

# A Review of Studies on The Effects of Imagery Training on Sports Performance

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**Abstract:** In the present scientific training system, image training has been an effective training strategy in sports science. In this paper, the influence of image training on sports performance and other related literature are reviewed, aiming to better help scientific sports training. According to the review of this paper, image training is an effective strategy to improve sports performance by improving skill learning, mental ability, physical fitness level and sports injury recovery. In addition, different levels of athletes should take different representation training methods, internal representation is suitable for higher level of athletes, while external representation is more suitable for beginners. Although image training has significant positive effects on athletic performance, the neural mechanism of enhancing athletic performance is not very clear at present, and how to apply image training to athletic rehabilitation remains to be further explored in the future.

**Keywords:** Image training; Sports performance; Mental ability; Mental skills; Physical fitness.

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## 1. Introduction

How to improve the sports performance of athletes is a long-lasting research topic. Physical ability, technology, tactics, psychological ability and intelligence are important guarantees for stable performance in the arena. The arena is not only a game between technology and tactics, the psychological ability is not to be underestimated. Therefore, the training of psychological ability has long been paid more attention to by coaches and researchers. In the psychological skill training, imagery training (Imagery training) is a training strategy that is widely favored and has been proved to have positive benefits for enhancing motor performance. Paravlic AH et al [1] pointed out that representation training refers to a clear virtual simulation of a specific action, but without any actual motor output, designed to activate the brain related nerves and produce basic cognition that is similar to the actual action. The representation is the brain's perceptual response to the past things [2], and the representation training under the guidance of implication, in the brain, so as to improve the emotional control ability and motor technology means [3]. Appearance training is divided into internal representation training and external representation training, the main difference is different observation perspective. Internal representation training is kinesthetic representation, also known as the first person perspective, through the individual imagination and the actual situation and activated in the brain; external representation is the visual representation, also known as the third person perspective, through the form of external observation, such as observation training video, game video [4]. Although there are some differences in internal and external motion representation, it has positive significance in different items and populations [4]. In the field of sports, motion representation training (Motor imagery training, MI) is an external form of representation, which is based on the premise of motion perception, so that the motion scene, action model, tactical execution and visual imagery reproduce [6] in the brain.

To sum up, motor imagery training can be regarded as a kind of simulation and adaptation, which is similar to the real

sensory experience, such as visual experience, auditory experience, tactile experience and neurocognitive experience. The subject's feelings are generated in the brain, but there is no obvious action intervention. Imagery training involves a wide range of fields, including rehabilitation and health care, cognitive psychology, neuroscience, sports training and other fields. Both in practical application and scientific research, representation training is one of the hot topics. Many experts and scholars believe that representation training is a good strategy to improve motor performance [7-8]. However, the intervention of motor representation training is nothing more than the purpose of achieving specific cognition or motivation. Scholars at home and abroad believe that the main functions of motor representation training are to improve emotional regulation and adaptability [9], promoting skill learning and mastery of [10], enhancing physical fitness [11], and optimizing motor performance [12]. In short, as far as the current competitive sports training is concerned, sports representation training is an important means to influence the diversity of athletes.

According to past research reports, representation training, as one of the methods of psychological skills training, many experts, scholars and coaches use representation training to improve athletes' sports performance and psychological quality. Lebon F And other [13] scholars found that imagery training at rest can promote the development of strength quality, which may be related to more motor unit activation and reorganization of the cerebral cortex. 18 weeks of functional representation training has enhanced the perseverance and self-confidence of football players, and improved their psychological ability [9]. It can be seen that the improvement of psychological ability will also promote sports performance. In addition, imagery training also has a promoting role in promoting skill learning and mastering technology [10]. Through the imagination and reproduction of brain scenarios, deepen the practitioners' understanding of the technical action, and then quickly master and consolidate the technical action [14-15]. It is worth noting that although the research history of representation training is long and widely used, many problems in representation training are

still unclear, such as the unclear mechanism affecting motor performance and the practical application of fuzzy.

Therefore, in the way of literature review, this paper intends to summarize the concept, theoretical basis, the mechanism and path of the influence on sports performance, and puts forward suggestions and prospects, in order to provide theoretical guidance for future researchers in the research and practical application of representation training.

