A COMPARISON OF THREE RACKET SKILLS EXECUTED BY NOVICE AND EXPERIENCED PERFORMERS

Darla R. Smith, Kathy M. Ludwig, G. Monique Butcher, Jerry D. Wilkerson

Texas Woman's University, Denton, Texas, USA

INTRODUCTION

Traditionally, motor skill performance has been measured by outcome scores indicative of the extent to which the goal of a task was achieved. This data was useful for revealing the effects of practice scheduling, the role of knowledge of results, the influence of fatigue, the consequence of various types of practice, and the effects of different teaching methods, but gave very little insight about the movement process and how these processes change (Kelso, 1982; Southard & Higgins, 1987). Southard (1989) stressed success should not be measured by outcome alone, particularly for a beginner. *How* an outcome was attained is equally or perhaps more important to assessment of skilled behavior because beginners may sacrifice efficient patterns of movement to achieve immediate outcomes. Because habits are difficult to break, measuring outcome alone may prolong the learning process and prohibit a mover from reaching his/her potential. To understand *how* an outcome was reached, the researcher should analyze the mechanics of the movement that contribute to the outcome (Kelso, 1982). Information about the differences between novice and experienced performers can provide clues about what information will best augment the learner's performance and perhaps provide a better understanding of the development of skilled movement.

Joint range of motion (ROM) is a very important component of skilled movement. Novice performers of a skill often immobilize or reduce the ROM of certain joints thereby reducing the number of active segments (Hudson, 1995; Southard & Higgins, 1987). As skill acquisition increases, more segments become active (Hudson, 1995). When the mover changes to this more flexible pattern, he/she can use the transfer of angular momentum from the more massive proximal segments to the progressively less massive distal segments (Southard & Higgins, 1987). Southard and Higgins (1987) observed significant changes in wrist angles from maximum backswing to contact during performance of a racquetball forehand after five days of practice. This increased ROM resulted in significantly greater velocity at contact.

The timing and sequencing of segmental movements is another important component of skilled movement. The sequencing of segmental contributions can be either simultaneous or sequential or somewhere in between. Simultaneous indicates the segments initiate and terminate the propulsive phase at the same time and is usually the coordination pattern exhibited by skilled performers of heavy, slow activities such as weight lifting (Broer, 1973; Hudson, 1995). Sequential means the larger more proximal segments precede the smaller distal segments in a temporal progression during propulsion (Broer, 1973; Hudson, 1995). Highly skilled strikers generally employ a sequential pattern of segmental coordination because more force can be applied to a relatively light object by the transfer of momentum principle (Broer, 1973; Kreighbaum & Barthels, 1990). Novice performers often exhibit the opposite pattern of coordination (e.g. sequential in heavy, slow activities and simultaneous in ballistic activities) (Hudson, 1995; Kreighbaum & Barthels, 1990). Bird, Hills, and Hudson (1991) investigated the sequencing and timing of the shoulder and wrist of beginning and advanced performers on a badminton deep serve. The advanced performer demonstrated an optimally sequential pattern of coordination (proximal to distal) in both initiation and termination of segmental contribution. After six weeks of practice, the beginners exhibited a predominantly sequential pattern.

A literature review revealed most of the studies were two-dimensional and limited to an analysis of limb movement only. The purpose of this investigation was to perform a three-dimensional analysis of novice and experienced performers of three striking skills: 1) a badminton deep serve, 2) a racquetball forehand, and 3) a racquetball drive serve. ROM, sequence of motion, and temporal values were assessed on the limb and the torso. Similarities and differences were observed between the novice and experienced performer of each skill and comparisons were made among the three skills.

METHODS

Three adult females volunteered to participate in the study. One participant was inexperienced in racket sports and served as the novice for all three skills. The other two participants were an experienced badminton player and an experienced racquetball player. All participants were right-handed. Reflective markers were placed on the left and right shoulder (acromion process of the scapula), left and right pelvis (ASIS), right elbow (lateral epicondyle of the humerus), and right wrist (ulnar styloid process). Reflective tape was placed on the top end of the racket and on the balls and birds.

