EFFECT OF PRE-LUNGE CONDITIONS ON PERFORMANCE OF ELITE FEMALE FENCERS

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INTRODUCTION, STATEMENT OF PURPOSE AND METHODS

Fencing is unique in many ways. It involves no ball, but does involve a long striking implement. This implement is not swung, but is used as an extension of the arm. It involves a basic stance which has hardly any similarity to other sports, except to some of the martial arts. A sport of legs and body propulsion, it involves neither running, jumping, or kicking, yet the body is propelled rapidly forward and backward during its execution. It is a sport of patient methodical set-up and then blinding speed. It well-deserves its definition as physical chess. Fencing is conducive to study, since most of the moves are uniplanar, and the fencers maintain a definite relationship to each other in space.

The purpose of this study was to determine if elite fencers performed the lunge differently under competitive conditions than under practice conditions. The subjects, three elite male fencers, were filmed at 200 frames per second with a Locam camera set perpendicularly to the plane of motion of the lunge. The subjects performed a stationary lunge at no target on a visual command. This was considered the type of lunge a fencer would do while practicing the lunge, and was called condition number one. The fencer then performed a lunge after parrying an attack by an opponent, which was called the retreat-riposte condition, or condition number two. The final lunge was performed after advancing and taking the opponent's blade. This was called the attack with blade condition, or condition number three. Each subject was directed to lunge as fast as possible. Comparisons were made between subjects and among conditions with respect to the speed and distance of each lunge, the acceleration of the body during each lunge, and the kinematics of the lead and rear leg, in particular rear foot drag. After the three conditions were performed, the subjects again performed the non-competitive condition to establish reliability.

RESULTS AND DISCUSSION

The distance of the lunge was measured from the ankle of the lead foot when the lead foot began its forward movement to lead foot landing. The distance of each lunge for each performer is shown in Table I.

Table I LUNGE DISTANCE (METERS)

Subject	Condition 1	Condition 2	Condition 3
1	1.0	1.0	1.0
2	1.0	1.2	1.3
3	0.6	0.8	1.5

Subject 1 was the most consistent performer in regard to distance lunged, as he lunged the same distance in all conditions. Subjects 2 and 3 lunged farther in the parry riposte condition, and still farther in the blade take condition. Although Subject 3 lunged the shorter distances in Condition 1 and 2, he outdistanced the other performers in the advance with blade take condition. Subject 3 was also the shortest subject, and part of the reason for his long lunge in Condition 3 may be a result of his real need to gain more distance than the other subjects in order to make a successful attack. The interesting fact is that 2 of the 3 subjects tested did change the distance of the lunge under competitive conditions.

The time of the lunge was measured from the ankle of the lead foot when the lead foot began its forward movement to lead foot landing. Speed is a major factor in the success of an attack, since a fast lunge gives the opponent less time to react. The time of the lunge for all subjects in all conditions is shown in Table II.

Table II LUNGE DURATION (MILLISECONDS)

Subject	Condition 1	Condition 2	Condition 3
1	400	400	250
2	550	500	400
3	500	550	600

All subjects differed in the time they took to complete the attacks in the different conditions, except for Subject 1, whose time differed only in Condition 3, the attack with blade take.

In actual time, which is more important than velocity, Subject 1 was the fastest performer. It took him 400 milliseconds to complete the practice lunge (Condition 1) and the parry-retreat lunge (Condition 2). He was even faster in the advance and blade take condition. Subject 2

became faster in each condition, and again, his fastest time was in Condition 3, advance with blade take. Subject 3 shows a reverse pattern from the other two, which seems strange at first, especially as he lunged the shortest distance of the subjects tested. However, in the third condition, he lunged the farthest of the subjects, so his time may not really have been longer in respect to the distance lunged.

The average velocities of the fencers are shown in Table III.

Table III AVERAGE VELOCITY (METERS PER SECOND)

Subject	Condition 1	Condition 2	Condition 3
1	2.5	2.5	4.0
2	1.8	2.4	3.3
3	1.2	1.3	2.3

Subject 1 had the greatest average velocity in all conditions; Subject 3, the least. Height and limb length may have contributed to this difference.

