The Effects of Mental Rehearsal on the Acquisition of Tennis Skills

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(Received October 11, 1990)

ABSTRACT

Sixteen female tennis beginners practiced tennis smashes for five days. Half of them practiced it with mental rehearsal (MR). The remainder practiced it without mental rehearsal (NMR). The performances (a. distance from target points, b. accuracy of hit angle, c. speed of the ball) of MR rose dramatically, while the ones of NMR stayed on the same levels as the first day. The reasons why the practice with MR attained high levels were inferred from a framework of TOTE model that was proposed by Miller, Galanter Pribram (1960).

Substantial research has confirmed the positive effects of mental rehearsal (MR) on the acquisition of sensory motor skills (Prather, 1973; Riley & Start, 1960; Schick 1970; Yamauchi, Yumino, & Okuma, 1979). Success was achieved with maximum effect when MR was used, not as a substitute for real practice, but as real practice itself (Scott & Pelliccioni, 1982; Weinberg, 1982). In addition, it had maximal time (Twinning, 1949), and was effective for novices and intermediate level players more than for advanced players (Clark, 1960).

However, only a little research has been conducted for the effect of MR on the acquisition of tennis skills (Loehr, 1979, Weinberg & Gould, 1980). Weinberg & Gould examined the effects of sexual difference, 4 cognitive strategies (imagery, positive self-efficacy statements, attentive focus and a control condition) and ability (advanced and beginning players) on the acquisition of a tennis serve. The results showed that none of the cognitive strategies improved performance; only the main factor of ability was significant. They inferred the cause of the null-effect of the 4 cognitive strategies including imagery, and attributed the cause to the fact that the learners could not utilize these strategies well enough in order to develop skills, especially a very complicated skill like the tennis serve. However, the effect of cognitive strategies on motor skills is delicate. For this reason, the null-effect of cognitive strategies should be reexamined by changing the experimental conditions. The present study was designed to investigate the effects of MR on the acquisition of a tennis smash.

[1]The author is grateful for assistance and advice of Yoshiko HATTORI.

METHODS

Subjects

The subjects were 16 female students who ranged in age from 18 to 19. All were beginners of tennis. They had been practising for only seven months at the college tennis club. On the day before the practice session (0th day), all subjects had a pretest in smash skills. They hit 40 smashes. The last 30 smashes were rated in 5 grades according to their distance from a target. Based on a measure of 30 smashes and every day observation by the author, half of the subjects were grouped into a MR group and remaining half into Non-MR (NMR) group. Levels of smash skill for both groups were nearly pair-matched. Consequently, there was no significant difference in performance in smash skills between the two groups.

Practice plan

The practice plan is shown in Fig. 1. This is a practice program for 6 days. On the 5th of the practice days (4th day of practice session), only the MR group performed because of rainfall. The MR group was asked to carry out MR for at least 10 minutes before going to bed. ■ shows more than 30 minutes MR in day time. ▮ shows more than 10 minutes MR before going to bed. □ shows 40 real smashes in the morning.

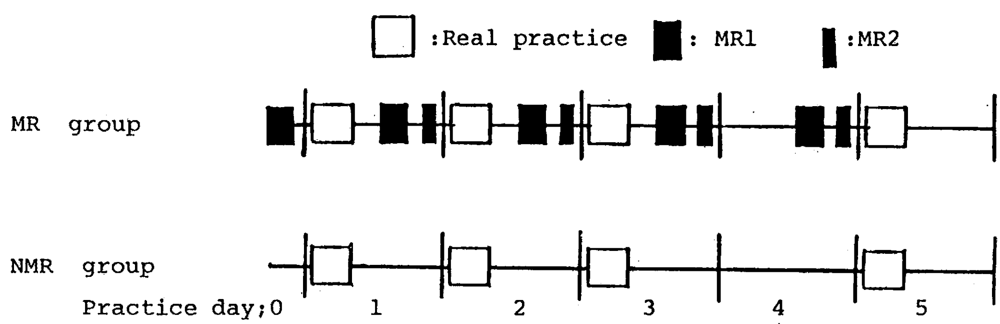

Fig. 1. Practice plans of MR and NMR groups.
MR 1, MR 2 show 30 or 10 minutes MR.