Each skill was performed in the laboratory. Movements were videotaped by 4 cameras at 120 Hz and the 3-D data were analyzed using the PEAK5 motion measurement system. Range of motion, sequence of propulsive segmental initiation, and temporal values were assessed on the following angular movements: absolute pelvic and upper torso rotation, and relative humeral, elbow, and wrist rotation. Humeral rotation was isolated to the primary plane of movement: sagittal plane movement for badminton and transverse plane movement for racquetball.

RESULTS

For each skill and performer, the segmental sequence, ROM, lag times (LT) between segments within the sequence, and the total time (TT) (backswing to contact) over which the skill occurred, are presented in Table 1. In the badminton serve, the EXP performer exhibited a greater range of motion for all angles except the E. The EXP performer also used a greater range of motion in all angles except the W during the racquetball forehand and serve.

The total time for the EXP racquetball serve was greater than that of the racquetball forehand. Total time for the badminton serve, both EXP and NOV, was greater than the other two skills. The sequential pattern of propulsive initiation of the EXP performer was essentially proximal to distal for all skills. The NOV performer exhibited no consistent pattern.

Table 1

Segmental sequence, ROM, Lag times of Three Different Racket Skills Performed by Experienced and Novice Performers

EXP				NOV		
SEG	ROM	LT		SEG	ROM	LT
			Badminton			
P	37.4			UT	30.4	
UT	69.6	.18		P	13.0	.14
H	76.3	.09		H	67.0	.08
W	59.7	.12		W	10.2	.06
E	16.0	.02		E	34.2	.01
TT = .23				TT = .20		
			Racquetball Forehand			
H	68.8			P	34.8	
P	57.9	.03		UT	69.2	.05
UT	71.1	.07		W	59.4	.13
W	11.9	.10		E	8.7	.03
E	12.8	.02		H	10.7	.05
TT = .11				TT = .20		
			Racquetball Serve			
P	92.4			P	64.3	
UT	122.0	.05		UT	77.9	.03
H	154.0	.01		W	81.0	.01
E	75.3	.10		H	87.0	.02
W	41.8	.00		E	0.8	.14
TT = .18				TT = .19		

Note. Segments are listed top to bottom in order of their sequential contribution. EXP - experienced, NOV - novice, ROM - range of motion (in degrees), LT - lag times (in seconds) between segments within the sequence, TT - total time (in seconds) over which the skill occurred, P - absolute pelvic angle, UT - absolute upper torso angle, H - relative humeral angle, E - relative elbow angle, W - relative wrist angle.

DISCUSSION

Results for the badminton serve showed the EXP performer exhibited a greater ROM for all angles except E. This greater overall use of ROM by the EXP is consistent with Hudson's (1995) and Southard and Higgins' (1987) conclusions that NOV performers often reduce the ROM of certain joints. The greater E ROM exhibited by the NOV was possibly due to the constrainment at the W. In other words, the small amount of W ROM used by the NOV may have necessitated the greater ROM at the E.

In the racquetball forehand and serve, the EXP performer exhibited a greater ROM for all angles except W. This large W ROM of the NOV was contrary to Southard and Higgins (1987) results, and appeared to be a last attempt to generate velocity given the small amounts of E and H ROM used. Unlike the badminton serve, with these two skills the NOV constrained the E more than the EXP. This was consistent with Southard and Higgins (1987), and was possibly due to the use of a shorter implement. In the badminton serve the longer implement posed a greater challenge for contact causing the elbow to flex more. In racquetball, the shorter implement could be held further from the body creating the E extension.

The EXP performer was more compact in executing the forehand than the racquetball serve. In the serve, the ball is tossed by the performer and has a smaller initial velocity before contact than it does in the forehand. Therefore, greater ROM was required to achieve the velocity goal.

In all three tasks, the EXP showed essentially the same proximal to distal sequential pattern consistent with a skilled performer (Broer, 1973; Hudson, 1995). The exception was the movement of H in the racquetball forehand, which appeared to initiate the sequence. Upon matching the computerized data to the actual movement, it was evident that the flexion at the E during the backswing was influencing the timing of the H movement. In other words to achieve maximum layback of the forearm during the backswing, the H began to move, probably rotating similar to that in a sidearm throw forward, and appeared to initiate propulsion forward. The patterns exhibited by the NOV were more simultaneous and the sequences varied between each task.

Results of this study were essentially consistent with aforementioned investigations. There was some variability depending on the individual task.

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