87) resulted in a wide variety of MI use in tennis and its beneficial effects, whatever the level or age of the players. MI interventions generally improve motor performance, motivational or affective outcomes. Moreover, MI is frequently combined with other mental skills and integrated in pre-performance routines including breathing, positive self-talk, and/or concentration. This study also highlighted the weak representation of female tennis players that’s why future research is needed to better explore the gender effect in MI interventions in tennis. Overall, MI appears to be beneficial for players, whatever their age or level, and should be incorporated in training programs. Practical implications are discussed.

Key words: Motor imagery; performance; review; tennis; training.

Imagerie mentale et tennis : Revue de littérature, recommandations appliquées et nouvelles orientations de recherche

Résumé

L'imagerie mentale (IM), définie comme la capacité du cerveau à recréer des expériences motrices en l'absence d'actions réelles, est une stratégie mentale communément utilisée par les joueurs de tennis et les entraîneurs dans le cadre de l'apprentissage et de la performance. Le but de cette revue était d'examiner l'utilisation de l'IM et ses effets sur la performance des joueurs de tennis. La méthode PRISMA a été utilisée et les travaux de recherche ont été collectés via SCOPUS, PubMed, PsycINFO, Science Direct et Google Scholar, en anglais et en français, jusqu'en août 2021. Quarante-et-une études ont respecté les critères d'inclusion. Cette revue a révélé une grande variété d'utilisation de l'IM au tennis et des effets bénéfiques, quel que soit le niveau ou l'âge des joueurs sur les performances motrices, les affects et la motivation. De plus, l'IM est fréquemment associée à d'autres habiletés mentales et intégrée dans les routines de pré-performance. Cette étude a mis en évidence la faible représentation des joueuses de tennis, des recherches futures sont donc nécessaires pour explorer s'il existe un effet du genre en lien avec l'IM. Dans l'ensemble, l'IM semble être bénéfique pour les joueurs, indépendamment de leur âge ou de leur niveau et devrait être intégrée dans les programmes d'entraînement. Des recommandations pratiques sont proposées.

Mots clés: Entrainement ; imagerie motrice ; performance ; revue de littérature ; tennis.

Mental Imagery and Tennis: A Review, Applied Recommendations and New Research Directions

Introduction

Tennis, which is one of the racket sports that involves hitting a mobile like a ball (Lees, 2003), requires the development and use of technical, physiological, tactical, mental skills and cognitive processes (Cece et al., 2020). For example, researchers highlighted the importance of attention control and focus in tennis (e.g., Guillot et al., 2013; Schmid et al., 2001). Akpinar et al. (2012) added that this sport requires coincidence-anticipation, accuracy in every stroke and requires a significant amount of practice, learning sessions and repetitions, generally spread over several years and of which the achievement and quality can be facilitated by the use of mental techniques such as mental imagery (Cece et al., 2020). The aim of the current study was to review the studies that concerned Mental Imagery (MI) specifically in tennis in order to provide consistency from data and to identify the main findings concerning the MI effects, uses, outcomes and characteristics in order to give information, precisions or applied recommendations to coaches and practitioners and also to identify limitations and new research directions.

Tennis and Psychological Components

Tennis players need to invest psychological resources (e.g., motivation), by notably using MI (Dana & Gozalzadeh, 2017), in order to improve learning, to progress, to continue participation and to obtain long-term performance (Crespo & Reid, 2007). In addition, because of dual competition and the need to continue playing despite of under-performance, errors or defeats, Covassin and Pero (2004) identified self-confidence as a salient factor in tennis. Moreover, anxiety control (Bolgar et al., 2008) and the emotional regulation of control (Laborde et al., 2014) have also been considered as really important mental skills to take into account, especially before and during tennis competitions. Indeed Jackson and Csikszentmihalyi (1999) argued that athletes competing at their best characterized their ideal state of performance as feeling confident and in control; and conceptualised these optimal experiences as flow state including pleasure, concentration or experiencing a balance between the challenges and one's ability levels. Authors found that awareness and flow was related to tennis performance and that a MI intervention increased flow state and performance in tennis competition (Koehn et al., 2013), and that the use of this mental technique was particularly useful in tennis (Cece et al., 2020). For example, during a match, tennis players perform an intermittent activity, consisting of playing time interspersed with frequent rest times between points and games during which they can use MI to notably improve their accuracy, strategy, concentration or emotional control (Dohme et al., 2019; Mathers, 2017). That's why we reviewed the use and the potential beneficial effect of MI to improve learning, performance and motivational or affective outcomes, and to give practical suggestions, to tennis players and coaches, in order to incorporate this mental technique in training programs as suggested by Di Corrado et al. (2020).

Imagery Definition

According to Kosslyn et al. (1995), imagining places, sounds and actions in the absence of appropriate stimuli for the relevant perception is done through MI. White and Hardy (1998) evoked that athletes use MI in various ways including analysing past performance, reducing anxiety, improving self confidence, focus, quality of training or mental rehearsing of match strategies or motor actions specifically called motor imagery. Motor imagery can be defined as a dynamic state during which the representation of a specific motor action is reactivated in the brain without any over movements (Decety & Jeannerod, 1995). Finally, MI is considered a mental technique that uses all senses to re-create or create an experience in the brain and programs the mind and body to respond optimally (Williams et al., 2012).

Imagery Outcomes

MI is commonly used by tennis players and coaches (Dominique et al., 2021; Lindsay et al., 2019), on its own and usually implicitly or as a part of a mental training program combined with other techniques or mental skills such as relaxation, breathing, self-talk, arousal regulation or concentration (Cece et al., 2020). MI is generally associated with a wide range of positives outcomes in the context of tennis such as motor learning (e.g., Cherappurath & Elayaraja, 2017; Guillot et al., 2012), motor performance (e.g., Cherappurath et al., 2020a; Dominique et al., 2021; Fekih et al., 2020b), regulation and emotional control (e.g., Dohm et al., 2019), anxiety (e.g., Mousavi & Meshkini, 2011) or self-confidence (e.g., Mamassis & Doganis, 2004).

Imagery Function

Authors evoked that MI can affect motor behaviour through both cognitive and motivational mechanisms operating at a general or specific level and identified five subcategories of MI practice also called function (Hall et al., 1998; Paivio, 1985). Cognitive Specific (CS) imagery involves the rehearsal of specific sport skills (e.g., imagining yourself performing a flat serve down the middle) whereas the Cognitive General (CG) imagery, focuses on playing strategies, routines and tactical points that players can use during matches (e.g., imagining performing a serve-volley and winning with a drop shot). Motivational Specific (MS) imagery (e.g., seeing your self winning a match) entails imaging specific goal and the ways to achieve it, influencing intrinsic motivation; Motivational General-Arousal (MG-A) imagery (e.g., imagining the anxiety associated with significant competition) is associated with stress, anxiety and arousal regulation, and Motivational General-Mastery (MG-M) imagery is associated with self-confidence, control and beliefs over an individual’s abilities (e.g., seing yourself coping under challenging situations like after losing a set).

