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# Motor imagery and serving precision: A case study.

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ABSTRACT

**The goal of this case study was to outline the influence of practice setting conditions and motor imagery on service precision. The eight conditions that were conducted showed that mentally imagining the serve four times whilst in the service position improved the accuracy and location of the ball bounce on the opponent's court and that using visual imagery whilst in the service position itself helped to improve consistency. The results have enabled the researchers to identify the strengths and weaknesses of the motor imagery ability of the evaluated player with a view to defining mental preparation goals for coaching sessions, as well as making the participant's serve more efficient in competitive situations.**

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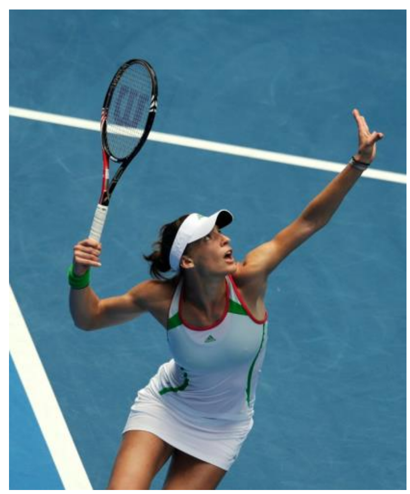
## INTRODUCTION

In the search towards greater efficiency, the serve must combine speed and precision in order to increase its percentage level of success, thereby augmenting the number of easily won points (Brody, 2003). Improving efficiency in the serve involves the optimization of the technical, physical and mental abilities of the player so as to produce the best possible outcome. Motor imagery techniques are commonly used for mental preparation (Mamassis, 2005) and consist in forming mental representations of an action without concomitant movement (Guillot & Collet, 2008). Motor imagery presents applications in four different fields, including that of performance (Guillot & Collet, 2008). Previous research has shown that motor imagery helps improve the precision of the serve for advanced tennis players (Guillot et al., 2011). The purpose of this work was to study the influence of different practice conditions using motor imagery and their associated effect on service precision. Using experimental design methodology, this research specifically aimed to study the influence of the type of imagery, the number of mental repetitions and the practice setting (where the imagery is performed) on the precision of the serve.

## METHOD

Three experimental variables were studied: type of imagery (TI), number of repetitions (NbR) and practice setting of imagery (S). Each one of these variables was divided into two modalities corresponding to two levels (-1 and +1), namely visual imagery vs. kinaesthetic imagery for TI, one vs. four repetitions for NbR, and off-court vs. in serve position for S.



A 23 full factorial design was used to define the 8 experiments/conditions to be conducted (Table 1) and to quantify the main effects and interactions between the variables of serve precision, based on the following mathematical model:

$$Y = b0 + b1*TI + b2*NbR + b3*S + b12*TI*NbR + b13*TI*S + b23*NbR*S + b123*TI*NbR*S$$

Y represents the response (serve precision), b0 the constant of the model, bi the coefficient of the main effects of the experimental variables (TI, NbR and S), bij the coefficients of level 1 interaction effects between the experimental variables, bijk the coefficient of level 2 interaction effects between the experimental variables.

The experimental protocol consisted of motor imagery of a serve (according to the conditions described in table 1) followed by the performance of an actual serve. All of the conditions were repeated 10 times (5 serves in each diagonal) on a hard in-door court and were performed by a volunteer tennis player (24-years-old; French ranking = 5/6). The performance instructions were to hit a precise and powerful serve on the "T" (i.e. to seek an ace). The precision was evaluated based on the location of the rebound of the ball in the opponent's box. The most accurate bounces within the 0.5*0.5m area (determined from the central line and the service box lines) yielded 5 points; a rebound located in the 1*1 m area yielded 3 points; a rebound located elsewhere in the box yielded 1 point. The precision was quantified by two parameters: the score corresponding to the sum of the points obtained after performing the 10 actual serves of each condition (the higher the score, the better the precision) and the consistency corresponding to the coefficient of variation (CV) of the score (the lower CV, the higher the consistency).

