Temporal Characteristics of the Final Delivery Phase and Its Relation to Tenpin Bowling Performance

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INTRODUCTION

The objective of tenpin bowling is to try to knock down as many pins as possible within the allotted number of tries. In the modern game, bowlers achieve this by generating a lot of momentum using heavy balls that are released accurately and consistently at great velocities.

Spatial variability in performing sport skills has been studied in various disciplines such as javelin and basketball [1]. In bowling, it was revealed that reduced variability of the medio-lateral foot path and anterior-posterior foot placement during the slide correlated to better bowling scores [2].

Meanwhile, in terms of temporal variability, it has been demonstrated that expert performers in a number of games (namely - baseball, table tennis and field hockey) execute their drives with more consistent movement times. It appeared that the time between the first forward motion of the implement and the moment of ball contact varied little between trials [3].

Such consistency in expert performers has been suggested by some as a motor program theory of control - a program which is thought to be a set of instructions for movement, organized ahead of its execution [3]. The consistency of movement therefore can be argued to be the result of consistent motor programming. Currently, there are no published works on the temporal variability of the delivery phase in tenpin bowling.

The final delivery phase in bowling comprised of three

major events which are the arm swing, front foot slide and ball release. The temporal variable that was measured was the execution time and the between-trial temporal variability while the measured performance criteria were average bowling score (B_{ave}) and ball release velocity (BR_{vel}).

The purpose of this study was to examine how temporal variability of the events in the delivery phase was related to the B_{ave} and BR_{vel}. In addition, the temporal characteristics and variability of the delivery phase between elite and semielite bowlers were also compared. Consistent execution times in the delivery phase were believed to be related to higher playing level and better bowling performance.

METHODOLOY

Participants were assigned into two groups based on their B_{ave} which was recorded over three tournaments. Those averaging above 200 pin falls were placed in the elite group. There were 18 elite (Male=10, Female=8; B_{ave} 213.2±6.80; BR_{vel} 17.66±0.85mph) and 12 semi-elite bowlers (Male=7, Female=5; B_{ave} 181.3±9.36; BR_{vel} 16.90±1.46mph).

Temporal data was derived from Kwon3D system, while BR_{vel} was measured using timing gates and recorded in miles per hour (mph) in accordance with common bowling literature. Four Basler (100Hz) cameras were used for motion capture at the bowling alley.

The participants aimed for a strike at each delivery, with pins reset after each trial irrespective of whether there were any pins left standing. There were seven trials in total and bowlers were instructed to use similar delivery methods for every trial. However, only trials 3 to 6 were used in the analysis. To assist in identifying events, reflective markers were placed at the wrist and metacarpal of the bowling arm as well as under the heel counter of the sliding foot. Event markers used in the delivery phase were:

- Top of back swing (TBS) – the start of the downward swing of the arm
- Front Foot Strike (FFS) – the point at which the font foot touched the ground

 Ball Release (BR) – the point at which the ball separates from the hand

The mean time over the four trials was calculated, while the standard deviation (SD) of each participant was used as the variability indicator. Lower mean SD values indicated less variability between trials. Independent samples t-test and Pearson product moment correlation were used to compare group score and identify relationships, respectively. Significance level was set at $p<.05$.

Full text is available at :