Imagery Modality

Regardless of the type (i.e., subcategories) of MI practice, many authors pointed out that MI modalities and perspectives are very important factors to consider (Cumming & Ste-Marie, 2001; Robin et al., 2020). Indeed, each MI modality can have differentiated impacts on motor performance (Hardy & Callow, 1999). The kinesthetic imagery (KI) modality is defined as what one feels during an action and includes sensations such as force, relaxation and effort involved in movement (Callow & Waters, 2005). Visual imagery modality consists to see an object, an action or a scene. It can be done from an external perspective (i.e., the athlete "views him or herself from another person's perspective") or an internal perspective (i.e., an individual "views the image through their own eyes") (Williams et al., 2012, p. 631). Given the existence of different imagery modalities and perspectives, clear and precise instructions must be given to participants before MI intervention (Callow et al., 2013; Hall et al., 1992; Robin et al., 2020). Finally, it is important to note that the effectiveness of the MI intervention may depend on the athlete's capacity to generate mental images (Seiler et al., 2015).

Imagery Ability

MI ability, which can be defined as an individual's capability to form vivid, controllable images and retain them for sufficient time to effect the desired rehearsal appears as a variable moderating the effects of imagery on sport outcomes (Martin et al., 1999). Indeed, studies showed that individuals with higher imagery abilities (i.e., good imagers) achieved higher levels of performance than participants with lower imagery abilities (i.e., poor imagers) after MI intervention (Goss et al., 1986; Robin et al., 2007). Therefore, Cumming and Ramsey (2009) suggested that it seems important to screen athletes for MI abilities before and during MI practice.

Aim and Objectives

According to Dominique et al. (2021), the mental aspect of performance in tennis represents a central preoccupation for players and coaches. Cece et al. (2020), who reviewed the use of mental training program in racket sports, recently showed that the most frequently used mental skill was MI. However, the use of this mental technic requires certain knowledge, know-how and precautions on the part of the users and to our knowledge no studies has so far synthetized the literature to make an inventory of the characteristics, effects and uses in the field of MI, in particular in tennis. Therefore the main aim of the current study was to provide a synthesis of the researches focused on both tennis and MI. The first objective was to list and collect the researches that concerned MI uses and interventions in healthy non-expert (i.e., novice and intermediate levels) and expert tennis players, regardless of their age (i.e., child, teenager and adult), in particular to verify if this mental technique can be beneficial whatever the age or the level of the players, and to provide an organized synthesis of these studies in order to better understand the effects of MI interventions on outcomes such as learning, performances or affective and motivational psychological factors (e.g., motivation, anxiety, self-confidence) and to give arguments to use it. The second objective was to propose practical recommendations to the players, coaches, researchers or even parents who wish to use imagery in the context of tennis. Finally, the third objective was to suggest potential further investigations concerning MI and tennis.

Materials and Methods

The present review was performed in accordance with Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Moher et al., 2009). The protocol was written before conducting the review. The literature search procedure, including the systematic approach of identification, screening, eligibility, and inclusion, is detailed by using a PRISMA flow diagram (Figure 1). The present review was obtained through electronic journal and manual searches, from the earliest record up to August 2021, in

SCOPUS, PubMed, PsycINFO, Science Direct and Google Scholar databases. The searches, restricted to English and French language publications, were carried out using the following Boolean phrases: ’mental imagery’ OR ‘motor imagery’ OR ‘mental rehearsal’ AND ‘tennis’. The authors (who are both Ph.D in sport science university, doctor in psychology, tennis coaches and mental trainers) screened all the studies, based on the information available in the title and the abstract, meeting the inclusion and exclusion criteria. This study assessed quality and included: (1) original studies, (2) published in scientific peer-reviewed journal, (3) including healthy participants, (4) using mental or motor imagery interventions, (5) in relation to tennis activity. The exclusion criteria were: Publication language other than English or French, MI realized during hypnosis or MI not related to movements or tennis environments. This review was approved by the local ethics committee of the university (registration number 2020-05-87) and was conducted in accordance with the Declaration of Helsinki.

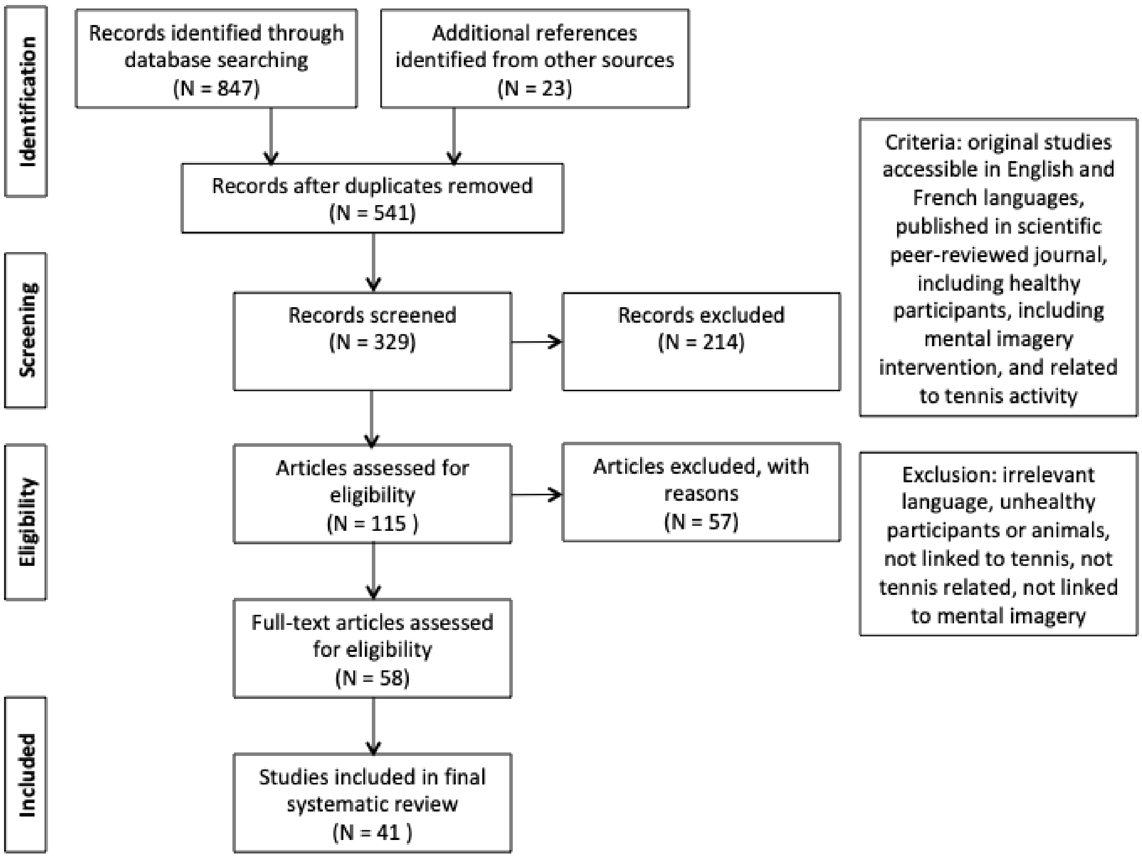

Figure 1. Flow diagram.