Hip translation was investigated to determine acceleration. It was evident, from line segment tracings (see Figures 1 and 2), that acceleration in the lunge occurred. With regard to Subject 1, acceleration occurred 2/3 of the way through the retreat-riposte condition (Condition 2). Subject 2 showed acceleration 1/3 of the way into the lunge in all conditions. Subject 3 also accelerated in all conditions. With regard to Subject 3, acceleration occurred at the same place in each condition, immediately after the lead leg reached full extension. Acceleration in the attack is important to successful attacks since the varying speed is difficult for the opponent to judge and defend against. In regard to the kinematics of the lead leg, with respect to Subject 1, the thigh of the lead leg reached the horizontal in all conditions and remained horizontal in the full out lunge position. There was no hyperextension of the lead leg on the recovery from the lunge. During the execution of the lunge, the lead leg extended to approximately a 180° angle at the knee. With respect to Subject 2, the lead leg did not fully extend during the execution of the lunge, and the largest angle at the knee was 135°. During the extension phase, the thigh was raised to the horizontal. Upon reaching the full out lunge position, the thigh passed the horizontal and the trunk continued to rotate forward well after foot strike occurred. On the recovery, hyperextension of the leg occurred. With regard to Subject 3, the lead leg hyperextended during the execution of the lunge. The thigh did not reach the horizontal, even in the all out lunge position. On the recovery, the leg also hyperextended. The hyperextension of the lead leg on the recovery is not surprising, since fencers are taught to recover from the lunge by pulling with the rear leg instead of pushing off with the lead leg. If the fencers were pushing off with the lead leg, flexion would have to occur. Therefore, it can be concluded that at least two of the subjects were recovering as taught and as is generally considered to be correct form. The fact that two of the subjects

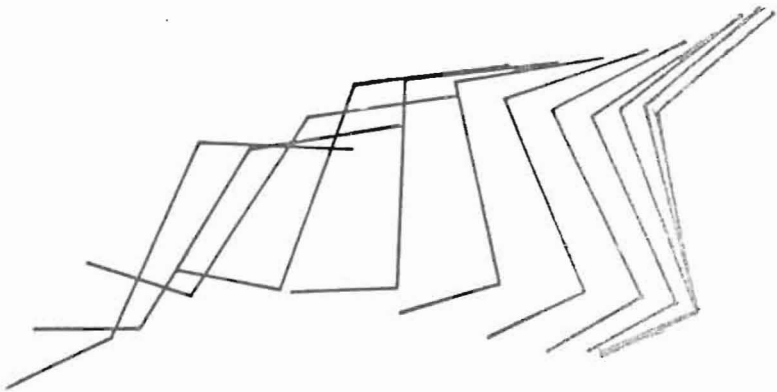

Figure 1. Hip translation and lower extremity displacements during the lunge, Subject 2

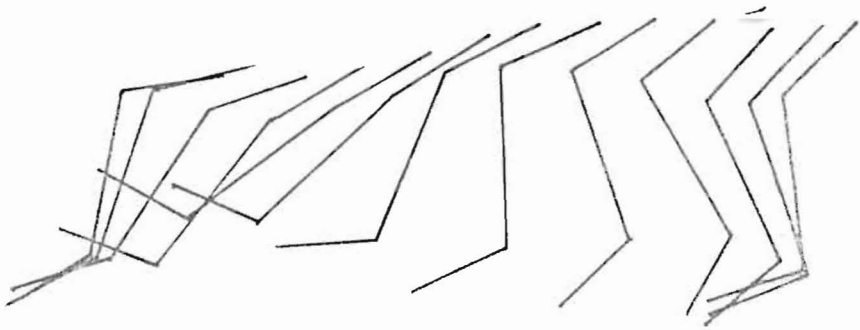

Figure 2. Hip translation and lower extremity displacements during the lunge, Subject 3

had lead thighs, which either did not reach the horizontal or did not remain horizontal in the lunge, is surprising, since bringing the thigh to the horizontal is generally believed to be necessary in order for the body to remain in balance and for the length of the lunge to be maximized. Since Subject 2 had already struck the target before his lead leg passed the horizontal, it seemed that there should be another reason for this phenomenon. Since Subject 2 is an epee fencer, it is possible that passing the horizontal with the lead leg permits more torso lean, and more ability to drive the point into the target, which good epee fencers do. With regard to Subject 3, however, failure to lift the lead leg to the horizontal definitely shortens the length gained by the torso in pressing the attack.