Mental rehearsal

MR was carried out in the following ways: (1) The subjects watched several smashes performed by a Japan ranking woman player on TV at normal speed and slow speed. (2) In order to grasp the key points of the smashes, they looked at the abbreviated drawings of the smash skill on a blackboard. (3) In their mind, they made an image of themselves "smashing" in slow motion. They made a series of images that include taking back the arm to hit the imagined falling ball with precise timing. (4) They repeated (1) to (3). The MR adopted here corresponds to "external imagery" in Mahoney's (1979) distinction.

Procedure

On the 0th day of the practice program, all the subjects hit 40 smashes as a pretest. An observer recorded the points where the balls bounced. The grouping of MR and NMR was based on both the data and everyday' observation that was consecutively carried out by one of the author. After the test, they saw the key points of the smash constructed from several drawings on the blackboard and simultaneously they heard the general instructions for the smash practice.

In a real practice, a player stood at the point P in Fig. 2. For warming-up and test trials, each of them hit 40 balls at the best position to smash that were tossed up by T (advanced player with career more than 6 years) aiming alternately at the target point A_1 and A_2.. The 1st 10 trials were for warming-up and were excluded from data. An observer (O_1) graded the speed of the balls in 3. O_1, who is a member of the tennis club, knew the highest speed of the ball. Hence she was able to evaluate the speed of the ball correctly. The practice, including a test,was carried out in 4 courts simultaneously. Accordingly, each player experienced different tossers everyday.

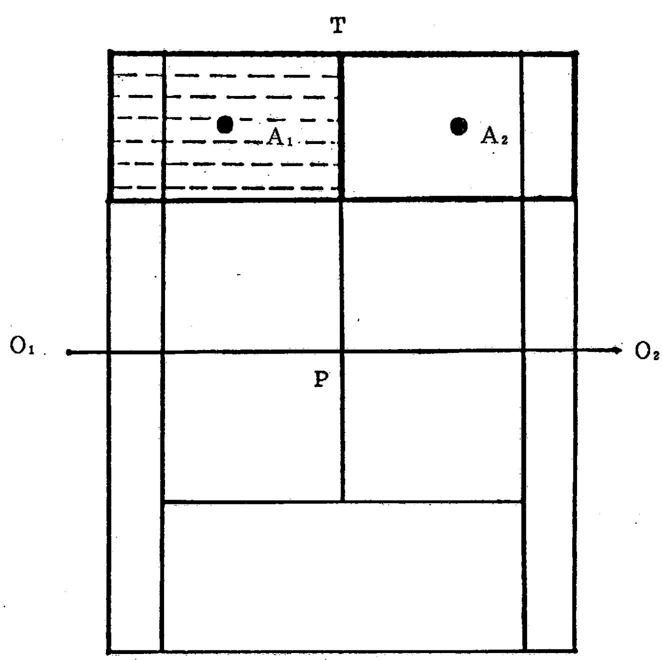

Fig. 2. The position of a player (P) , a tosser (T) and two targets (A_1, A_2) .

RESULTS

The data were taken from 3 points of view : (1) distance from the target point. (2) accuracy of hit angle. (3) speed of the ball.

Distance from the target points

In order to measure the distance from one of the target points, 4 concentric circles were drawn with equal proportions. Five points were given to a ball which bounced in the center of the circle and 4, 3, 2, and 1 point were given according to the distance from the center of the cocentric circles. Four or 5 points were given if a ball bounced in the left half of the shaded zone when the subject aimed at point A_1 in Fig. 2. Therefore the best score in a day is 150 (5×30). Fig. 3a shows a transition of average scores concerning how accurately the balls hit the target point. The score of the MR group increased with each practice day, while those of NMR group stayed on the same level as the 1st day.