The authors independently realized the search and identified records (*N* = 870) through database searching (*N* = 847) and from other sources (*N* = 23). Articles duplicated in two or more databases were identified and removed from this review. Then, the authors screened the records (N = 329) and excluded articles that do not meet the criteria (e.g., irrelevant language or subjects, unhealthy participants, not tennis related). In order to determine the interrater reliability concerning the eligibility of the articles, Cohen's Kappa (McHugh, 2012) was calculated and showed a strong level of agreement (Kappa = 0.893) between the reviewers. Then during meetings, the authors compared and discussed their findings, and a third external reviewer was consulted to resolve any disagreements and avoid bias. The articles assessed for eligibility (*N* = 115) were independently screened (e.g., title, abstract and key-words) to determine if they met the criteria and could be included in the review. The authors screened the full-text articles assessed for eligibility (*N* = 58), for bias such as lack of blinding, absence of randomization, lack of study design or disclosure of conflicts of interest. The selected studies (*N* = 41), found identically by the two authors, were extracted according to references, type of study (e.g., laboratory, ecological condition), MI modalities (e.g., internal visual, external visual, kinesthetic imageries) and types (i.e., cognitive specific, cognitive general, motivational general-arousal, motivational general-mastery, motivational specific) characteristics of the sample (i.e., sample size, gender, mean age, athletic level), experimental groups and duration, outcome measures and main results. The latters were analysed using descriptive statistics with the software package Statistica 12, and the characteristics of the selected studies were summarised (see Table 1).

The evaluation of the quality was realized by using two rating lists because studies with different quantitative designs were included in this review. Randomised controlled trials and non randomized trials were evaluated on the basis on the Physiotherapy Evidence Database guidelines (Maher et al., 2003) with a maximum of eleven points or eight points respectively. Single cases experimental designs were evaluated by using the Single Case Experimental Design guideline (Tate et al., 2008) with a maximum of eleven points (Schuster et al., 2011). Therefore, the studies (*N* = 41), which were included in the final review and were independently scrutinized by the experimenters, received one point for fulfilled methodological criterion such as random allocation of the participants to the groups, similar pre-intervention levels, blinding of all the participants and assessors, statistical comparisons reported, replication and generalisation on the respective rating list (see Table 1) with the higher the score obtained, the better the quality of the study. The evaluation of the quality, which may help the reader to interpret and to use the results of a study with caution especially for a low score, was performed by the authors (for similar procedure see Schuster et al., 2011). A third external reviewer was consulted to resolve any disagreements.

Table 1.

Summary of article characteristics

Authors and years	Titles	Study type	Mental imagery modalities and types	Participants (N, Gender, mean age) and athletic level	Intervention group(s) and duration	Outcomes measures	Main findings or results	Qua-lity rat-ings
Atienza et al. (1998)	Video modelling and imaging training on performance of tennis service of 9- to 12-year-old children	Experimental Ecological condition	Externally guided motor imagery. CS	(22 females, 10 yr.), school tennis players	Physical, Physical + video, Physical + video + MI. 24 weeks	Tennis service Pre-post	Mental practice (i.e., MI and/or video) groups had greater post intervention performances than the control group.	6
Bisio et al. (2014)	The tool as the last piece of the athlete's gesture imagery puzzle	Experimental Laboratory	Kinesthetic imagery CS	(11 males, 9 females, 25 yr.), 10 expert tennis players, 10 novices	Expert and, novices groups. Real movement, 60 MI trials with racket, tennis-like racket or umbrella 1 session	Movement Imagery Questionnaire-R Real and MI durations, Movement kinematic	MI and real movement durations were similar with the rackets. When not handled specific tool, MI duration increased but not in the control condition.	7
Blankert & Hamstra (2017)	Imagining success: Multiple achievement goals and the effectiveness of imagery	Experimental Ecological condition	Internal visual and kinesthetic imagery, CS	(49 males, 16 females, 27 yr.), tennis players level (4-7 US rating)	Mastery goal, performance goal, mastery plus performance goal groups 1 session	Service Pre-post	Post imagery intervention service performance was greater in the mastery plus performance goal group than in the other groups.	6
Cherap-purath & Elayaraja (2017)	Combined effects of SAQ and PETTLEP imagery training: A study on the learning process of new skills among novice tennis players	Experimental Ecological condition	Internal visual and kinesthetic imagery, CS	(40 males, 10-12 yr.), novice tennis players	Speed, Agility and Quickness training group, MI group, SAQ and MI group, control group 12 weeks	Forehand, backhand, volley Movement Imagery Questionnaire-R Pre-post	Experimental groups had higher post intervention performances than control group, and the SAQ + MI group had greater performance than the other groups.	6

Cherap-purath et al. (2020)	PETTLEP imagery and tennis service performance: An applied investigation	Experimental Ecological condition	Internal visual and kinesthetic imagery, CS	(44 males, 13 yr.), 2-6 yr. practice	Service training, MI, service training + MI, control groups 12 weeks	Service Movement Imagery Questionnaire-R Pre-post	Service training and MI group had higher performance than other groups.	7
Coelho et al. (2007)	Imagery intervention in open and closed tennis motor skill performance	Experimental Ecological condition	Mutli-modal imagery MG-M	(48 males, 17 yr.), national tennis players	Technical practice, MI + technical practice 2 months	Service and service return Pre-post	MI intervention improved service performance.	6
Coelho et al. (2012)	Use of multimodal imagery with precompetitive anxiety and stress of elite tennis players	Experimental Ecological condition	Mutli-modal imagery, control imagery: good moments on the beach, MG-M	(46 males, 17 yr.), elite tennis players	Multimodal imagery, placebo imagery, control groups 9 weeks	Competitive State Anxiety Inventory Perceived Stress Scale Pre-post	Multi-modal MI can lower cognitive anxiety and perceived stress levels and to build self-confidence.	7
Cumming & Hall (2002)	Deliberate imagery practice: The development of imagery skills in competitive athletes	Experimental	Deliberate MI uses CS, CG, MS, MG-A, MG-M	(78 males, 72 females, 21 yr.), novice (n = 50), provincial (n = 50) and national (n = 50); 5 tennis players	Recreational athletes, provincial athletes, national athletes groups. 1 session	Deliberate Imagery Practice Questionnaire Time spent performing mental imagery	National athletes perceived MI more relevant to improving performance and competition effectively than recreational. Provincial and national athletes use more often MI than recreational.	6
Dana et al. (2017)	Internal and external imagery effects on tennis skills among novices	Experimental Ecological condition	Internal and external imagery CS	(36 males, 15-18 yr.), novice tennis players	Internal imagery, external imagery, control groups 6 weeks	Forehand, backhand Service. Pre-post	Internal MI group had higher serve and External MI group had greater forehand performances.	6

