THE ROLE OF MENTAL IMAGERY ON SPORTS PERFORMANCE IN JUMPING SPORTS

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Abstract—**Background: Mental training is a broad term used in many situations. It was defined by Richardson (1967) as the mental rehearsal of a task without any muscular movement and is often referred to as imagery. Jumping sports, such as long jump, high jump, and triple jump, require a combination of physical strength, technical skill, and mental focus. Mental imagery has been proposed as a valuable tool for enhancing an athlete's performance by improving their focus, confidence, and execution of skills.**

Methods and Materials: A thorough search of the research literature has been administered articles studying the effects of mental imagery on sports performance in jumping sports. Records identified through various search engines was 58, Studies Included in qualitative synthesis was 20.

Result: Studies have shown that mental imagery training, when combined with physical practice like plyometric training, leads to significant improvements in vertical jump performance and agility in athletes. Additionally, imagery techniques, such as cognitive imagery, have been found to be more effective in enhancing sports performance among male athletes, highlighting the importance of mental energy levels in utilizing imagery effectively.

Conclusion: In conclusion, the body of literature reviewed herein strongly supports the notion that mental imagery is a potent psychological tool that holds significant benefits for athletes in jumping sports. The research consistently indicates that mental imagery can enhance not only the physical aspects of performance, such as power and technique, but also the psychological factors, including confidence, focus, and anxiety management. It bridges the gap between mental preparation and physical execution, offering athletes a competitive edge.

Index Terms— **Mental Imagery, jumpers, jumping sports, sports performance, visualization.**

I. INTRODUCTION

Mental training is a broad term used in many situations. It was defined by Richardson (1967) as the mental rehearsal of a task without any muscular movement and is often referred to as imagery. Mental imagery (MI) is the imagining of an action without its physical execution and motor imagery is a subtype of MI, which refers to the internal reproduction of a specific motor action without any overt motor output. Mental practice is a training method by which MI is used with the intention of improving performance, in other words it is the imagined rehearsal of a motor act with the specific intent of learning or improving that act.[1]

Visual and kinesthetic abilities are the most used systems to generate images and using them forms the basis of MI with the aim of improving performance in motor tasks and competitive situations, and facilitates motor acquisition and learning.[2]

MI can be performed through two definite visual methods, namely the internal or external perspective and kinesthetic imagery (refers to someone's ability feeling the movement) [3]. The internal perspective concerns the mental performance of a motor task from within the body and the external perspective concerns the mental performance as if it is outside the body [4]. The internal perspective has been shown to be the preferred choice of rehabilitation due to the high levels of cortical activation. On the peripheral nervous system, MI can imitate responses of the autonomic nervous system (ANS), which usually take place during physical exercise, such as playing a sport or exercising for physical recovery] These responses include the increase of heart rate, respiratory rate, and consequently the blood oxygen saturation -SpO2 rate [8].

Sports performance achievement can be gained in two core contexts, training and competition. Peak performance when competing can be obtained using performance prospects that integrate the physical and mental aspects of sports skills through the right mindset to produce maximum performance achievement [6]. The unique characteristics and individual situations of each athlete need to be considered and are connected to sports psychology and its relevance in influencing the focus of athlete's performance in competition. [7]

According to the psychoneuromuscular theory purposed by Jacobson in 1930, when an individual mentally imagines performing a skill (such as jump), the same neural pathways are activated as when physically executing the skill.[8] Essentially, the brain simulates the motor patterns associated with the movement, even though no overt muscle contraction occurs. The feedback received from imagined muscle innervation allows individual to make subtle adjustments in motor behaviour. [9]

Mental imagery stimulates specific regions of the brain involved in executing physical skills. This stimulation strengthens the neural networks associated with specific movements.[10] As a result, these movements become more automatic and efficient during actual performance. In the context of jumping sports, athletes can mentally rehearse their jumps, fine-tuning their motor patterns and enhancing their overall performance.[11]