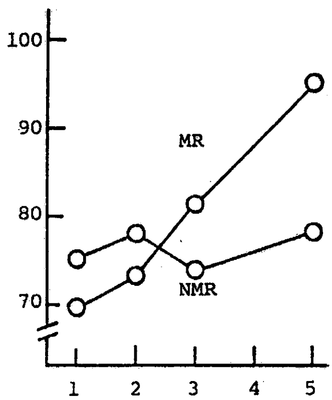

Fig. 3 a. Distance from target points.

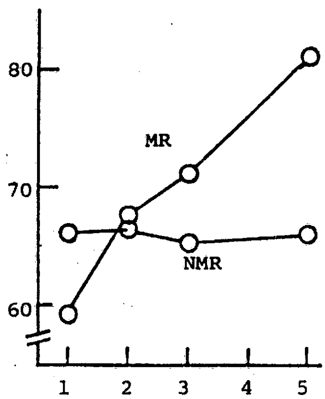

Fig. 3 b. Accuracy of hit angle.

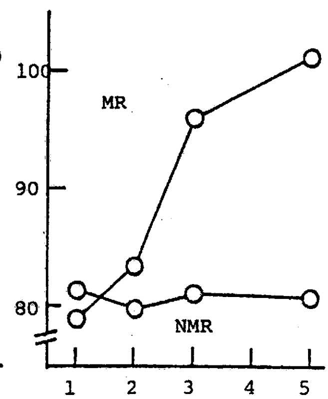

Fig. 3 c. Speed of the ball.

A(2:MR-NMR)×B(4:practice day) analysis of variance applied to Fig.3a data. Main effect A was not significant ($F(1,4)=1.14$, n.s.), but main effect B was significant ($F(3,42)=31.00, p<.01$). Interaction A×B was also significant ($F(3,42)=18.63$, $p<.01$). As the interaction was significant, a sub-analysis was performed. The performance of MR increased with each practice day ($q(3,42)=46.74, p<.01$), whereas that of NMR stayed at the same level as the 1st day ($q(3,42)=2.88$,n.s.). On the 3rd and 5th day, the performances of MR were superior to the ones of NMR (3rd:$q(1,56)=4.67$, $p<.05$; 5th:$q(1,56)=18.39, p<.01$). On 1st and 2nd day, NMR got higher performances than MR, however the difference was not significant.

Accuracy of hit angle.

Tangent lines were drawn from P to each concentric circle. Three points were given to the ball that hit the zone divided between the innermost 2 lines. Two points were given to the ball that hit the zone divided between the next 2 lines (exclude 3 points zone). One point was given to the ball that hit the zone divided between the outermost lines (exclude 3 and 2 points zone). The ball that bounced outside the outermost lines got no score. Hence the best score of a day is 90 (30×30). Fig. 3b shows a transition of the average scores on the accuracy of hit angle. The scores of the MR group increased with practice, while those of the NMR group did not change.

A(2:MR-NMR)×B(4:practice day) analysis of variance applied to Fig. 3b data. Main effect A was nearly significant($F(1,14)=3.62, p<.1$), and main effect B was significant ($F(3,42)=31.01, p<.01$). Interaction A×B was also significant ($F(3,42)=36.96, p<.01$). As the interaction was significant, a sub-analysis was performed. The performance of MR increased with each practice day ($q(3,42)=67.87, p<.01$), whereas the one of NMR stayed at the same level as the 1st day($q(3,42)=.7$, n.s.). On 3rd and 5th day, the performances of MR were superior to those of NMR (3rd:$q(1,56)=4.26, p<.05$; 5th:$q(1,56)=53.83, p<.01$). On the other hand, NMR got a higher performance than MR on 1st day ($q(1,56)=12.63, p<.01$).

Speed of the ball

The speed of the ball was evaluated according to the following 3 grades;frame shot or chip shot got 1 point, ordinary shot got 3 points and fast shot got 5 points. Accordingly, the best score of a day was 150 (5×30). Fig 3c shows a transition of the average scores of the speed of the ball. The scores of the MR group rose remarkably as a result of each practice day, while those of the NMR group fell slightly.