Daw et al. (1994)	Evaluation of a comprehensive psychological skills training program for collegiate tennis players	Experimental Ecological condition	Psychological skills training CS, MG-M	(13 males, 13 females, 18-23 yr.), intermediate (collegiate) tennis players	Psychological skills training group, control group 3 sessions	Forehand, backhand stroke, Service. Pre-post	Participants who had psychological skills training exhibited greater self-confidence and committed fewer double faults than the control group.	6
de Sousa Fortes et al. (2019)	Effect of motor imagery training on tennis service performance in young tennis athletes	Experimental Ecological condition	Video before MI First person imagery CS	(28 males, 15 yr.), regional tennis players	Imagery training, control groups 8 weeks	Movement Imagery Questionnaire-3 Service, Pre-post	The first person imagery training improved the running speed and performance of the tennis service.	7
Dereceli (2019)	Investigating the imagination levels of students playing tennis	Experimental	CS, CG, MS, MG-A, MG-M	(57 males, 94 females, 8-16 yr.), students recreational level	Age, gender, persistence of sporting 1 session	Sport Imagery Questionnaire	The level of imagery did not differ significantly based on age or gender in the students engaged in tennis.	4
Desliens et al. (2011)	Imagerie motrice et precision au service: Etude de cas [Motor imagery and service accuracy: A case study]	Experimental Case study Ecological condition	Visual imagery, Kinesthetic imagery CS	(1 males, 24 yr.), expert tennis player	Imagery modality, number of mental repetition, context 1 session	Service	4 MI repetitions, in serving position, improved accuracy. Visual MI practice, in serving position, improved consistency.	6
Di Corrado et al. (2019)	Imagery ability of elite level athletes from individual vs. team and contact vs. no-contact sports	Experimental Laboratory	Mental imagery transformation, Kinesthetic imagery, Internal visual imagery, External visual imagery CS	(64 males, 56 females, 24 yr.), national (16 males, 14 females), control (28 males, 32 females, 23 yr.)	Gender, contact /no-contact sports, team/individual sports 1 session	Vividness of Visual Imagery Questionnaire Vividness of Movement Imagery Questionnaire-2 Mental Image Transformation	Individual sports exhibit better vividness of visual MI ability, and kinesthetic and external visual imagery scores than team sports, and internal visual imagery scores than team and contact sports.	6
Dohm et al. (2019)	Development, implementation, and evaluation of an	Experimental Ecological	Psychological skills training (self-talk, imagery and	(11 males, 8-15 yr.), elite youth tennis	3 phases: pre-intervention, intervention,	Observation, field notes, athlete-	Psychological skills training improved the players' regulation,	7

	athlete-informed mental skills training program for elite youth tennis players.	Condition	performance routines) CS	players	evaluation. 15 month	workshop data and semi-structured interview with the coach	emotional control and use of psychological skills.	
Domini-que et al. (2021)	Effect of a routine based on mental imagery on service efficiency of expert tennis players	Experimental Ecological Condition	External visual MI + breathing + ball rebound CS	(27 males, 13 females, 18 yr.), expert tennis players	MI, control groups 20 weeks of a routine based MI + practice.	Service Mental imagery vivacity scales Pre-post	Service routine (breathing + ball rebound + MI) induces higher post-test performance than control condition.	7
Fekih et al. (2020a)	The Impact of a motor imagery-based training program on agility, speed, and reaction time in a sample of young tennis athletes during Ramadan fasting: Insights and implications from a randomized, controlled experimental trial	Experimental Ecological Condition	Visual imagery External visual imagery Kinesthetic imagery CS	(27 males, 17 yr.), national tennis players	Imagery group, control group 4 weeks	MAT-Agility test, Speed (ZIG-ZAG test), Movement Imagery Questionnaire-RS MI duration Pre-post	Fasting during Ramadan reduced speed, agility, and reaction time performance. Mental imagery intervention can reduce the effect of fasting by stabilizing reaction time, speed and agility performance.	7
Fekih et al. (2020b)	Effects of motor mental imagery training on tennis service performance during the Ramadan fasting: A randomized, controlled trial	Experimental Ecological Condition	Visual imagery Kinesthetic imagery Video First person perspective CS	(38 males, 16 yr.), national tennis players	Imagery, control groups 4 weeks	Service performance, Movement Imagery Questionnaire Pre-post	The imagery group improved the accuracy, running speed and performance of the service, mitigating the negative effects of Ramadan.	7
Féry et al. (2000)	Kinesthetic and visual image in modelling closed motor skills: the	Experimental Ecological Condition	Visual imagery (VI) Kinesthetic imagery (KI)	(32 males, 21 yr.), novice tennis players	Kinesthetic modelling + KI, visual modelling + VI, kinesthetic	Vividness of Visual Imagery Questionnaire	Participants who realized MI practice had beneficial effect on tennis serve precision. Novices who	6

	example of the tennis serve		CS		modelling, visual modelling and control groups 6 sessions	Service Pre-post	performed KI had higher form and speed scores than those who performed VI or control.	
Fourkas et al. (2008)	Kinesthetic imagery and tool-Specific modulation of corticospinal representations in expert tennis players	Experimental Laboratory	Kinesthetic imagery CS	(14 males, 2 females, 20-33 yr.), 8 expert tennis players, 8 novices	Expert tennis players, novice groups 1 session	Movement Imagery Questionnaire Transcranial Magnetic Stimulation	Novices were not modulated across sport. Muscles of expert tennis players showed increased corticospinal facilitation during MI of tennis but not table tennis or golf.	7
Gabr. (2010)	Mental imagery and self-talk as approach to cope with pressure among individual sports	Experimental Ecological condition	Visual imagery, auditory imagery, kinesthetic imagery, emotional + control imagery CS, MS, MG-M	(22 NC, NC yr.), NC	Fencing player, tennis player, karate player groups 8 weeks	Multi-dimensional Mental Imagery Scale in Sport, Self-Talk Scale in Sport, Skills of Facing Sports Pressure Scale Pre-post	All the groups had higher post treatment scores in all the dependant variables.	3
Guillot et al. (2005)	Duration of mentally simulated movement: A review	Experimental Laboratory	Mental Imagery CS	(10 males, NC), 10 expert tennis players, 10 gymnasts	Expert tennis players, Experts gymnasts 1 session	Duration of actual and MI actions: service + volley	Durations of actions were longer during MI than during actual performance in both gymnastics and tennis athletes.	5
Guillot et al. (2004)	Relationship between visual and kinesthetic imagery, field dependence-independence, and complex motor skills	Experimental Laboratory	Visual imagery (VI) Kinesthetic imagery (KI) CS	(10 males, 10 females, 16-35 yr.) 10 expert players, 10 gymnasts	Expert tennis players, Experts gymnasts 1 session	Skin resistance as peripheral indicator or mental imagery MI duration	50% of the tennis players make better use of VI than KI, whereas the other makes better use of KI than VI.	6
Guillot et al. (2012)	Motor imagery and ‘placebo-racket effects’ in tennis serve performance	Experimental Ecological condition	Combination of visual, auditory and kinesthetic imagery	(15 males, 7 females, 14-16 yr.), regional	Imagery, placebo, control groups. 6 weeks	Movement Imagery Questionnaire-R Service	MI improved service performance. Placebo racket + MI induced greater serve accuracy	7

