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ENHANCING LIMB SYMMETRY: THE IMPACT OF MENTAL PRACTICE ON NON-DOMINANT FOOT PERFORMANCE

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Abstract:
This study investigates the following question: Does the mental practice of the non-dominant foot enhance its performance, as well as that of the corresponding limb—the foot that did not undergo mental practice? The research involved a sample of 15 football players specializing in the sport, who engaged in mental training for their non-dominant foot during practice sessions. The findings indicate that the mental practice of one limb can positively affect the performance of the opposite or contralateral limb. The conclusion drawn is that promoting symmetrical limb performance is a valuable strategy in athletic training, contributing to holistic development and optimizing an athlete's potential, including applications in rehabilitation and sports training.

Keywords: mental practice, non-dominant limb, limb symmetry, performance, motor learning

1. Introduction

The question of this study is whether mental practice or mental rehearsal of a body part, for example, the non-dominant foot, enhances dominant foot accuracy during performance. In fact, many studies of mental practice in various scientific fields in sport, medicine, and health psychology have confirmed that mental practice plays a significant role in improving performance. However, there are many definitions of mental practice; one of them is that mental practice, the internal rehearsal of movements to improve later performance, underlies both the development and the execution of many performance and motor tasks for athletes. It can be defined as the mental repetition of a task, without observable movement or real movement (Asa, 2014; Hardwick *et al.*, 2018; Simonsmeir *et al.*, 2018; Schack *et al.*, 2014; Rajaratnam *et al.*, 2022). The mental practice has been used by

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athletes to achieve the best possible performance and by coaches to teach and develop performance, particularly with difficult behaviors or complex performance situations. It typically takes one of two forms. First, mental rehearsal can directly precede action execution, taking the form of an explicit act of a motor task (Jeannerod & Jacob, 2005). Platform divers could take a few seconds to visualize their movements before jumping off, or weightlifters may visualize the ideal weight distribution relative to their center of gravity. Second, mental practice can be used offline and employed to visualize behaviors the athlete will perform much later, often in circumstances that bear no similarity to the actual performance situation. For instance, goalkeeper David James supported his training regime by engaging in mental rehearsal, even when stuck in traffic (Wohldmann *et al.*, 2008; Naish *et al.*, 2014; Jimenez-Diaz *et al.*, 2024).

Mental practice has several general benefits. For example, mental practice has direct emotional benefits. It helps develop self-confidence and reduce worry and is therefore used as a mental management skill in the sports field (McNeill *et al.*, 2019; Toth *et al.*, 2020). In a typical intervention, a coach might ask the athlete to mentally rehearse the task with positive outcomes before the actual performance to increase self-confidence (Mizuguchi *et al.*, 2017; Villa, 2023). However, benefits arise from the use of mental practice to control attention, focusing, and refocusing. For example, before hitting a ball towards the goal, an athlete might imagine the center of the location or accuracy of the goal and visualize it as large as possible in their mind. Evidence suggests that such practice, especially when directed towards the intended goals of the action, leads to direct performance improvements, increasing outcomes and reducing cognitive demands on motor control during performance (for a review, see Wulf & Lewthwaite, 2016).

Another example: before attempting a high jump, a coach might ask the athlete to mentally practice the approach towards the bar and to imagine running towards it without jumping. This allows the athlete to focus and perform an accurate run-up before the actual attempt. If the athlete feels that the last step is too close to the bar, then s/he moves his/her starting point back a few inches. If the athlete feels that the last step is too far away from the bar, he/she moves it forward. It usually takes several attempts to find exactly the right starting point. find exactly the right starting point.

Mental practice is used by athletes to improve best possible performance and by coaches to teach and develop performance, particularly with difficult behaviors or complex performance situations. It typically takes one of two forms. First, mental rehearsal can directly precede action execution, taking the form of an explicit act of motor task (Jeannerod & Jacob, 2005). Platform divers could take a few seconds to visualize their movements before jumping off, or weightlifters may visualize the ideal weight distribution relative to their gravity Centre. Second, mental practice can be used offline and be used to play through behaviors the athlete will perform much later, often in circumstances that bear no similarity to the actual performance situation. For instance, goalkeeper David James supported his training regime by engaging in mental rehearsal. Even when stuck in traffic (Wohldmann *et al.*, 2008; Naish *et al.*, 2014; Jimenez-Diaz *et al.*, 2024) Mental practice has included various general benefits. For example, mental practice

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Finally, and most importantly, mental rehearsal has been shown to have powerful effects on skill learning and the acquisition of motor tasks, both when used in performance and when used outside of it. It is effective for a broad range of skills, ranging from simple manual movements to expert movements in sports, such as swimming, diving, or football (Nakashima *et al.*, 2024; Van-Cutsen *et al.*, 2018; Duck-won Oh, 2010; Jimenez-Diaz *et al.*, 2024). Mental practice and symmetrical limbs (feet or hands): There are several definitions for symmetrical limbs; one of them defines symmetrical limbs as limbs that are identical in size, shape, and position on opposite sides of the body, for example, hands and feet. The question of the study is whether the mental practice of the non-dominant limb improves or enhances the accuracy of the dominant foot.