## **2. Research Evidence That Motor Imagery Training Improves Motor Performance**

### **2.1. Motor imagery training and skill performance**

Motor imagery training plays a good auxiliary role in the learning of motor skills, and can accelerate the connection of neural related pathways of learning content, so as to reduce the time of automatic formation, and then quickly master the technical movements or tactics. According to the research report, in the learning of golf sports skills, in the timing of matters to actively review, repeat the superficial movements, deepen the athletes' understanding of the technical movements and master [16]. In the 24 Taijiquan sports in China, the representation training really accelerates the students' learning progress of the movements, and improves the students' representation ability, which lays a good foundation for the students' representation training in their spare time [14]. Motor imagery training can cause rapid changes in related cortical plasticity, which can promote the learning of skills and the consolidation of training benefits. Yoxon E [17] et al. found that the cortical representation of thumb movements underwent plastic changes in the representation of thumb movements induced by transcranial magnetic stimulation.

Motor imagery training not only affects learning motor skills, but also has positive benefits in improving motor skill performance. Previous studies show that the national tennis team, during the training through external representation training observation Federer, Djokovic excellent sports video, then 30 seconds of internal representation training, mind repeated recall action representation, the result, representation training improves the accuracy of the high level athletes serve, representation training as an auxiliary means of tennis technology training [18]. Special representation training can effectively improve tennis during Ramadan fasting and reduce the serving performance of fasting on tennis serve performance, reducing the negative impact [19]. Combining motor imaging training programs in physical and technical training courses seems to be an sufficient intervention strategy, however, motor representation training lacks somatosensory afferents, and providing somatosensory input during motor representation training may enhance learning-induced plasticity in the human motor cortex. In the training of special full blind swimming, the representation training is combined with real swimming, and the benefit of the representation training can effectively promote the athletes to establish alternative orientation orientation and body position orientation, and then improve the accuracy of the athletes in the actual swimming [20]. It can be seen that the representation training consolidates and improves the competitive ability of the athletes, and the effect combined with the actual training will

be better. However, some scholars believe that motor representation training has the retention and consolidation effect after skill training, but the benefit is slightly worse than that of physical execution. Therefore, it is once again emphasized that the training effect of motor representation training combined with the actual intervention of body movements may be better.

In addition, some scholars specifically for never after system representation training population research found that the internal and external representation training of the representation ability of subjects, representation training improved the representation of the subjects, and a high level of representation ability will actively improve motor skills performance, therefore, the two present "interaction effect" [22]. However, to improve the performance of excellent sports, it may need to perform special movement representation training. YouMaLin [23] scholars think special representation training in improving sports performance or form representation representation of excellent athletes has positive effect, also pointed out that the representation ability and representation training benefit of the "interaction effect", not only improve the basketball players, also enhances the other penalty related sports representation ability. In addition to its influence on individual technical movements, representation training also has a positive effect on the tactical organization of collective projects. Using the general cognitive imagery procedure, the athletes are required to imagine the tactical organization training of passing and organizing attack in the volleyball match. As a result, it is found that the representation training improves the ability of decision-making of male athletes to perform passing in the game and optimizes their sports performance [24]. It is worth noting that athletes with different skill levels, age and gender should adopt different sports representation methods to improve skill performance. High-level athletes mainly focus on kinesthetic representation, and when learning new tactics and technical movements, the visual representation is the best. In the later stage, kinesthetic representation training can be consolidated for [15]; When teenagers develop cognitive skills, the external representation is more active than the internal representation. In addition, older teenagers can arouse clearer action representation than younger teenagers, and boys have stronger representation ability [8] than girls. In addition, when facing different skill categories, open motion uses external representation, and closed motion uses more internal representation may be more effective.

### **2.2. Sports imagery training and psychological ability**

Athletes representation training can consciously use representation, stimulation involves the actual movement of the brain area, the nerve and behavior is similar to actual experience, help athletes improve the psychological ability, enhance the fluency and autonomy of movement, improve athletes in high stress, stress environment and psychological stress, and improve its sports performance.