			CS	players		Pre-post	compared to MI alone.	
Guillot et al. (2013)	Motor imagery and tennis serve performance: The external focus efficacy	Experimental Ecological condition	Mental imagery with external focus CS	(7 males, 5 females, 11 yr.), elite tennis players	2 consecutives conditions: 8 weeks control, then 8 weeks MI. 16 weeks	Movement Imagery Questionnaire-R Service Test-retest	An increase in the service accuracy, velocity, and first successful serves was showed after MI practice.	6/10
Guillot et al. (2015)	Implementation of motor imagery during specific aerobic training session in young tennis players	Experimental Ecological condition	Combination of internal visual, external visual and kinesthetic imageries CS	(6 males, 4 females, 13 yr.), young elite tennis players	Two playing training session: a session including mental imagery and a control session	Movement Imagery Questionnaire-R Forehand and backhand Pre-post	Embedding MI during high intermittent training sessions increases physical fitness and preserves forehand and backhand performances.	6
Hegazy et al. (2015)	The effect of mental training on motor performance of tennis and field hockey strokes in novice players	Experimental Ecological condition	Photo and video of expert tennis players Visualization CS	(24 males, 19-20 yr), novices	Experimental group, 16 sessions	Visualization test Forehand and backhand Pre-post	The participants of experimental group significantly improved their forehand and backhand performances.	4
Jung et al. (2015)	Effect of imagery tennis training on cerebral activity	Experimental Laboratory	Visual imagery CS	(11 males, 25 yr), novice players	Experimental group 1 session	Electroencepha-lography	MI of tennis activates the hippocampal-occipital alpha networks.	4
Koehn et al. (2014)	Imagery intervention to increase flow state and performance in competition	Experimental Ecological condition Case study	CS, CG, MS, MG-M	(4 males, 14 yr.), national tennis players	6 weeks baseline flow state and performance, and 6 weeks intervention phase	Sport Imagery Ability Measure Flow State Scale-2 Single-case A-B multiple-baseline design	3/4 tennis players increased flow experiences. All of them improved service and groundstroke performances, and ranking-list position.	6
Mamassis (2005)	Improving serving speed in young tennis players	Experimental Ecological condition	External visual imagery CS	(48 males, 10 yr.), intermediate tennis players	Service, service + strength training, mental training +service, mental training + service + strength, control	Service Imagery quality rating Pre-post	Mental training + service had higher performances than the other groups. Mental training + service + strength training group	5

					groups. 8 weeks		had greater performances than the control group.	
Mamassis et al. (2004)	The effects of a mental training program on juniors pre-competitive anxiety, self-confidence, and tennis performance	Experimental Ecological condition	Mental training program (MTP) CS, CG	(9 males, 14 yr.), elite junior tennis players	Experimental, control groups Season-long mental training program	Competitive State Anxiety Inventory-2 Overall tennis score. Vividness imagery scores Pre-post	Higher scores in the direction of the somatic and cognitive anxiety and self-confidence, on the intensity of self-confidence, and overall tennis performance after MTP.	6
Mathers (2017)	Professional tennis on the ATP tour: A case study of mental skills support	Experimental Ecological condition Case study	Mental skills External Visual Imagery CS, MG-M	(1 male, 27 yr.), international tennis player	3 years	Mental skills development Global tennis performance	Mental skills and pre-service routine improved tennis performance and outcomes.	6
McAle-ney et al. (1990)	Effects of flotation restricted environmental stimulation on intercollegiate tennis performance	Experimental Ecological condition	Visual imagery of optimal shots CS	(10 males, 10 females, 19 yr.), inter-collegiate	Flotation REST with MI, MI only groups. 3 weeks	Service Pre-post	Flotation REST with MI group had higher post-treatment first service accuracy than the MI only group.	7
Mizugu-chi et al. (2015)	The effect of somatosensory input on motor imagery depends upon motor imagery capability	Experimental Laboratory	First imagery perspective CS	(12 males, 5 females, 19-29 yr., 22 yr), 2-12 yr. practice	Forehand and backhand with racket, MI of forehand and backhand with or without racket, congruent or incongruent grips 1 session	Vividness of MI scores Time for real and MI movement with congruent or incongruent grips	A congruent grip improves whereas an incongruent grip deteriorates motor imagery of the backhand swing. A congruent forehand grip did not improve motor imagery of the forehand swing.	7
Morais et al. (2019)	Pre-service routines, mental toughness and performance enhancement of young tennis athletes	Experimental Ecological condition	Mental toughness including: Visualization CS, MG-M	(10 males, 1 females, 12 yr.), amateur competitors	Performance baseline and intervention phases 10 sessions	Service Pre-post	More service games won after the program.	5

Mousavi et al. (2011)	The effect of mental imagery upon the reduction of athletes' anxiety during sport performance	Experimental	MG-A	(50 males, NC), NC	Experimental group, control group 1 session	Kettle anxiety questionnaire Pre-post	MI reduced post intervention tennis players' anxiety.	2
Noel (1980)	Effect of visuo-motor behavior rehearsal tennis performance	Experimental Ecological condition	Visual imagery CS	(14 males, NC), novice players	Visuo-motor behaviour rehearsal, Control groups, 10 days	Service Pre-post	The visuo-motor behaviour rehearsal group marginally improved first serve %.	5
Robin et al. (2007)	Effects of motor imagery training in service return accuracy in tennis: the role of imagery ability	Experimental Ecological condition	Internal visual imagery CS	(30 males, 19 yr.), expert tennis players	Good imagers, Poor imagers, Control groups, 10 weeks	Return service Movement Imagery Questionnaire Pre-post	MI groups had higher post-test scores than control group. Good imagers had higher scores than poor imagers.	6
Spittle et al. (2007)	Internal and external imagery perspective measurement and use in imagining open and closed sports skills: An exploratory study	Experimental Ecological condition	Internal imagery perspective External imagery perspective CS	(23 males, 18 females, 19 yr.), novice tennis players	1 condition 1 session	Imagery Use Questionnaire Rating scale on MI perspectives Retrospective verbalisation	A general imagery participants' perspective preference is not a good predictor of MI uses. Participants experienced less external than internal MI.	5
Turan et al. (2019)	The impact of cognitive-based learning and imagery training on tennis skills	Experimental Ecological condition	Visual imagery and video CS	(16 males, 19-25 yr.), 3 yr. practice	Experimental, control groups 8 weeks	Hewitt test (forehand and backhand) Pre-post	Cognitive-based learning and MI training improved forehand and backhand performances.	4
Türk et al. (2019)	Technical parameters and mental toughness in tennis players	Experimental Ecological condition	Mental toughness including: Visualization MG-A, MG-M	(24 males, 25 females, 13 yr.), NC	Experimental group 1 session	Ground shots, volley, Service, Mental Toughness Inventory Questionnaire	A negative relationship was found between ground stroke depth, volley, ground shots precision power tests, and service performance and imagery in participants.	3

Note. Cognitive Specific (CS), Cognitive General (CG), Motivational Specific (MS), Motivational General-Arousal (MG-A), Motivational General-Mastery (MG-M), Mental Imagery (MI).