Imagination is terrifically powerful. By mentally rehearsing a routine before a major competition, athletes can prepare themselves to achieve their optimal performance when it counts most.[12] By imaging playing at their peak, athletes can build their confidence for a match. Imagery can also help a performer through a tough injury layoff by shifting attention away from the injury onto the mental rehearsal of sport skills [13]. Knowing that research supports the value of imagery for maintaining skill level when physical practice is not possible can help motivate an athlete during recovery. When physical practice is not possible

such as, during travel, imagery can provide athletes with a way to practice [14]. It allows them to review previous strokes or movements so they can correct errors. It is difficult to think of anything else that has as much potential to enhance or destroy not only performance outcomes but also the entire experience of sports.[15]

Imagery is effective when it incorporates all five senses and kinaesthetic sensations, just like in the actual performance [16]. Mental imagery aims to produce the athletic experience precisely so that athletes feel like they are playing their sport. A powerful imagination leads to the creation of nerve impulses like what is produced during actual performances. The brain cannot distinguish between being at an actual event and vivid imagery of the same event. Therefore, imagery can be used to provide this intense, repeated, and preserved nature of important athletic skills.[17] This has been a prevalent technique used in improving the performance of athletes. In addition to the primary senses, athletes can also experience the emotions associated with sport participation. For example, athletes can feel the nervousness and excitement build as they prepare for a competition in their mind [18]. They can also experience the satisfaction, joy, and pride associated with performing well in their mind's eye. Whether you imagine yourself becoming angry as you argue with the umpire, feeling anxiety as you prepare to perform, or enjoy the excitement you feel when you are playing well and with confidence, the effect on the nervous system may be almost identical to the actual experience.[19]

Jumping sports, such as long jump, high jump, and triple jump, require a combination of physical strength, technical skill, and mental focus [20]. Athletes in these sports must not only possess the physical ability to execute precise movements but also the mental fortitude to overcome challenges and perform at their best. Mental imagery, also known or mental rehearsal, has been proposed as a valuable tool for enhancing an athlete's performance by improving their focus, confidence, and execution of skills.[21]

II. NEED OF STUDY

It seems reasonable to study the effect of MI on sports performance in jumping sports. The use of mental imagery in sports performance has been a topic of interest and debate among researchers, coaches, and athletes for several decades. The ability to create vivid mental images of movements and actions has been suggested to have a significant impact on an athlete's performance in jumping sports. The effectiveness of MI in relation to jumping sports is insufficient, thus the present study has been proposed

III. AIM OF STUDY

To examine the various theories and models of mental imagery that have been proposed in the context of jumping sports, that will examine the efficacy of Mental Imagery on sports performance in jumping sports.

IV. OBJECTIVES

To determine the efficacy of mental imagery on sports performance specifically in jumping sports.

To determine the potential impact of mental imagery on the technical and psychological aspects of performance in jumping sports.

Review of literature

Przybylska et al. (2023) Explored the influence of personal factors on physiological responses to mental imagery in sport. The aim of this study was to understand how individual differences in personality (e.g., neuroticism), general imagery and situational sport anxiety are linked to arousal measuring with SCL in situational imagery. Thirty participants aged between 14 and 42 years (M = 22.93; SD = 5.24), with sport experience ranging between 2 and 20 years (M = 10.15; SD = 4.75), took part in this study. Participants listened to each previously recorded script and then were asked to imagine the scene for a minute. During the task SCL was monitored using Biofeedback Expert 2000. Machine learning predictive models based on artificial neural networks have been trained for prediction of physiological response, as a function of selected psychological tests. They found an association among neuroticism, prestart anxiety, and general tendency to use imagery with SCL. From a practical point of view our results may help athletes, coaches, and psychologists to be more aware of the role of individual differences in sport.

In 2022, Ezumah examined the distinct factors contributing to the efficacy of mental imagery intervention on a sports performance task. There is minimal research measuring the various uses of mental imagery in sports and what makes imagery effective. Research on mental imagery has primarily focused on ways imagery has been used to improve skills and performance in sports and other motor tasks. However, the exact factors contributing to how mental imagery enhances skill are still in question. In addition, contemporary imagery research does not systematically accept the same view regarding the benefits of imagery used in enhancing performance tasks in sports. Therefore, this demonstrates a need for increased research to validate the acceptance of factors contributing to the efficacy of mental imagery interventions on a sports performance task. Relevant uses of imagery within sports performance are reviewed, Further, predictive factors that have been shown to determine how well an individual can perform a task using imagery are also reviewed, including imagery ability, the performer's skill level, and the imagery perspective. Findings summonsed in this review; it displayed that individual differences may be a substantial factor in the efficacy of a mental imagery intervention on sports performance.