The horizontal momentum of the lunge is such that the fencer's rear leg is displaced forward. This displacement has been termed rear foot drag. The amount of rear foot drag determines how much total ground will be covered by the fencer. The distance of rear foot drag for each fencer is shown in Table IV.

Table IV REAR FOOT DRAG (METERS)

Subject	Condition 1	Condition 2	Condition 3
1	.29	.34	.53
2	.27	.58	.69
3	.14	.41	.68

All subjects had the greatest amount of foot drag in the attack with blade condition. Since all subjects also had the greatest average velocity in this condition, this result is not surprising. Subject 3 is particularly interesting in this respect, however, since he dragged his rear foot over 5 times farther in Condition 3 than in Condition 1. Subject 2 dragged over 2 1/2 times the distance and Subject 1 not quite twice the distance in this condition. The differences in the foot drag, in all conditions, is very important, since it signifies that the distance the fencer will travel in each condition will be different, while the distance to the target may be the same. Incorrectly estimating the distance to the target is a common and often costly mistake, as such an error can cause a fencer to miss his attack or be touched by an opponent.

The reliability of the data was checked by having each subject repeat Condition 1 after having completed all three conditions. All three subjects demonstrated high reliability on this retest.

CONCLUSIONS

1. Subjects 2 and 3 increased the distance of the lunge in the competitive conditions. Subject 1 did not increase his lunge distance in any condition.

2. All subjects changed the speed of the attack during the

competitive conditions. Subjects 1 and 2 were faster during the competitive conditions. Subject 3 was slower. However, as Subject 3 covered the greatest distance in the blade take condition, he may not have been slower overall.

3. Acceleration in the lunge occurred in all three conditions for Subjects 2 and 3, and in the retreat-riposte condition for Subject 1.

4. The kinematics of the lead leg of each subject differed slightly. Subject 1 reached the horizontal with the lead thigh and the thigh remained horizontal in the full out lunge position. Subject 2 reached horizontal and then passed horizontal as body lean continued in the full out lunge. Subject 3 never reached horizontal with the lead thigh at any time.

5. During recovery from the lunge, Subject 1 did not hyperextend the lead thigh. Subjects 2 and 3 both hyperextended the lead leg during recovery.

6. All subjects dragged the rear leg much less in the practice lunge condition than in the competitive conditions. Subject 1 had about twice as much drag on the blade take condition as in practice; Subject 2 had 2 1/2 times as much drag; Subject 3 had about five (5) times as much drag.

7. In fencing, to be elite is to be individual within certain technically prescribed parameters. While elite fencers performed the same technical actions, they differed individually among themselves in many aspects of these performances. These differences may be due to anatomical factors, age, weapon fence or other variables, but others are a matter of personal style which the athlete has developed.

IMPLICATION FOR COACHING

1. Elite performers in fencing are more than technically perfect. They have a personal style that transcends technical perfection while still demanding it as a cornerstone of performance. Therefore, coaches should try to develop this personal style rather than make the athlete conform to any one model.

2. From a safety standpoint, the actions of the elite are not always suitable for the beginner or intermediate performer to emulate. The elite fencer should not serve as a model for the beginner until the beginner has been conditioned to withstand the stresses placed upon the body in the extreme positions which elite fencers assume.

3. Each fencer dragged the rear foot much less during the practice condition than in the competitive situations. Thus, the coach needs to train the fencer with respect to the fact that the distance moved when attacking in competition will be greater than the distance moved in practice. If the distance to the target is incorrectly judged, the fencer will miss the target by overreaching and, additionally, run the risk of being touched by his opponent.