Results

Type of Participants and Sample Size

This review included a total of 1341 tennis players, from 41 studies, including children (12.1%), teenagers (38,7%), and adults (49,2%). An over-representation of males (70.5%) compared to females (29.5%) was highlighted. The participants were novice (N = 227, 16.9%), or had intermediate (N = 402, 29.9%), regional to national (N = 571, 42.6%) or international (N = 71, 5.3%) levels. Only 3 articles were considered as case studies (7.3%) with less than 5 participants (and only 1 for two articles), the majority of the studies had sample size from 10 to 49 participants (N = 32, 78.0%), and 6 studies had 50 or more participants (14.6%).

Outcomes and Tasks

Most of the studies reviewed (N = 31, 75.6%) found beneficial effects of MI interventions, primarily on performance improvements (i.e., accuracy, speed, efficacy, technique of the strokes, global performance, rank and match wins, see Table 2). Among the studies that showed improved performance, this improvement was observed during tests (N = 22, 53.65%), practice matches (N = 11, 26.82%), or real competitions (N = 8, 19.51%). More specifically, during matches, MI was performed only prior to execution (N = 6, 14.63%), only during execution (N = 5, 12.19%) or during both (N = 7, 17.07%). The outcome measures of the studies reviewed mainly focused on quantitative motor performance gains (e.g., accuracy, speed, percentage of success) in service (N = 18, 43.9%), forehand, backhand and volley (N = 17, 41.15%), service return (N = 2, 4.9%) or duration of movement (i.e., isochrony between real and imagined movement; N = 4, 9.8%). In addition, other dependant variables concerned psychological factors such as anxiety, perceived stress, flow or self-talk (N = 16, 39.0%) mainly evaluated by means of questionnaires, scales and interviews, or physiological activities such as skin resistance, electroencephalography or electromyography activities (N = 3, 7.3%) measured by specific tools.

Table 2.

Summary of the main results concerning the effects of motor imagery

Outcomes	Positive results	Neutral results	Negative results
Service performance	N = 15	N = 2	N = 1
Service return performance	N = 2	-	-
Forehand performance	N = 8	N = 1	N = 1
Backhand performance	N = 7	N = 1	-
Volley performance	N = 2	N = 1	-
Global match performance	N = 18	-	-
Speed/agility performance	N = 2	-	-
Emotional control and flow state	N = 10	N = 2	-
Self-confidence	N = 6	-	-
Physiological activity	N = 3	N = 1	-

Imagery Function

Most of the studies used the Cognitive Specific (CS; N = 36, 87.8%) and 4 the Cognitive General (CG; 9.8%) functions of MI, while 11 studies used the Motivational General-Mastery (MG-M; 26.8%), 4 the Motivational General-Arousal (MG-A; 9.8%), and 4 the Motivational Specific (MS; 9.8%) functions of MI.

Imagery Modality

Concerning the modalities used during MI interventions, 16 articles (39.0%) mentioned the use of kinesthetic imagery, most of the time combined with visual imagery modality (N = 14). Twenty-five studies (61.0%) reported the use of visual imagery modality only. Specifically, 10 studies (24.4%) reported the use of external visual imagery, and 6 indicated (14.6%) the use of internal visual imagery perspectives.

Imagery Ability

Several studies have used questionnaires or Likert-type scales to measure: MI ability (N = 19, 46.3%), MI use (N = 7, 17.1%), anxiety (N = 5, 12.2%), flow (N = 1, 2.4%), or perceived stress (N = 1, 2.4%). Most studies controlled the MI ability of the participants (N = 18, 43.91%). One study revealed that national level tennis players exhibit better vividness visual MI ability scores than participants of team sports and another study revealed that good imagers had greater performance than poor imagers.

Imagery and Practice

Concerning the practice, 25 studies (61.0%) used MI technique alone, while other studies (N = 11, 26.8%) included MI in mental training programs or routines (i.e., pre-performance or pre-competitive). For example, MI was combined with techniques such as relaxation (N = 2, 4.8%), breathing (N = 1, 2.4%), video observation (N = 5, 11.2%), goal setting (N = 1, 2.4%) or positive self-talk (N = 2, 4.8). Finally, 29 studies (70.7%) used MI intervention in combination with physical practice.

Concerning the experimental procedures, twenty-five studies (61.0%) used a pre- post measurement design. The duration was: 1 day for 14 studies (34.1%), more than 4 weeks and 12 sessions for 23 studies (56.1%), and up to 1 year (N = 1, 2.4%) or more (N = 2, 4.8%). The intervention times varied between 10 and 120 minutes per session and between 1 and 3 sessions per week. While only 7 studies (17.1%) were carried out in laboratory, the others were performed in ecological (N = 35, 85.4%) conditions (i.e., on the court).

[Table 1 near here]

Discussion

Apart from a recent study that reviewed the effects of mental training programs in racket sports, to our knowledge, no review has specifically investigated the effects of MI in tennis context. Based on 27 studies, including 12 studies that concerned tennis players, Cece et al. (2020) found that the most frequently used technique in mental training programs was MI, which confirms previous researches (e.g., Daw & Burton, 1994; Defrancesco & Burke, 1997). The current review revealed that MI is effective in tennis by improving learning and performance in different tennis tasks, regardless of participant type, as well as positive influence on motivational and affective factors. However, it is important to specify that the current review revealed that MI is generally combined with other techniques such as: Goal setting (e.g., Mamassis & Doganis, 2014), arousal regulation (e.g., Daw & Burton, 1994), positive statement (e.g., Mathers, 2017), self-talk (e.g., Dohm et al., 2019), relaxation (e.g., Koehn et al., 2013), breathing (e.g., Dominique et al., 2021; Mamassis, 2005), or video (e.g., Atienza et al., 1998; de Sousa Fortes et al., 2019). The latter combination can be used whatever the age or level of the participants (Di Corrado et al., 2020). For example, the use of the video of a model can make it easier to activate the mental representation of the action that will be used in MI (McNeill et al., 2020). This is why it seems recommended to coaches and players to use video of a model before MI, especially for tennis players who have difficulty in imagining actions, and to develop the use of psychological skills whatever the level or age of the participants.