Gosh et al. (2022) The aim of the study was to find out the differences in sports imagery ability among the runners, jumpers & throwers of track & field. Total 30 male Inter University level Athletes out of which 10 runners, 10 jumpers, 10 throwers were selected as subject for this study. The age of the subject was 21-25 years. The result shows that there is no significant difference of sports mental imagery ability among the runners, jumpers & throwers.

In 2021, Ladda et al. conducted study Using motor imagery practice for improving motor performance, in this review, they describe the technique of motor imagery practice and its neural representation, considering different fields of application. The current practice of individualized motor imagery practice schemes often lacks systematization and is mostly based on experience. They reviewed literature related to motor imagery practice in order to identify relevant modulators of practice effects like previous experience in motor training and motor imagery practice, the type of motor task to be trained, and strategies to increase sensory feedback during physical practice. Relevant discrepancies are identified between neuroscientific findings and practical consideration of these findings. To bridge these gaps, more effort should be directed at analysing the brain network activities related to practically relevant motor imagery practice interventions.

Kishore (2021) This paper Reviewed that imagery can enhance performance in motor tasks, aid in skill acquisition, boost motivation, increase sport confidence, and reduce anxiety in athletes. Different forms and functions of imagery have been proven effective based on the characteristics of sports and the expertise level of athletes, showcasing the versality of mental imagery.

In 2018, Singh did analysis of literature on imagery used in sports and its relation with performance and found Imagery has an important role to play in the sportsman's motor performance. Extensive experiential and observational research have led to the development of applied models in the field of sport psychology which seek to highlight some of the key components required to ensure its effective implementation. Furthermore, this research reviewed the efficacy of mental imagery interventions within sports performance with an emphasis on (a) uses of imagery, and (b) factors affecting imagery.

Azizan (2018) this study attempted to investigate the effect of PIM training on jumping performance of high jumpers. Double-blind experimental design research was conducted to twenty-six high jumpers (n =26) aged between 13 to 17 years old. Participants were randomly assigned into two different groups (PIM group and control group) with 13 participants for each group. Both groups completed 18 training sessions three times per week in a six-week intervention program. The results showed that PIM group had significantly performed better in jumping performance compared to control groups. The finding supports the idea of using PIM training to improve sports skills performance. Additionally, high jumpers should not focus on their skills training only to be successful but also develop their psychology training particularly in imagery training.

In 2014, Nagar studied the effect of mental imagery on muscle strength and balance performance in recreational basketball players. Thirty male collegiate recreational basketball ball players, randomly assigned into two groups, were the participants of the study. Group 1 subjects underwent strength and balance training, and group 2 subjects underwent strength, balance and mental practice. This study design was repeated measure experimental design. Assessment was done before the training and after the completion of training. Results. The anterior direction, posteromedial direction, posterolateral direction and composite score showed a significant interaction between programme type (group) and time with p=0.00, p=0.041, p=0.001, p=0.001, p=0.001 and for main effect for time with p=0.001, in all direction and composite score of the balance measure. There was significant interaction between programme type (group) and time, p=0.001 for knee extensors and p=0.018 for ankle plantar flexor strength. There was a significant main effect for time p=0.001 for both knee extensors and ankle plantar flexors strength in both groups. The main effect for group comparing the two types of intervention was significant for knee extensor strength, p=0.023. There is significant interaction for time ×group for balance and strength, so it can be concluded that there is effect of mental imagery on strength and balance.