Sports self-confidence level is one of the most common psychological factors affecting sports performance, the study shows that the volleyball before volleyball and sports representation training on the characteristics of young male volleyball players confidence and confidence has significant positive influence, effectively alleviate the pressure of high intensity game, enhance the confidence of the win [25]. In shooting, the level of psychological ability is very important,

especially the confidence level of the competitors. Meng Haijiang and other scholars believe that eight weeks of appearance training can effectively improve the stability of shooters, the main reason may be the good emotional state and confidence of the athletes after appearance training. In addition, the more athletes conduct psychological imagery training, the more specific the action representation, and the higher the athletes' confidence level improvement [26]; athletes adapt to the high pressure competition situation, increase the stability of their sports performance, improve their self-confidence, which in turn will promote a higher level of sports performance and achievement [27]. In addition to improving the level of self-confidence, representation training can also help athletes relieve anxiety and tension, rebuild the motivation to participate in, so as to improve sports performance. Severely injured skiers overcame fear and anxiety from injury and won a gold medal at the Pyeongchang Winter Olympics (Li Danyang et al., 2020). This follows that representation training helps to establish appropriate incentive levels to control emotions and overcome negative emotions. In addition, You Maolin and other [23] scholars believe that special representation training has positive effects in improving sports performance or forming sports representation characteristics of excellent athletes, and pointed out that the psychological burden is reduced under the interactive effect of representation ability and representation training. A recent review concluded that representation training can effectively reduce stress reaction and increase confidence in competition, such as reducing muscle tension and increasing perceptual ability [28]. In addition, Rhodes J [9] scholars found representation training mobilize athletes to participate in training or competition in the goal setting and evaluation, and enhance the courage and confidence in the game, in its study, 19 football players' confidence and courage are improved, athletes think representation training has positive benefits to improve sports performance. Therefore, athletes can practice their technical skills through the representation, while fully preparing for the competition and training.

As an adaptive mental skill, motor imagery training simulates and reconstruct competition scenes by replaying memories in the brain, thus helping athletes enhance the memory of body movements and behaviors, and thus maintaining a reasonable level of arousal. Previous studies have shown that the athletes of the women's pistol team in a city take 2-3 times a week for 10-15 minutes each time. The results suggest that the representation training for 4 weeks improves the rapid shot appearance of the athletes in the actual combat situation, and makes the awakening level closer to the shooting state [29] in the competition. In addition, the representation training will adjust the attention allocation of athletes in the competition. Lacrosse players can improve their scoring ability after receiving the representation training task stimulation, but there are still some differences between individual athletes, which may have some relationship with their own representation ability [30]. Neural evidence suggests that imagery training improves cortical activity, which is a manifestation of concentration and mental effort during the representation, and then reaches a specific mental state [31]. It can be seen that representation training optimizes sports performance by maintaining the reasonable arousal level of athletes.

### **2.3. Sports representation training and strength quality**

Competitive fitness is the highest level of physical fitness. As the basis for athletes to adapt to high-intensity sports, the strength involved in competitive fitness plays a vital role in sports performance [32]. Studies show that sports representation training has a deep correlation on the strength of athletes, such as increasing strength and delaying the decline of strength quality during training suspension. Therefore, representation training can be used as an effective intervention strategy for competitive fitness. Saumur TM et al. [33] scholars believe that under the guidance of psychological neuromuscular theory, it was found that 3 weeks of motor imagery training increased the peak torque of knee joint extension. The results suggest that short-term imagery training could improve the strength of the quadriceps muscle. High level of athletes familiar with sports skills, through visualization and feeling the actual muscle contraction and joint tension, even few practice, this method can be more effective distinguish imagine in the process of contraction load, form the actual practice of more real representation benefit [13], therefore, elite athletes combine representation training and physical training, improve strength performance, and improve the efficiency of movement. In addition, injuries are inevitable during training and competition, and to maintain and develop muscle strength without ensuring normal training, perhaps representation training is an effective choice. Studies show that unwell subjects undergo representation training and watch daily movies containing high-intensity bilateral shoulder flexion scenes improve improved shoulder flexion strength without any resistance training [35]. It follows that imagery training and movement observation may provide a way for physically impaired individuals to restore muscle strength during daily activities. In addition to the positive benefits in the strength quality, the representation training also has an impact on the regular speed, sensitivity and other physical fitness components of the athletes. Fekih S And other [19] scholars found that the physical performance of tennis players became worse during the fasting period of Ramadan, but the appearance training stabilized the sensitivity, reaction and speed performance of tennis players during the special period. It is worth noting that the positive benefits of enhancing the physical fitness level of motor imagery training are gradually confirmed, but the mechanistic path is still unclear. Some scholars believe that the descending neural drive of the cerebral cortex increases during imagery training, and the spinal cord network increases excitability at rest, and then enhances muscle strength [35].