Imagery and Participants

The present review revealed that MI can be used with tennis players of all skill levels. Indeed, while beneficial effects have been observed in novice players (e.g., Dana & Gozalzadeh, 2017; Féry & Morizot, 2000; Jung et al., 2015), other studies have also shown improvements in performance in intermediate level (e.g., Cherappurath et al., 2020; de Sousa Fortes et al., 2019; Morais et al., 2019) or experts (e.g., Di Corrado et al., 2019; Dominique et al., 2021; Hegazy et al., 2015) tennis players. These results confirm those of previous studies which have shown that MI interventions can be beneficial regardless of the level of practice of the participants (Toth et al., 2020) and can be used by children and pre-teens (Cherappurath et al., 2017; Dereceli, 2019; Di Corrado et al., 2020; Dohm et al., 2019; Guillot et al., 2013) in motor learning context. Therefore, it is suggested that tennis coaches start using MI with beginners and school tennis players, and encourage them to use it as they progress. It is possible that the use of a particular imagery modality (e.g., kinesthetic imagery), which may be difficult to use in young players (Martini et al., 2016) could induce a lack of (short-term) performance improvement, especially among non-experts. That's why authors suggested the use of general MI training, in the targeted imagery type, to make the athletes more aware of the stimulus and response information in their MI (Smith & Holmes, 2004), and to progressively increase the amount of detail and complexity of the MI instructions (Calmels et al., 2004). Apart from studies on deliberate imagery use (e.g., Cumming & Hall, 2002), few tennis studies investigated the effects of MI intervention according to skill level. Further research is needed to compare, the potential difference in the effects of imagery modalities (e.g., kinesthetic, internal visual, external visual), in tennis players of different skill levels (i.e., novice, intermediate and experts), performing the same tennis tasks such as service or service return for examples.

Imagery and Outcomes

A recent meta-analysis revealed that MI interventions can enhance motor performance, motivational and affective outcomes (Simonsmeir et al., 2020). These results were corroborated in the current review, in which it was observed that MI was used to increase intrinsic motivation (e.g., Gabr, 2010; Whitbread & Newell, 2013), self-confidence (e.g., Coelho et al., 2012; Mamassis & Doganis, 2004), or emotional control (Di Corrado et al., 2019; Dohm et al., 2019), and to lower anxiety (e.g., Mamassis & Doganis, 2004; Mousavi & Meshkini, 2011) or perceived stress (Coelho et al., 2012) in tennis players. As suggested by Cumming and Hall (2002), it seems important for tennis players to realize that

MI should not only be used as a strategy to improve motor performance but can have other functions such as cognitive general (e.g., use of different tactical solutions during a match) or motivational specific (e.g., seeing your self winning a medal) for examples, that can be beneficial to progress and perform in match.

Imagery Function

Although participants reported using MI for all five functions: cognitive specific, cognitive general, motivational general-arousal, motivational general-mastery, motivational specific imageries (Cumming & Hall, 2002), motivational general-mastery and cognitive specific imageries were the most frequently used by the tennis players as generally observed in the literature (Slimani et al., 2016). Indeed, studies revealed that MI facilitated the learning and increased performance in service (e.g., Blankert & Hamstra, 2017; Cherappurath et al., 2020; Dominique et al., 2021; Fekih et al., 2020b; Noel, 1980), service return (Coelho et al., 2007; Robin et al., 2007), volley (Cherappurath et al., 2017; Türk et al. 2019), forehand and backhand stroke (Dana & Gozalzadeh, 2017; Hegazy et al., 2015; Koehn et al., 2014), or general (Mathers, 2017; Morais et al., 2019) performances. One applied implication is the importance of educating tennis players, especially beginners and non-experts, on the value of using different function of MI (Cumming & Hall, 2002), including the motivational specific function which can influence intrinsic motivation and the motivational general-arousal function which is associated with stress, anxiety and arousal regulation which will find its use especially during competitions. The different functions of MI can be performed by using different imagery modalities that we will now discuss.

Imagery Modality

Each imagery modality can have differentiated effects on performance depending on the constraints of the actions to be performed (Callow & Roberts, 2012; Munroe et al., 2000). Indeed, while proprioceptive imagery (i.e., rediscovering sensations of movement, force, stretching) seems to be beneficial for motor actions involving inter-segmental coordination (Féry, 2003) or execution speed (Féry & Morizot, 2000), other authors have put in evidence the superiority of internal visual imagery (i.e., to the first person as if one were looking with his own eyes) for tasks carried out in which environmental changes induce planning constraints as for the service return in tennis (Robin et al., 2007). In addition, it has been shown a superior effect of external visual imagery when it comes to reproducing with precision of forms (Hardy & Callow, 1999) or to pay attention to the trajectory of the ball as is the case for the service on the tennis court (e.g., Atienza et al., 1998; Dominique et al., 2021; Guillot et al., 2013; Mamassis, 2005). Finally, authors using a combination of kinesthetic and visual MI showed beneficial effects in forehand and backhand (Guillot et al., 2015) or service (Desliens et al., 2011) performances in experts, but lesser positive effects were obtained in beginners (e.g., Cherappurath & Elayara, 2017), or non-experts players (Cherappurath et al., 2020). Indeed, Hardy and Callow (1999) have suggested that the use of kinesthetic imagery is more beneficial when participants have certain degree of expertise at a task, non-experts usually have more difficulties in feeling motor actions that they have to imagine (Guillot & Collet, 2005). It will therefore be recommended to favour visual imagery with novice tennis players and to gradually use kinesthetic imagery with the players especially those who have difficulty in performing MI.

Imagery Ability

It is important to remember that while all tennis players are able to perform MI (Goss et al., 1986), and that it is not necessary to be a good imager to begin MI training, its degree of effectiveness depends upon the athlete’s ability to generate mental images. Indeed, Robin et al. (2007) showed that good imager tennis players had greater service return performances than poor imagers, who still performed better than participants in a control group who did not performed MI. That’s why many authors evoked the necessity to control the tennis player’s imagery ability when using MI interventions (e.g., Cherappurath et al., 2020; Dominique et al., 2021; Fekih et al., 2020a,b; Guillot et al., 2012; Mizuguchi et al., 2015; Spittle et al., 2007). Indeed, Cumming and Williams (2012) suggested that if an athlete is not able to accurately form images of particular content or from a certain modality, the potential for using MI to improve the movement or performance can be considerably reduced and it will need more practice time. For example, Goss et al. (1986) showed that good imagers acquired simple movements in fewer trials than poor imagers and that good imagers were able to reproduce movement patterns more accurately. However, it is important to note that, even if they are poor imagers, all tennis players can benefit from MI interventions (Robin et al., 2007) and can improve their MI ability after training (Cumming et al., 2004; Rodgers et al., 1991) by first imagining simple actions or parts of movements and then gradually increasing the complexity of MI scripts. As previously evoked, the use of video (e.g., Atienza et al., 1998) could help poor imagers to access to the motor representation of the action to imagine during MI practice.

Imagery and Practice

It is very important to note that in most of the studies reviewed, MI was used in addition to physical practice, which is likely due to the facts that imagery practice alone is known to have smaller effect than that following physical practice alone (Toth et al., 2020). However, MI combined with physical practice is generally more effective than physical practice alone (Lindsay et al., 2019; Simonsmeir et al, 2020), that’s why coaches should frequently include MI in training sessions. For example, the positive effects of the combination of MI and physical performance were demonstrated in a recent study in which Dominique et al. (2021) showed the beneficial effects of a pre-performance routine consisting of breathing, ball bounces and MI, performed before serving. The use of routines is very common in skilled and professional tennis players (e.g., Mamassis & Doganis, 2004; Mathers, 2017). For example, Morais and Gomes (2019) developed, in tennis athletes, a systematic behavioural and cognitive preparation prior to serve that notably included concentration and MI (i.e., the players imagined hitting theirs shots exactly where they wanted). More importantly, the routine was individualized and automatized during training as recommended by Dominique et al. (2021). The latter authors, also suggested to specify to the participants the imagery modality and/or perspective they must use during MI intervention and/or routine.