The coefficients of the models were calculated through multiple linear regressions by using the NEMROD-W program (LPRAI, Marseille, France). The level of significance of the coefficients was set to $p \leq 0.05$.

| EXP. | *TI* | | *NbR* | | *S* | | *Score* | *CV* |
|---|---|---|---|---|---|---|---|---|
| | Modality | Level | Modality | Level | Modality | Level | (points) | (%) |
| 1 | Visual | -1 | 1 | -1 | Off-court | -1 | 9 | 97 |
| 2 | Kinaesth. | +1 | 1 | -1 | Off-court | -1 | 8 | 115 |
| 3 | Visual | -1 | 4 | +1 | Off-court | -1 | 15 | 110 |
| 4 | Kinaesth. | +1 | 4 | +1 | Off-court | -1 | 14 | 122 |
| 5 | Visual | -1 | 1 | -1 | In serve position | +1 | 16 | 79 |
| 6 | Kinaesth. | +1 | 1 | -1 | In serve position | +1 | 19 | 104 |
| 7 | Visual | -1 | 4 | +1 | In serve position | +1 | 21 | 69 |
| 8 | Kinaesth. | +1 | 4 | +1 | In serve position | +1 | 18 | 101 |

*Table 1. Matrix of experiments showing the modalities and levels of the three experimental variables (TI: type of imagery; NbR: number of mental repetitions; S: practice setting of imagery), and responses corresponding to each experiment (CV: coefficient of variation).*

## RESULTS

Results showed that the best compromise for optimal accuracy is to perform four mental repetitions whilst in the service position.

The model calculated for the precision score is the following:

$$Score = 15 - 0.25*TI + 2*NbR + 3*S - 0.75*TI*NbR + 0.25*TI*S - 1*NbR*S - 0.75*TI*NbR*S$$

Only the coefficients associated with variables NbR and S are statistically significant ($p=0.03$ and $p=0.003$, respectively).

Furthermore, results showed that the best way to increase consistency (lower CV) according to this study is to use visual imagery whilst in the serve position. The model calculated for CV is the following:

$$CV = 15 + 10.7*TI + 0.9*NbR - 11.5*S + 0.2*TI*NbR + 3.3*TI*S - 4.1*NbR*S + 1.5*TI*NbR*S$$

Only the coefficients associated with variables TI and S are statistically significant ($p=0.008$ and $p=0.006$, respectively). The number of mental repetitions and the interactions between the experimental variables had no significant influence on CV.

## DISCUSSION

The main results show that four mental repetitions performed in the service position help improve the precision score of the serve and that using visual imagery in the service position improves consistency in the serve. This information makes it possible to refine the instructions and practice conditions associated with imagery in order to increase its effectiveness.

First and foremost, the results of this case study confirm the efficiency of motor imagery in tennis performance (Coehlo et

al., 2007 ; Noel, 1980 ; Robin et al., 2007). They also confirm the importance of the practice setting of motor imagery, which means that it must be used preferentially in a context close to the environment of actual practice (Holmes & Collins, 2001 ; Guillot et al., 2005). Indeed, mentally simulating the movement using data from the visual, kinaesthetic, auditory and proprioceptive senses can facilitate the production of mental representations. These data are first memorized during practice before being recognized, selected and retained, which helps form a better representation of the situation.

The results also show that using visual imagery prompted a better consistency in the serve of the evaluated player. This modality gives the player the opportunity of visualising the outcome of the movement, including the trajectory and the impact of the ball in the opponent's box. Likewise, repeating the serve four times has allowed the player to improve the precision of his serve. The choice of the modality of imagery, as well as the number of repetitions will be considered as conditions that remain specific to the evaluated player since no previous study has really established the superiority of visual imagery over kinaesthetic imagery, nor has determined a specific number of repetitions for optimal efficiency. However, this study allows us to formulate recommendations for improving efficiency in the serve of the tested player.

In competitive situations, this player will use preferentially visual imagery several times before serving and will endeavour to do it while in serve position. Integrating these modalities of imagery into the preparation routine seems to be the best compromise; however, it will be necessary to adapt the number of repetitions in order to avoid exceeding the 20 seconds limit between points imposed by the rules of tennis. It may therefore be possible to propose to players a concentration routine based on motor imagery that would really optimize their serve, distinguishing itself from the usual bounce-the-ball ritual. During coaching sessions, it will be recommended to develop the ability of modalities of imagery other than visual in order to diversify training and avoid any sense of weariness due to using only the visual channel. For instance it would be possible to devise an imagery protocol based on kinaesthetic information (relaxation during preparation, muscle activation, and explosiveness when hitting the ball), and then to make it evolve towards the visualization of the ball bouncing off the racket strings all the way to the opponent's box. Similarly, a complementary work could be undertaken in order to reduce the number of repetitions necessary for the imagery to be efficient, and therefore limit the mental load before serving.

## CONCLUSION

This study confirms the fact that imagery contributes to improving the precision and consistency of the serve in tennis. Based on a simple and rigorous methodology, this study has allowed us to identify the strengths and weaknesses of the motor imagery of the tested player in order to define mental preparation objectives for that player in coaching sessions, and to make the participant's serve more efficient in competitive situations.

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