2. Method

2.1 Participants

Fifteen students (21 years, men: mean age, SD = 2.4) participated in this experiment. They satisfied all requirements for volunteerism and gave informed consent approved by the Education College Ethics Committee at Mustansiriyah University. All participants considered themselves to be in good health, had no history of disease, and were not undergoing any medical treatment that might influence motor or visual-motor functions. The final sample size of 15 provides 81% power to detect effects with $d > 0.75$.

2.2 Material and Apparatus

In the experiment, a handball goal with dimensions of 3 meters in width and 2 m in height was used. The goalposts had a depth of 1 m (3.28 ft) along the bottom and a top depth of

80 cm (2.62 ft). These height and width dimensions do not include the thickness of the posts. Two squares, each measuring one meter, were placed in each corner. From a distance of 9 meters, the students attempted to kick the ball from that distance when they heard the signal to start kicking.

2.3 Procedures and Design

Each participant had five attempts with both the dominant and non-dominant foot. An unsuccessful attempt counted as minus one, and a successful attempt earned one point. In the second trial or test, mental practice for the non-dominant foot was conducted before each attempt. Each foot also had 5 attempts.

3. Results

The results of the experiment for $t(14) = -5.10$, $p > 0.01$, $d = -0.65$ indicate highly significant results. Participants demonstrated a greater number of successful trials during performance execution. The second body part examined was the dominant foot, with results showing $t(14) = -4.011$, $p > 0.001$, $d = -0.69$. Additionally, a one-way ANOVA revealed $F(15) = 8.30$, $p = 0.001$. see Tables 1 and 2.

Table 1: Descriptive Statistics for Both the Dominant and Non-dominant Foot

Summary	**Anova: Single Factor**		**Average**	**Variance**
Groups	**Count**	**Sum**		
Non-dominant foot	15	-29	-1.93333	3.352381
Dominant foot	15	5	0.333333	7.238095
Non-dominant foot	15	-10	-0.66667	2.809524
Dominant foot	15	24	1.6	2.828571

Table 2: Results of a One-way Anova Comparing the Non-dominant and Dominant Foot

ANOVA						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between groups	101.1333	3	33.71111	8.309077	0.000116	2.769431
Within groups	227.2	56	4.057143			
Total	**328.3333**	**59**				

The results displayed for all attempts of the dominant and non-dominant foot before mental practice clearly show that the dominant foot performs better than the non-dominant foot, as illustrated in Figure 1. However, in Figure 2, after practicing mental rehearsal, the non-dominant foot performed better. This desired outcome demonstrates that the dominant foot, which was also influenced by mental imagery or the mental recall of the non-dominant foot, improved.

Figure 1: Data without Mental Practice for Non-dominant and Dominant Foot

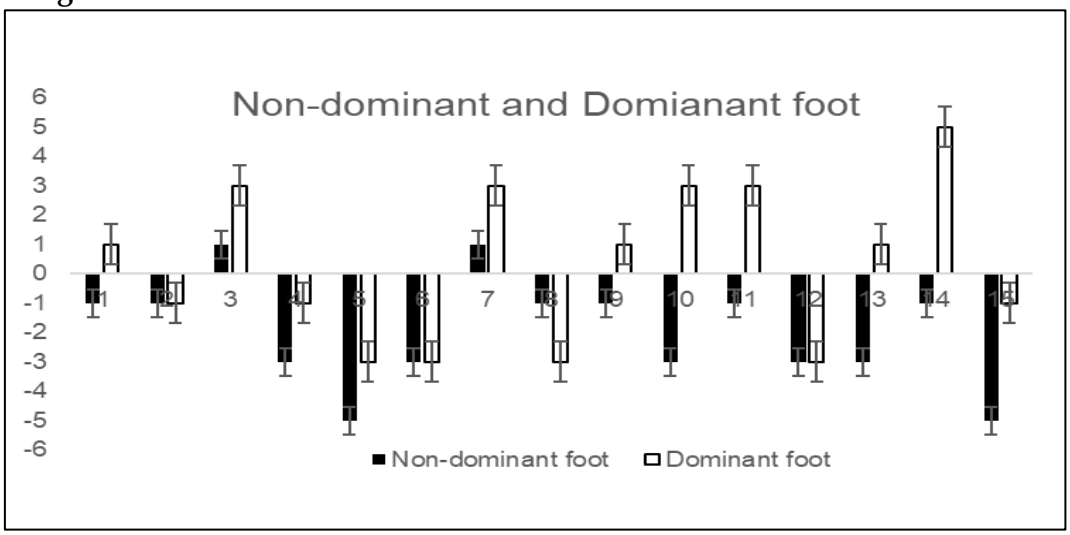
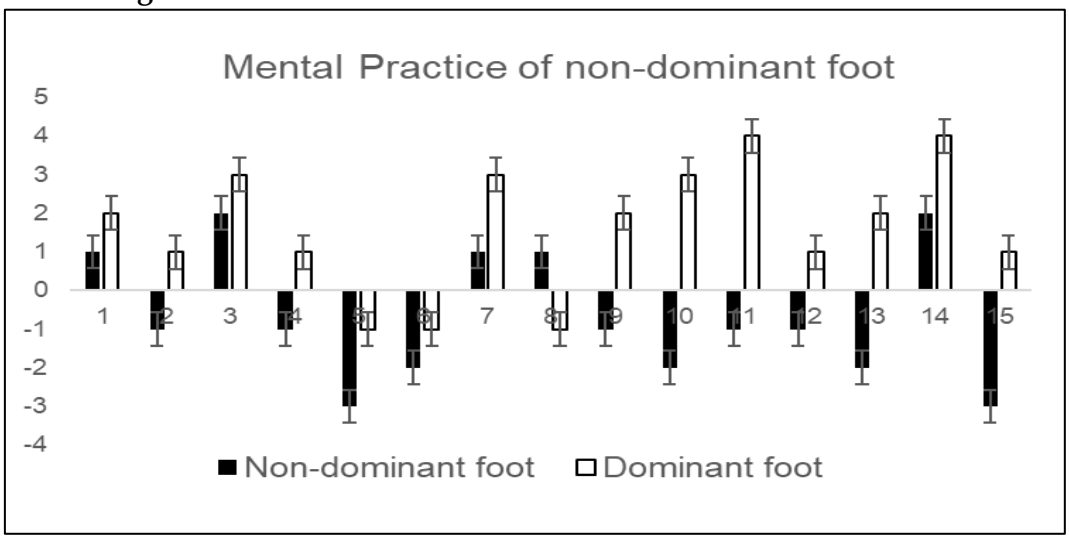