Gaggioli et al. (2013) conducted a study on Benefits of Combined Mental and Physical Training in Learning a Complex Motor Skill in Basketball. The goal of this study was to investigate the benefits of combining mental and physical training in learning a complex motor skill in basketball (the lay-up shot). To this end, sixty female university students were randomly assigned to either mental practice with physical training, or physical training alone. Motor performance was assessed before and after a four-week training period. To assess motor learning performance, a video analysis was carried out by three independent raters on the motor task before and after the training in both conditions. Results showed that mental practice condition improved coordination and movement accuracy, suggesting the potential effectiveness of this approach in training complex motor skills; furthermore, findings indicate the feasibility and accuracy of using video-based analysis of movement in the assessment of motor performance improvements.

In 2012, Cumming et al. Introducing the revised applied model of deliberate imagery use for sport, dance, exercise, and rehabilitation. This revised model proposed builds on the original version by retaining its empirically supported "where", "when", and "why" components. Incorporating recent advancements in imagery research, the model distinguishes between what is imaged (i.e., the content) from why it is imaged (i.e., the function). This revised model also acknowledges the importance of the individual and how they interpret an image by including "who" and "meaning" components, as well as expanding on how imagery ability is likely to influence the relationship between imagery use and outcomes. Based on imagery's increased usage beyond the sport setting, this review explains how the revised model can also be applied to individuals in the exercise, dance, and rehabilitation settings.

MacIntyre et al. (2009) described Motor imagery, performance and motor rehabilitation. Motor imagery has been central to advances in sport performance and rehabilitation. Neuroscience has provided techniques for measurement which have aided our understanding, conceptualization and theorizing. Challenges remain in the appropriate measurement of motor imagery. Motor imagery continues to provide an impetus for new findings relating to our emotional network, embodied cognition, inhibitory processes and action representation. New directions are proposed which include exploring the physical setting and conditions in which imagery occurs and investigating if short term impairments to the motor system detract from motor imagery ability and the potential application of motor imagery for recovery.

In 2008, Olsson et al. conducted study on Internal imagery training in active high jumpers. The main purpose of this study was to examine whether the use of internal imagery would affect high jumping performance for active high jumping athletes. Over a period of six weeks, a group of active high jumpers were trained with an internal imagery program for a total of 72 minutes. This group was compared to a control group consisting of active high jumpers that only maintained their regular workouts during the same time period. Four variables were measured: jumping height, number of failed attempts, take-off angle, and bar clearance. There was a significant improvement on bar clearance for the group that trained imagery ($p < 0.05$) but not for the control group. No other differences were found. The results suggest that internal imagery training may be used to improve a component of a complex motor skill.

Nippert et al. (2008) studied the Psychologic Stress Related to Injury and Impact on Sport Performance. They found the impact psychosocial stressors have on injury recovery and the sport performance of young injured athletes. Medical professionals aware of psychosocial stressors unique to young athletes that may contribute to injury occurrence and influence rehabilitation, may help counter the negative effects and unhealthy behavioral responses that sometimes occur post-injury. Through awareness and appropriate interventions, medical professionals can help facilitate an optimal physical and psychologic recovery.

In 2008, Guillot et al. described the Construction of the Motor Imagery Integrative Model in Sport: a review and theoretical investigation of motor imagery use. This article reviewed the models of greatest conceptual viability, and aims at describing the fields in which MI may play a crucial role, by integrating these functions in a unique model within motor performance and recovery. The detailed description of the imagery-based interventions considers distinct outcomes: (i) motor learning and performance, (ii) motivation, self-confidence and anxiety, (iii) strategies and problem-solving, and (iv) injury rehabilitation. The Motor Imagery Integrative Model of Imagery in Sport (MIIMS) may be used as a global guiding framework in the field of MI studies to develop

more effective imagery interventions by covering the major key components of MI training related to the outcome achieved by athletes.

Methodology

A thorough search of the research literature has been administered, articles studying the effects of mental imagery on sports performance in jumping sports. Studies that have been searched through electronic databases PubMed, Scopus, and ScienceDirect and study which are in English or translated in English is included.

