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Motor imagery and 'placebo-racket effects' in tennis serve performance

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ABSTRACT

Objectives: This study aimed at confirming whether Motor Imagery (MI) enhances tennis serve performance, and determining whether a placebo condition could affect the beneficial effects of MI.
Design: This study used a 3 × 2 factorial design. Three groups of tennis players were compared in service performance outcomes before and after a training session.
Methods: Twenty-two tennis players were assigned into three groups: a control (C) and two experimental groups subjected to a similar MI intervention, one group using their regular own racket (MI group) while the other used a placebo racket (P group).
Results: Analyses of Covariance revealed no significant group difference when comparing serve velocity after training session, but MI training improved serve accuracy and regularity. Combining placebo racket with MI further resulted in greater serve accuracy score as compared to MI alone. Players' perception of their serve quality improved after MI, and this effect was reinforced in the P group.
Conclusion: These findings revealed that MI may be useful to achieve peak performance, and that the implement placebo effect might be a factor in sport performance, hence promoting the beneficial effects of alternative methods to improve tennis serve performance.

Motor Imagery (MI) is the process of mentally rehearsing a motor act without overt body movement (Jeannerod, 1994). A large body of research provided evidence that MI and physical practice of the same movement share similar cerebral substrate, although neural networks are not totally overlapping (Gerardin et al., 2000; Guillot et al., 2008; Munzert & Zentgraf, 2009; Solodkin, Hlustik, Chen, & Small, 2004), and demonstrated the influence of central activations on autonomic effectors during MI (e.g., Decety, Jeannerod, Durozard, & Baverel, 1993; Guillot & Collet, 2005). The fact that MI and actual practice are mediated by the same neural mechanisms is known as the principle of functional equivalence (Guillot, Debarnot, Louis, Hoyek, & Collet, 2010; Holmes & Collins, 2001; Munzert & Zentgraf, 2009), which tends to suggest that unless MI is congruent with physical practice, it will not be as effective in achieving its desired effects. Over the last two decades, MI research has more specifically been designed to understand why, when, where and how using imagery, as well as what is imagined (Guillot & Collet, 2008; Munroe, Giacobbi, Hall, & Weinberg, 2000). Overall, there is compelling evidence that MI substantially contributes to improve motor learning and motor performance (Driskell, Copper, & Moran, 1994; Weinberg, 2008). Particular attention has been paid to the effect of cost-effective and easily feasible MI interventions in enhancing skill learning. Interestingly, some researchers argued that MI might be more effective in closed skills, where the environment is predictable, compared to motor skills involving an ever-changing environment (Coelho, De Campos, Da Silva, Okazaki, & Keller, 2007). This may be due, at least partially, to the fact that athletes can imagine in their own time and without the distraction of an opponent (Highlen & Bennett, 1979). For instance, the effectiveness of MI has been reported in sports such as gymnastics or golf (Smith, Wright, Allsopp, & Westhead, 2007; Smith, Wright, & Cantwell, 2008), as well as elements in sports such as tennis serve (Coelho et al., 2007; Noel, 1980), or basket-ball free-throw (Wrisberg & Anshel, 1989). The effectiveness of MI interventions is improved when MI is used next to physical practice (e.g., Guillot & Collet, 2008; Holmes & Collins, 2001), in an adequate environmental context (Callow, Roberts, & Fawkes, 2006; Guillot, Collet, & Dittmar, 2005) and with a level of arousal matching those observed during actual practice (Holmes & Collins, 2001; Louis, Collet, & Guillot, 2011). Also, MI should ideally preserve the spatial and temporal

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characteristics of the movement when this technique is used to perform/rehearse movements (Guillot, Hoyek, Louis, & Collet, 2012 for review). However, little is known in regards to the use of a placebo condition to examine the theoretical relevance of these prerequisites for effective MI interventions (e.g., Cupal & Brewer, 2001), and more specifically to the use of a deceptive placebo procedure during MI where participants are wrongly informed that they are using custom-made implement. Such experimental approach might shed light on whether thinking that implement is individually optimized positively affects the beneficial effects of MI.

The placebo effect is frequently defined as a favorable outcome arising from the belief that one has received a beneficial intervention (Clark, Hopkins, Hawley, & Burke, 2000). In medical research, the placebo procedure is a simulated medical intervention making the patients believing that the treatment has a beneficial therapeutic effect. More recently, some researchers examined the prevalence of the placebo effect in competitive sport (Beedie, 2007; Beedie & Foad, 2009). Most of these studies investigated whether the administration of an inert substance believed by athletes to be an ergogenic aid contributed to improve motor performance. Interestingly, athletes also recognized their willingness to adopt almost any technical innovation that could impact on their performance positively, even if equipment might have amounted to a placebo effect (Beedie, 2007). Some authors further examined the impact of sport equipments' characteristics using a placebo procedure (Bertram & Guadagnoli, 2008). In such case, participants were unknowingly tested with a placebo implement while being convinced they were using custom-made implement designed to provide additional benefits. Altogether, these data suggested that both the placebo effect and the placebo procedure might occasionally be a factor in sport performance.