A(2:MR=NMR)×B(4:practice day) analysis of variance applied to Fig 3c data. Main effect A was significant($F(1,14)=20.66, p<.01$), and main effect B was significant ($F(3,42)=16.23, p<.01$). Interaction A×B was also significant ($F(3,42)=15.83, p<.01$). As the interaction was significant, a sub-analysis was performed. The performance of MR increased with each practice day ($q(3,42)=31.44, p<.01$). On the other hand, that of NMR stayed same level as the 1st day ($q(3.42)=.61$, n.s.) On 3rd and 5th day, performances of MR were superior to those of NMR (3rd:$q(1,56)=21.03, p<.05$; 5th:$q(1,56)=47.60, p<.01$). On 1st and 2nd day, the performances of NMR were as same as those of MR.

DISCUSSION

MR group showed remarkable progress in all of the scores of (1) the distance from the target point, (2) the accuracy of the hit angle and (3) the speed of the ball. These findings are inconsistent with Weinberg & Gould (1980) who found that mental preparation did not improve performance on motor task involving speed, balance, and accuracy. Therefore, the facilitating effects of cognitive strategies on the performance of tennis skills appear to be practice plan specific.

Why was our practice plan of MR so effective? There seem to exist several reasons. Based on the TOTE model, that was originally proposed by Miller, Galanter & Pribram (1960), let us analyze the facilitating effects of MR on acquiring the smash skill. Our TOTE model(Fig. 4) has 4 phases; (1) search for a suitable pivoting point: this process includes an indication to a tossed ball that helps the player to measure the exact height and direction of the ball; accordingly it helps the player to anticipate the place the ball falls, (2) taking back the racket, (3) preparation for hit, (4) hit ball and follow through. Each phase proceeds alone or interconnectively with others. The facilitating effects must be explained based on the model. Let us discuss the facilitating effects on the model.

In exploring the source of the effects, the followings emerge as critical factors:

(1) By watching video and abbreviated drawings, the players of MR group could make a whole plan of hitting action that corresponds to the whole TOTE units in Fig. 4. (2) He could connect between the sub-skills that were already mastered and make them up into a wholly organized skill. (3) He could pay attention to the key points of hitting form;one of the authors expounded the key points of the smash skill to the players. In both MR and real practice, the players consecutively focussed attention to the points. Such reflective behavior must have accelerated the speed of acquiring smash skills. (4) He could grasp the good timing of execution of the sub-skills of smash;A smash is composed of phases in Fig. 4. Each phase has a few basic TOTE units. As each phase proceeds alone and/or together with other phases, the basic unit also begins and ends alone and/or together with other units. It is plausible that MR helped the player judge good timing about when should he start and finish each unit. (5) As Jacobson (1930) pointed out, imagery on physical movement is deeply concerned with kinesthetic movement. Therefore, MR played a similar role of physical training. (6) As MR was easy to repeat, he could practice a lot of smashes with less fatigue.

All or some of the above reasons must have improved dramatically the smash skills of the MR group. However, there was another reason : The MR group practiced more time than the NMR group, and this should be taken into consideration. Practice time is usually an important factor in motor skill learning. But this factor alone can not explain fully the remarkable progress of the MR group. As the performance of the NMR group stayed at the same level as the 1st day, it would be hard to expect the same developing pattern in both groups, even if the NMR group had the same practice time as the MR group.