Eligibility Criteria: Studies that were selected for further critical appraisal met the following criteria

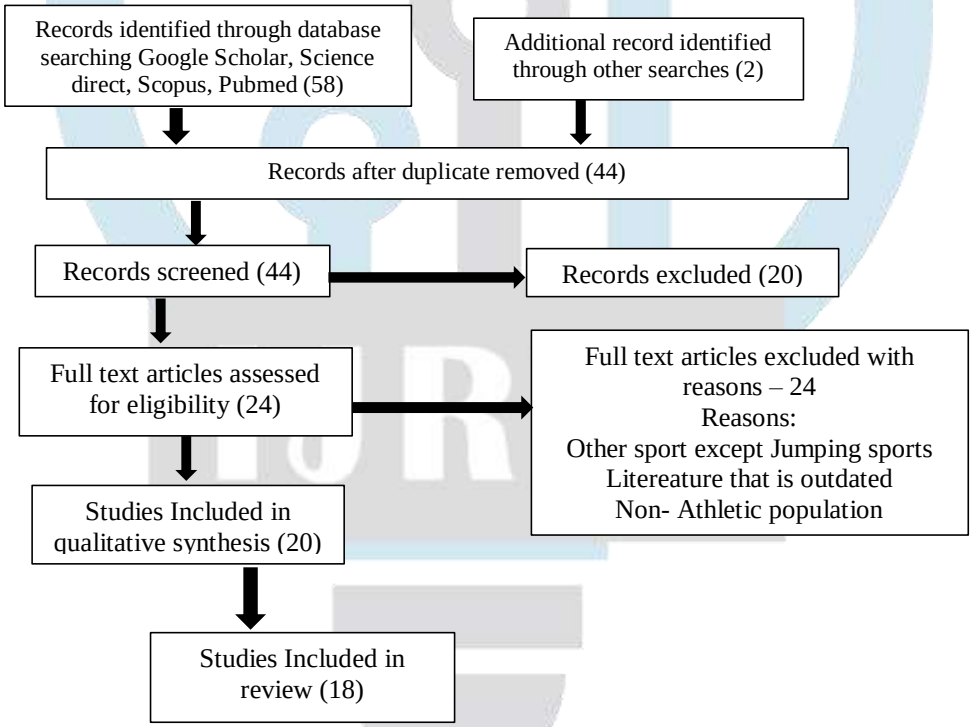
Inclusion criteria:

i. Research articles and review papers related to mental imagery in the context of jumping sports or similar athletic activities.
ii. Research conducted on athletes and individuals engaged in jumping sports.
iii. Studies that investigate the effects of mental imagery on sports performance related to jumping sports.
iv. Literature written in English, as well as translations of non-English publications if available and relevant.

Exclusion criteria:

i. Studies that focus solely on mental imagery in non-sports contexts (e.g., clinical psychology, education) unless they have direct relevance to the application of mental imagery in jumping sports.
ii. Research that primarily examines mental imagery in sports other than jumping sports (e.g., running, swimming)
iii. Literature that is outdated or not representative of current research trends (e.g., studies published more than 15 years ago).

Figure 1: Flow diagram



V. RESULT

Mental imagery plays a crucial role in enhancing sports performance in jumping sports by improving cognitive functions, skill acquisition, motivation, and confidence while reducing anxiety. Studies have shown that mental imagery training, when combined with physical practice like plyometric training, leads to significant improvements in vertical jump performance and agility in athletes. Additionally, imagery techniques, such as cognitive imagery, have been found to be more effective in enhancing sports performance among male athletes, highlighting the importance of mental energy levels in utilizing imagery effectively. Furthermore, self-hypnosis and mental imagery are immersive procedures that help athletes prepare for future duties and enhance their performance capacity, making them valuable tools in the field of sports.

Four studies found significant improvement with only using MI for enhancing Performance.

Six studies combine MI with other inventions like Relaxation and self-talk also has a significant role in enhancing performance.

One study used the intervention Motor imagery, visual imagery, Spatial imagery and it found that Motor imagery continues to provide an impetus for new findings relating to our emotional network, embodied cognition, inhibitory processes and action representation. One study that used psychological intervention also has positive influence on sports performance.

VI. DISCUSSION

This review of literature on the role of mental imagery in sports performance on jumping sports provides compelling evidence that mental practice can be an effective strategy for enhancing athletic performance. Mental imagery, often referred to as visualization, has been shown to activate the same neural pathways in the brain that are involved in the actual physical execution of sports movements. This phenomenon suggests that mental rehearsal can improve neuromuscular coordination, which is crucial in jumping sports that require precision, timing, and explosive power.