Interestingly, looking at the sport psychology literature offers some alternative, or at least complementary, viewpoints. Accordingly, an important body of research explored the relationship between self-efficacy beliefs and motor skill learning (e.g., Feltz & Lirgg, 2001; Feltz & Riessinger, 1990; Garza & Feltz, 1998; Law & Hall, 2009). At the core of the social cognitive theory (Bandura, 1997), self-efficacy refers to beliefs in the ability to organize and execute the course of action required to produce given attainments. For example, observing similar others succeed was shown to increase a learner's self-efficacy for the task (Bandura, 1997). More generally, '*people's level of motivation, affective states, and actions are based more on what they believe than on what is objectively true*' (Bandura, 1997, p. 2). Brown (2003) further stated that athletes need to have confidence in themselves, in their skills, in their equipment, in their team-mates, in their officials and in their coaches, as well as a high degree of social and competition confidence. As a consequence, people's behaviors may be sometimes better predicted by their self-efficacy beliefs than by their previous attainments, knowledge, skills or abilities (Short, Tenute, & Feltz, 2005). Taken together, we think that convincing athletes that they are using custom-made equipment designed to provide additional benefits (placebo condition) is likely to improve their self-confidence and, therefore, motor performance.

The present study was designed to determine whether combining physical practice with a MI intervention contributes to improve the effectiveness of tennis serve, and to see whether influencing athletes' belief might reinforce this effect. Within a MI intervention design which closely approximated motor performance and allowed examining athletes in a competitive environment to improve the ecological validity (Munroe-Chandler, Hall, Fishburne, & Shannon, 2005), we therefore explored whether both cognitive and motivational imagery functions (Hall, Mack, Paivio, & Hausenblas, 1998; Paivio, 1985) might simultaneously affect motor performance. Apart from a control group subjected to physical practice but without intervening MI practice, we compared two experimental groups subjected to a similar MI intervention, with one group using a custom-made tennis racket (placebo group) while participants of the other group used their own racket (imagery group). The aim of the study was twofold: *i)* confirming whether MI enhances motor skill performance, and *ii)* determining whether using a placebo racket is likely to positively affect the expected beneficial effects of MI training. Accordingly, we predicted that the beliefs about the outcome of the MI training session would be positively influenced by having the participants thinking their racket is optimized for their specific needs.

Methods

Participants

Twenty-two tennis players volunteered to participate in this study, which was approved by the ethics committee Sud-Est II. Written informed consent was obtained from all participants before data collection. All participants had played tennis for at least three years. Before the experiment, they completed the French version of the Revised Movement Imagery Questionnaire (MIQ-R; Hall & Martin, 1997; Lorant & Nicolas, 2004). Players were assigned to one of three groups, i.e. an imagery group (MI), a placebo group (P) and a control group (C), although we checked that there was no group difference according to gender, age, height, mass, ranking, and weekly training, in order to avoid influence of these parameters onto the ability to use MI. However, the manufacture of the 'placebo rackets' did not allow players to be grouped as a function of their initial performance that resulted in great intra-group variability in performance measurements. To ensure that enhanced performance would not depend upon individual MI abilities, we further verified that MIQ-R scores did not significantly differ among groups. The characteristics of each group are presented in Table 1.

Testing protocol

The effects of a 6-weeks MI and placebo training sessions were evaluated using a test-retest procedure. The week before and after training sessions, participants were requested to perform 16 serves, eight per diagonal. They were instructed to hit first serve with their own racket, as fast as possible, in a predetermined target while looking for an ace. The experiment was conducted in an indoor tennis court. To assess objective measurements, a radar gun (error margin = $\pm .28$ m s^{-1}, SR3600, Sports-radar, Homosassa, FL, USA) was located behind the player to record ball velocity after serve impact. The target was defined from the service and center lines, and divided into three areas (Fig. 1). A ball rebound in the small area, defined between the service box line and .5 m forward in the

Table 1
Mean ± standard deviation for the Motor Imagery (MI), Placebo (P) and Control (C) groups of tennis players' characteristics.

	MI	P	C
Male/Female	6/2	6/1	3/4
Age (years)	14.25 ± 2.60	14.43 ± 3.05	16.29 ± 5.50
Height (cm)	163.75 ± 13.35	163.43 ± 17.27	167.33 ± 14.11
Mass (kg)	50.06 ± 12.12	51.43 ± 14.95	53.17 ± 14.82
Current ranking	6.75 ± 3.11	7.86 ± 2.91	7.29 ± 3.45
Weekly tennis training (h)	6.31 ± 3.77	7.36 ± 2.95	5.33 ± 4.28
Tennis experience (years)	6.75 ± 3.66	8.14 ± 2.67	5.33 ± 2.25
MIQ-R	21.86 ± 2.25	22.93 ± 3.00	22.88 ± 2.68