Figure 2: Data with Used Mental Practice for Non-dominant Foot



4. Discussion

Mental practice plays a crucial role in the influence on the direct performance of body parts, e.g., right hand or left hand, but it is not sure that limb symmetry influences; the study referenced presents an intriguing exploration into the effects of mental practice on the contralateral limb. The findings suggest that the mental practice of one limb can indeed have a positive impact on the performance of the opposite, or contralateral, limb. This phenomenon is often referred to as "cross-education" or "cross-training effect." The implications of such results are significant, particularly in the fields of rehabilitation and sports training. For instance, individuals recovering from an injury may benefit from mental training techniques to maintain or enhance the performance of the uninjured limb. Additionally, athletes might use mental practice to improve overall symmetry and performance without physically overloading both limbs (Nakashima *et al.*, 2024).

This study contributes valuable insights into the understanding of neural plasticity and the interconnectedness of motor functions across the body. If you have any specific questions or need further elaboration on aspects of the study, in the field of sport, the multiple motor limbs in enhancing athletic performance are indeed noteworthy. Athletes like Lionel Messi, who exhibit exceptional proficiency with both feet, exemplify the advantages of developing symmetrical limb capabilities. This ability allows for greater versatility, adaptability, and efficiency in their respective sports (see Jimenez-Diaz *et al.*, 2024). Focusing on symmetrical limb development can lead to improved coordination, balance, and overall performance. It can also reduce the risk of injury by preventing over-reliance on a single limb, thereby promoting more balanced muscular development.

Incorporating training techniques that emphasize bilateral skill development, such as practicing drills with both limbs equally, can be beneficial. Additionally, strength and conditioning programs that target both sides of the body can further enhance an athlete's ability to perform with symmetry. Overall, fostering symmetrical limb performance is a valuable approach in the athletic training regimen, contributing to the holistic development of an athlete's skill set (Rajaratnam *et al.*, 2022; Villa-Berges, 2023).

However, the significance of symmetrical limb development in athletic performance is indeed profound and well-articulated. Athletes like Lionel Messi, who demonstrate remarkable proficiency with both feet, serve as exemplary models of the benefits derived from such balanced development. The advantages you highlighted—enhanced versatility, adaptability, and efficiency—are crucial for athletes striving for excellence. The focus on symmetrical limb development not only improves coordination and balance but also contributes to overall performance enhancement. By reducing the risk of injury through balanced muscular development, athletes can maintain longevity and sustainability in their careers. Incorporating bilateral skill development through drills and exercises is indeed a strategic approach. Such training ensures that both sides of the body are equally conditioned, allowing athletes to perform with symmetry and precision. Strength and conditioning programs tailored to target both limbs equally further reinforce this balanced development, contributing to a more comprehensive and robust athletic skill set.

In conclusion, fostering symmetrical limb performance is a valuable strategy in athletic training, promoting holistic development and optimizing an athlete's potential. It will also be beneficial to use this strategy, and the implications of such results are significant, particularly in the fields of rehabilitation and sports training.

Conflict of Interest Statement

The author declares that there are no conflicts of interest, finical or otherwise, that could compromise the integrity of this proposal.

About the Author

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