On the 4th day of the program, it was impossible to make a real practice because

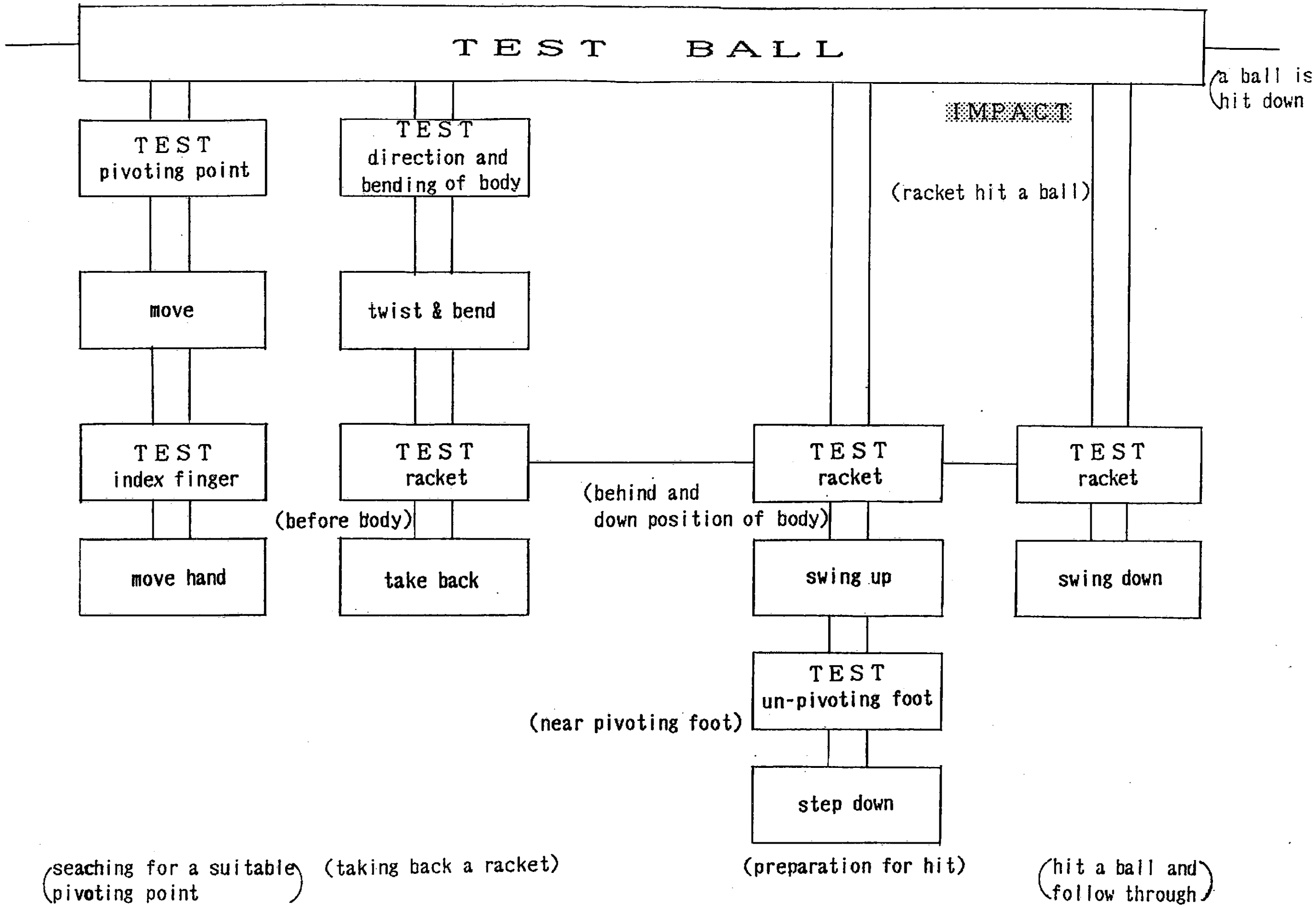

Fig.4. A TOTE model of a smash.

of rainfall. Only the MR group had MR on that day. The rapid increase in performance of MR group in day 3－5 can be attributed to MR, not to the reminiscence resulting from a break in real practice. As the performance of NMR group stayed at the same level during these days, it could be concluded that a suitable rest with MR in a long training program improves skills effectively.

After 5 days' practice, the players were asked on the motivation for practice. All of the MR group answered that they wanted further MR and real practice. The reason for this positive answer was that they found themselves competent in developing skills using MR. Such experiences must have raised the players' motivation for the practice day by day. On the contrary, most of the NMR group answered that they didn't want to continue practice with the test. For the NMR group player, this experimental practice with the test was no better than the usual one.

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