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Original Research

Performance accuracy and functional variability in elite and developing fast bowlers

Elissa Phillips [a,b,c,*], Marc Portus [b,d], Keith Davids [c], Ian Renshaw [c]

[a] AIS Movement Science, Australian Institute of Sport, Bruce, ACT, Australia
[b] Sport Science Sport Medicine Unit, Cricket Australia Centre of Excellence, Albion, QLD, Australia
[c] School of Human Movement Studies, Queensland University of Technology, Victoria Park Road, Kelvin Grove, QLD, Australia
[d] Praxis Sport Science Pty Ltd, Albion, QLD, Australia

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Abstract

Objectives: The relationship between performance variability and accuracy in cricket fast bowlers of different skill levels under three different task conditions was investigated. Bowlers of different skill levels were examined to observe if they could adapt movement patterns to maintain performance accuracy on a bowling skills test.
Design: 8 national, 12 emerging and 12 junior pace bowlers completed an adapted version of the Cricket Australia bowling skills test, in which they performed 30 trials involving short ($n = 10$), good ($n = 10$), and full ($n = 10$) length deliveries.
Methods: Bowling accuracy was recorded by digitising ball position relative to the centre of a target. Performance measures were mean radial error (accuracy), variable error (consistency), centroid error (bias), bowling score and ball speed. Radial error changes across the duration of the skills test were used to record accuracy adjustment in subsequent deliveries.
Results: Elite fast bowlers performed better in speed, accuracy, and test scores than developing athletes. Bowlers who were less variable were also more accurate across all delivery lengths. National and emerging bowlers were able to adapt subsequent performance trials within the same bowling session for short length deliveries.
Conclusions: Accuracy and adaptive variability were key components of elite performance in fast bowling which improved with skill level. In this study, only national elite bowlers showed requisite levels of adaptive variability to bowl a range of lengths to different pitch locations.

Keywords: Cricket; Elite athletes; Adaptive movement variability; Performance analysis

1. Introduction

An important characteristic of skilled behaviour concerns the functional relationship between adaptive variability and performance accuracy.[1,2] For example, in cricket fast bowling, accuracy of a delivery is predicated on functional levels of variability needed to adapt to changing performance conditions.[3] Functional levels of movement pattern variability in fast bowling are important, but too much variability could adversely affect consistency of ball landing position/line and provide opportunities for a batter to score runs.

Previous research in fast bowling has focused on ball speed during performance[4–6] but the relationship between accuracy and performance consistency in elite and developing cricketers has received little attention. Accuracy is a key component for taking wickets and reducing runs scored by opposition batters in cricket. Consistency is essential to build mental pressure by depriving batters of run scoring opportunities. From an ecological dynamics perspective, maintaining accuracy in an aiming task like bowling requires functional variability or movement flexibility to make appropriate adjustments to satisfy changing performance constraints.[1,2] In cricket, fast bowlers aim for consistency and accuracy while maintaining high ball speed and adjust movement patterns to generate different types of deliveries (e.g. bouncer, good length or yorker) when required.[7] Performance flexibility is necessary for adapting to changing environmental and task constraints such as pitch conditions and to bowl against batters with different tactical styles.

* Corresponding author.
E-mail address: elissa.phillips@ausport.gov.au (E. Phillips).

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In fast bowling, deliveries can be adapted by changing ball flight characteristics (trajectory), described as 'line', and landing position, described as 'length'. Delivery *line* refers to the horizontal location of the ball relative to the wicket, and *length* describes the proximity to target of the ball's bounce point on the pitch. The ability to consistently bowl the ball onto a desired pitch location is crucial to successful performance.[7] Delivery length can be grouped into three categories: short, good and full. Short length deliveries are aimed to bounce towards the batter's head and are often used as an intimidation tactic. Good length deliveries are aimed at the top of the wicket's off-stump and the ball is projected where the batter is unsure whether to move forwards or backwards to play it. Full length deliveries are aimed at the bottom of the bat and are difficult to play because the ball bounces so close to the batter.[7]