More Applied Recommendations

In order to facilitate the construction of mental representation in racket sports, Guillot et al., (2015) suggested performing MI on the court, wearing sport clothing, hearing the ball bounces and handling the racket. Indeed, Mizuguchi et al., (2015) suggested that tactile input associated with holding the tennis racket could improve imagery vividness especially in poor imagers or beginners. In addition, Bisio et al. (2014) found, in expert tennis players, that the duration of an imagined tennis gesture was similar to that of the same gesture physically performed when holding a tennis racket while an absence of isochrony was observed when they held a tennis-like racket (i.e., an object resembling a racket, of the same mass: 300 grams but different size) or an umbrella. It is conceivable that the prolonged use of a tennis racket, in skilled tennis players, could induce neuroplastic modification of the body representation in the brain incorporating the racket in their own body representation (Maravita & Iriki, 2004) and considering it as an extension of the hand (Fourkas et al., 2008). Moreover, the fact that MI can be performed on the court indicates that tennis players can use it during competition before serving, between points and when changing sides for examples.

During tennis competition, pressure is an important problem facing most of the players that can lead to loss of flow experience and performance (Gabr, 2010). Koehn (2014), examining the effectiveness of an MI intervention on improving performance and the experience of flow state, showed an increase in flow experiences in three of four junior tennis players. Although these results need to be confirmed by further research, the idea that MI interventions might facilitate optimal flow experiences in competition (e.g., being focused on the task, totally absorbed, feeling in control and confident) is particularly interesting because cognitive and motivational imagery can be easily incorporated into training and competition preparation (Koehn et al., 2013). Indeed, Koehn (2014) mentioned that linking flow dimensions of sense of control and challenge-skills balance with motivational general mastery imagery appears to have a beneficial effect on the positive experience, especially on tennis players' confidence. In addition, the use of cognitive specific imagery (e.g., before performing a service or a service return) could allow the tennis players to be more focused and know what to do during a rally. Moreover, cognitive general imagery, focussed on tactical points and strategies, could cognitively better prepare tennis players to react to different match situations. That's why we recommend athletes to use MI both before and during matches. In addition, it is also important to note that tennis mental trainers also recommend athletes to use MI after matches in order to "keep in memory what worked well" and on the contrary "erase" or "replace" with positive imagery of actions (Coelho et al., 2007) or strategies the negative outcomes.

Moreover, it is important to note that MI intervention do not consistently provide a beneficial effect on learning and performance. For example, studies showed a lake of service improvement (e.g., Noel, 1980; Withbread & Newell, 2013) after MI intervention probably due to low amount of MI training session or trials. In addition, Guillot et al. (2005), who found that tennis players systematically overestimate self-estimation of tennis movement duration during MI, mentioned that MI training might be based upon individual characteristics such as MI abilities and preferences. Indeed, in novice tennis players, Dana and Gozalzadeh (2017) who showed similar backhand strike performance between the Control and MI groups, also revealed greater service accuracy when using internal MI and forehand accuracy when using external MI. It seems that clear MI instructions and a sufficient amount of practice are recommended in order to benefit from positive effects of MI whatever the level or type of participant.

Indeed, it is finally important to note that the female tennis players improved their performance (e.g., Atienza et al., 1998; Blankert & Hamstra, 2017) when benefited from motor imagery and had similar MI uses (e.g., Derecli, 2019; Guillot et al., 2004) than males, that’s why it is recommended to use this mental technic regardless of gender. But the current study highlighted the weak representation of female tennis players within the studies’ participants highlighting a male tennis player predominance in researches that used MI interventions in tennis or racket sports (Cece et al., 2020). Although many studies have not found gender difference in MI ability and vividness (Robin et al., 2020; Subirats et al., 2018), more research is needed to better explore the gender influence in MI interventions in tennis.

New Research Directions

Whereas it was previously mentioned that the beneficial effects of MI could be influenced by the imagery ability of the tennis players (e.g., Robin et al., 2007), we may envisage that the combination of MI with other mental technics such as instructional self-talk could help the participants to imagine all the parts of complex motor actions to imagine such as the service. A study will soon be carried out in our laboratory to test this hypothesis in novice tennis players; and further research will also be conducted to assess the potential beneficial effect of combining model video, coach feedback and MI as previously shown by Robin et al. (2020) in a precision task.

Likewise, although several studies showed that MI was effective to improve performance, most of them used acute (e.g., a single day; Deslins et al., 2011; Di Corrado et al., 2019) or short duration interventions (i.e., a few sessions or weeks; Fekih et al., 2020a,b; Turan et al., 2019) and very few studies (i.e., less than 10%) used long (several months; e.g., Atienza et al., 1998; Dominique et al., 2021) or chronic (i.e., one year and more; e.g., Dohm et al., 2019; Mamassis et al., 2004; Mathers, 2017) interventions. Therefore, further research is needed to determine, using post-performance measures long after the MI intervention, whether the effect of motor imagery lasts over time to stabilize a good performance or could be considered an acute intervention that could be beneficial before a competition for example. Whereas the use of pre-competition positive MI seems beneficial in closed tennis skill performance (Malouff et al., 2008), more research is needed to better explore the effect of positive MI during and after competition in open tennis skill (e.g., service return) and match performances.

Finally, due to many different outcomes (i.e., learning, performance improvement, preferences, uses, mental chronometry or neurophysiological measures), participant’s characteristics (age, level, gender) and sample sizes, MI interventions durations (only one, weeks, months, years), types of studies, experimental groups and procedures and the differences in study’s quality, there are risks of bias and the use of a meta-analysis did not seem relevant which can be considered as a limitation of this study. The increase in number and quality research in the field of tennis, especially in the motor learning or performance improvement following MI intervention context, should make it possible to have more similar studies allowing the realization of meta-analysis in the future.

Conclusion

This study, based on the review of 41 selected published studies, examined the effect of MI on novice to expert tennis players and revealed that most studies used the cognitive specific (e.g., rehearsal of specific sport skills such as service) and motivational general mastery (e.g., self confidence or control of emotions during challenging tennis situations) function of MI. More precisely, this study revealed that MI interventions significantly enhanced motor performance (i.e., improvement of forehand, backhand or volley quality, and service efficacy) as well as motivational and affective outcomes for tennis players, regardless of their level and age. In addition, MI was frequently combined with other mental skills and integrated in pre-performance individualized routines including breathing, positive self-talk, ball bounces and/or concentration. In addition, MI can be used between point and during side changes and it is also recommended to employ it after competition. However, the results of the review highlighted the unequal distribution of the population with over-representation of males in the studies reviewed. To conclude, this review proposed potential implications for tennis players, coaches, parents or researchers, and suggested that the regular practice of motor imagery should be incorporated in tennis player training programs and that could also concerns other dual and racket sports such a table tennis, badminton, paddle or beach-tennis.

Declaration of Interest Statement

The authors declare that they have no competing interests.

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