The evidence presented reveals that mental rehearsal of jumps leads to improvements not only in psychological readiness but also in the physical execution of the movements. The intricacies of the mind-body connection are brought to light, demonstrating that vivid, kinesthetic mental imagery can prime the muscles for action and refine neuromuscular coordination. Individual when performing a Mental imagery skill (such as jump), the same neural pathways are activated as when physically executing the skill. Essentially, the brain simulates the motor patterns associated with the movement, even though no overt muscle contraction occurs. The feedback received from imagined muscle innervation allows individual to make subtle adjustments in motor behaviour.

Mental imagery stimulates specific regions of the brain involved in executing physical skills. This stimulation strengthens the neural networks associated with specific movements. As a result, these movements become more automatic and efficient during actual performance. In the context of jumping sports, athletes can mentally rehearse their jumps, fine-tuning their motor patterns and enhancing their overall performance.

In light of the findings, it is recommended that coaches and sports psychologists consider the integration of mental imagery as a core component of training programs for jumping athletes. Tailored imagery interventions have the potential to unlock psychological resilience, enhance motivation, and solidify the technical aspects of sports performance

The studies included in this review encompassed a variety of jumping sports, including basketball, volleyball, and track and field events such as the high jump and long jump. Across these sports, athletes who engaged in mental imagery exercises demonstrated significant improvements in performance metrics such as jump height, distance, and technique. Notably, the benefits of mental imagery were not confined to novice athletes; experienced jumpers also reported performance gains, indicating that mental rehearsal can be beneficial regardless of an athlete's level of expertise.

Furthermore, the research underscores the importance of individualizing imagery scripts to cater to the athlete's unique needs and sensory preferences. This personalization is crucial for eliciting the strongest and most beneficial imagery effects.

Despite the positive findings, this review also identified several limitations within the existing literature. One such limitation is the heterogeneity of the imagery interventions used across studies, which included differing durations, frequencies, and visualization techniques. This variability makes it challenging to establish standardized guidelines for the implementation of mental imagery in training regimens. Additionally, the majority of the studies relied on self-reported measures of imagery ability and did not account for individual differences in imagery vividness and control, which can influence the effectiveness of mental practice.

Another critical consideration is the lack of longitudinal research on the long-term effects of mental imagery on performance. While short-term gains have been documented, it remains unclear whether these improvements are sustained over time and how mental imagery interacts with physical training to yield cumulative benefits.

Furthermore, the studies reviewed suggest that imagery training interventions can lead to measurable improvements in performance metrics in jumping sports. However, it is also clear that more research is needed to understand the optimal conditions for imagery practice, including the ideal frequency, duration, and timing of imagery sessions, as well as the most effective types of imagery for different athletes and contexts.

Despite the promising findings, it is important to acknowledge the limitations present in the current literature, such as methodological differences between studies, the subjective nature of mental imagery, and the challenges in measuring its direct impact on performance. Future research should aim to standardize imagery training protocols and explore the underlying neural mechanisms to further solidify our understanding of how mental imagery contributes to athletic performance in jumping sports.

VII. Conclusion

In conclusion, the body of literature reviewed herein strongly supports the notion that mental imagery is a potent psychological tool that holds significant benefits for athletes in jumping sports. The research consistently indicates that mental imagery can enhance not only the physical aspects of performance, such as power and technique, but also the psychological factors, including confidence, focus, and anxiety management. It has been observed that both novice and elite athletes can reap the benefits of mental imagery, although the impact may vary according to the individual's level of experience and the specificity of the imagery used. Studies consistently indicate that mental imagery, when used systematically and combined with physical practice, can lead to improvements in motor skills, self-confidence, focus, and ultimately, performance in sports that require jumping abilities. This psychological tool harnesses the power of visualization to create mental representations of specific sports actions which, when rehearsed mentally, can prime the body for physical execution. It bridges the gap between mental preparation and physical execution, offering athletes a competitive edge.

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