Previous data on performance accuracy has been obtained as part of more general research programs examining factors such as technique changes during repetitive bowling spells,[8,9] effects of pitch length on performance and technique in junior bowlers[10] and effects of dehydration in fast bowlers.[11] Portus and colleagues[8] found that, when bowling good length deliveries, bowlers with high counter rotation of the shoulders were less accurate during the latter stages of an 8-over spell. Typically in previous research only one type of delivery has been investigated and accuracy has not been considered. Some studies have only recorded data on the fastest ball speed, without reference to target accuracy at all (e.g. Pyne et al.[12]). However, a combination of short, good and full length deliveries, achieved through different bowling techniques, is needed by fast bowlers to compete internationally. Additionally, due to restrictions preventing short pitched bowling in junior cricket,[13] younger bowlers may be expected to demonstrate less control of short deliveries, than good or full length balls, due to lack experience with this specific skill.

In previous research highly skilled athletes have been shown to be more accurate and consistent than less skilled performers, in golf,[14] throwing tasks,[15–17] and baseball pitching.[18] In cricket fast bowling Portus and colleagues[8] used three rectangular scoring zones at the batters' stumps to measure bowling accuracy. Similar zoned performance outcome measuring systems have been used to examine bowling[9–11] and throwing accuracy in cricket.[15,17] More rigorous methods for measuring accuracy and consistency have been presented in motor control to examine speed–accuracy trade-offs.[19] These measures provide more sensitive scales for examining accuracy and consistency across multiple delivery types than methodologies in previous fast bowling research.

A related question alluded to in previous work concerns whether high skilled performers are able to pick up and use performance outcome feedback to improve subsequent performance trials within the same practice session. Previous research[20] demonstrated that, following post-performance outcome feedback, participants were able to correct movements in subsequent trials of a simple throwing task. The repetitive nature of fast bowling highlights the pertinence of understanding the role of outcome feedback in this task. During bowling performance it is likely, given the repetitive nature of the task, augmented information from previous deliveries during performance can act as a significant informational constraint to assist performers to achieve desired performance outcomes.[21] Therefore, the purposes of this paper were to: (a), examine accuracy and consistency differences between skill levels in cricket fast bowling under three different task constraints; (b), examine the relationship between variability and accuracy in performance of this multi-articular action; (c), examine the relationship between speed and accuracy in fast bowling; and (d), identify whether bowlers differing in skill level could make adjustments to subsequent deliveries to enhance performance accuracy on a cricket bowling skills test.

2. Methods

Participants were: 8 Cricket Australia nationally-contracted athletes (in the Australian or Australian 'A' squads) (NAT mean (s): age 29.1 (3.2) yrs; body mass 92.1 (5.3) kg; height 188.9 (7.7) cm), 12 emerging squad members (state bowlers selected in the Australia senior pace squad) (EMG mean (s): age 21.2 (3.3) yrs, body mass 89.9 (7.9) kg; height 190.3 (6.2) cm), and 12 junior pace squad members Australian (Australian Under-19 or state representative bowlers selected in the Australian junior pace squad) (JNR mean (s): age 17.3 (0.7) yrs; body mass 84.2 (4.9) kg; height 187.8 (3.4) cm). Before participation, all individuals were informed of potential risks and requirements of the study and provided informed written consent. The study protocol was approved by the human research ethics committees of the Australian Institute of Sport and the Queensland University of Technology.

Participants completed an adapted version of the Cricket Australia bowling skills test, in which they performed 30 randomised trials of short ($n = 10$), good ($n = 10$), and full ($n = 10$) length deliveries, bowled in five 'overs' of six deliveries each. Athletes were instructed to bowl at match intensity towards a rear-projected image of a right-handed batter on a screen, to simulate match conditions (Fig. 1(a)). The skills test measured the bowlers' ability to hit specific targets, with the resultant scores (0–100) averaged to yield an accuracy score (Fig. 1(b)). Location of all deliveries on the target screen was recorded with a video camera (Sony 3CCD HDR-FXIE, Sony Corporation, Tokyo).

The instant of ball contact on the target was digitised using customised software written in Visual Basic for Applications (Microsoft Corporation, Washington, USA). Known distances (20 cm × 20 cm) on the target grid were used to calibrate the target area. Performance error was calculated by digitising ball position relative to the centre of the intended target. In line with previous work,[19] mean radial