### **2.4. Motor imagery training and injury recovery**

Imagery training has been applied to rehabilitation medicine in the 1980s. Combined with rehabilitation exercise, in addition to improving operational performance, patients can conduct self-training at a specific time. In addition to improving the psychological skills and competitive fitness level, representation training is considered as a psychological intervention that can effectively reduce anxiety, tension and pain, while promoting and encouraging the healing of athletes after injury. Considering the influence of psychological factors of injury on athletic performance, addressing psychological factors is crucial to rebuild confidence and

overcome the fear of re-injury during physical rehabilitation.

Recent studies show that after a year of psychological skills training, athletes returned to the Winter Olympics and achieved good results, which is closely related to the overcoming of anxiety and improved self-control in psychological training [36]. Motor imagery and action observation are motor simulation paradigms that are thought to affect the neural representation of movement (i. e., distributed and complex neuronal networks associated with motor planning and execution) and the excitability of the motor cortex. However, there is little evidence in the literature of imagery training to the neural representation of athletes. However, through imagery training combined with vibrotactile stimulation and other rehabilitation methods, special cases can significantly improve the excitatory [37] of the motor cortex, and then improve the plasticity [38] of the motor cortex. Therefore, imagery training may be a potential means of recovery from brain damage in high-intensity competitive competitions, such as boxing, taekwondo, gymnastics, etc. In most ball sports, the risk of lower limb injury is high, especially the knee, so the prevention and repair of knee injury should be paid enough attention to. Cederstrom N And other [39] scholars include novel motor imagery to promote sensorimotor relearning (Motor Imagery to Facilitate Sensorimotor Relearning, MOTIFS) Applied to the recovery training program, Concurrent psychological training and physical rehabilitation exercises, And then restore the muscle function and address the psychological factors, To allow for the resumption of the activity, the results show that, Representation training effectively promotes the lower limb recovery in athletes, The possible reasons are related to their more positive attitude, perceived arousal, perceived dominance, perceived intensity, etc. Similar studies also found that MOTIFS improves psychological readiness for physical function recovery and muscle function, focusing on the knee, improving both fear and increased activation of the central nervous system, this increased activation could potentially address the plastic changes in the brain and is a potential cause of persistent sensorimotor deficits in patients with ACL injury [39]. Therefore, imagery training may be used as an alternative treatment option for knee treatment and prevention. In addition to relieving the fear of the secondary injury, the pain perception of patients also has positive utility [40]; compared with conventional treatment, the combination of imagery training and conventional treatment can reduce the pain intensity, pain distraction and increased cortical excitability may be the regulatory mechanism of representation training to relieve pain [41-42].

To sum up, representation training shows positive benefits in skill performance, psychological ability, physical fitness level and competitive injury rehabilitation, and different representation training methods have different effects on sports performance, which may be related to the skill level and representation ability of athletes themselves. In addition, imagery training affects athletes through a comprehensive influence mechanism of multiple systems, but the current theoretical mechanism still cannot clearly explain how imagery training affects sports performance.

### 3. Conclusions and Outlook

#### 3.1. Conclusion

1) There is no unified theory of representation training concept and theoretical evidence at present, but according to

different literature evidence, the benefit of representation training in the field of sports training is beyond doubt.

2) Representation training is an effective strategy to improve sports performance. Enhance sports performance by improving skill learning, psychological ability, physical fitness level and sports injury recovery. Both coaches and athletes can design imagery training in training and competition.

3) Athletes of different levels should adopt different representation training methods. The internal representation is suitable for higher level athletes, while the external representation is more suitable for beginners.

4) The effect of action observation combined with representation training is better than that of a single representation training. Therefore, reasonable representation training methods are adopted according to different needs.

#### 3.2. Expectation

Through literature review, much literature supports the utility of representation training to enhance sports performance and rehabilitation care, but it is not common to apply representation training to athletes in China. In addition, it is crucial to evaluate the content and quality of the representation training, such as its accuracy, vividness, controllability and consistency with the actual action, and more research design is needed to confirm its efficacy and scientific application methods. From the perspective of the mechanism of representation training, the exact mechanism has not been explored. In the future, we can study and design from the psychological and physiological mechanism path, such as the study of brain mechanism.

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