EXPERT COACHES' EXPERIENTIAL KNOWLEDGE IDENTIFIES THE NEED FOR GREATER REPRESENTATIVE DESIGN IN BIOMECHANICAL ANALYSES

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Twenty expert coaches were interviewed exploring their conceptions of the fast-bowling technique and how they coached it. Coaches noted highly individualised techniques, that altered at varying times, due to game structure and tactical imperatives, which often required technical intervention. Previous have failed to identify these changes; however, these studies have not included a tactical context. Without taking these contexts into consideration, many changes in technique may have been missed in analysis. By following principles of ecological dynamics, the tactical environment that contextualises a technical analysis, alongside the psychological and emotional states of the athlete, can be used to design more closely representative experimental research settings.

KEYWORDS: EXPERTISE; FAST-BOWLING; ECOLOGICAL VALIDITY; COACHING

INTRODUCTION: Ecological validity has long been an objective of much biomechanical research (Bartlett 1997). The recognition that techniques alter between laboratory settings and actual sport competition conditions (Fox et al 2013), means that much current research practice in the field needs to change if we are to collect relevant data and build appropriate models based on competitive performance.

Araújo et al. (2008) and later Pinder et al. (2011), argued that it is not *ecological validity* that we seek, but in fact a similar term, *representative experimental design*. Ecological validity originally referred to "*the statistical correlation between the perceptual cues available to an organism and the distal criterion variables of interest"* (p.71). Whereas representative experimental design refers to the arrangement of conditions of an experiment so that *"they represent the behavioural setting to which the results are intended to apply"* (p.71). Most claims of ecological validity are in reality, claims of greater *representative experimental design*.

Fox (et al., 2013) explored the landing patterns of netball players in game contexts compared to those reported in laboratory settings. They found that that netball landings occur with a wide range of surrounding game events rather than the narrow few techniques witnessed in the laboratory. They requested *"researchers to incorporate these "game-like" factors where possible to enhance the ecological validity (sic) of laboratory-based testing"* (p. 699).

Representative experimental design is not necessarily a straight-forward or easy task for biomechanics research, due to the need for precision measurement, and because of the equipment required to perform analyses with levels of precision in performance contexts (Adams et al 2020). Therefore, much research, including most of the biomechanical research into fast-bowling, takes place in laboratory settings.

In cricket, the 'fast bowler' is seen as having a key role to the success of a cricket team and tends to bring great interest to the spectating public (Johnstone et al 2014; Bartlett et al 1996; Morton et al 2014; Glazier and Wheat 2014). Whilst fast bowers are often seen as match winners in cricket and bring excitement to the spectator, they are also the most likely set of players to be injured (Johnstone et al 2014; Bartlett et al 1996; Morton et al 2014; Glazier and Wheat 2014), with injuries to the lower back the most prevalent (Johnstone et al 2014; Stretch 2003). With prevalence rates being reported between 6% and as high as 67%, injury prevention as well as performance should be areas of focus for the cricket community (Johnstone et al 2014; p.45). Much research has taken place in the analysis of fast bowling technique in relation to ball release speed and relationships to injury (Anderson 2019; Glazier & Wheat 2016). However, game-like physical environmental entities (for example an opposing batter or an umpire), as well as game-scenario contextual settings (for example opening the

bowling in the ‘powerplay’ phase of a T20 game), have not been used to represent the game while conducting biomechanical research.
Schaefer et al. (2018 a& b) looked at the consistency of fast bowling techniques across a spell of bowling (10 overs) with under 19 fast-bowlers, and across a season (13–16-year-old bowlers) and found no noticeable changes in technique in either condition. It is important to note however, that in both studies, bowlers were only directed to bowl at *“competition speed”,* within laboratory settings. There was little contextualisation of their actions apart from that instruction. It is also worth noting that junior cricketers are only likely to take part in one format of cricket (limited overs). In both cases, the experimental design failed to account for *physical-, psychological- and contextual-* representation of the fast-bowling context in cricket.
Greenwood, Davids and Renshaw (2014) and Phillips et al. (2014) have demonstrated how the experiential knowledge of experts (coaches and players) can inform the investigations of academic researchers, to give real-world insight that can then enhance the representativeness of experimental design. The aim of this study was to explore how the experiential knowledge of expert fast bowing coaches could support investigators to better understand how to design representative experimental contexts for biomechanical analyses.

METHODS: Twenty expert fast-bowling coaches (n=20) from around the world were purposefully sampled, and took part in semi-structured interviews, that were transcribed verbatim. Ethical clearance followed SHU protocols including informed consent. Interview questions focussed on five key areas:

1. Is there an ideal fast bowling technique?
2. What is a good fast-bowling technique?
3. What is a poor fast-bowling technique?
4. How do you coach it?
5. How do you know all the above to be true?

All transcriptions were subjected to a thematic analysis (Braun & Clarke 2006) by the lead researcher, with model answers drawn, using thematic networks (Attride-Stirling 2001), across each research question. Only themes uncovered that relate to representative experimental design are discussed in this paper.

RESULTS: There were six first-order, twenty-one second-order and four third-order themes that were identified in relation to the approaches that the coaches took in their coaching practices. The second-order themes relevant to this study were *‘Individualisation’* and *‘game/tactical influences’*.
Coaches noted, firstly, that a fast-bowling technique is individualised, and what works for one bowler will not work on another. They also stated that fast-bowlers altered their techniques in subtle ways both in short term (individual deliveries) and across months of playing in different formats contrary to the findings of Schaefer et al (2018 a & b)
Examples of these changes included:

- Alterations of alignment of the delivery stride (near or far from the wickets) dependent on the game format and delivery type required.
- Alterations of posture to allow different angles for the delivery arm to rotate in.
- Alterations of the release technique, including wrist, and fingers of the bowling arm in order to *camouflage* the delivery type from the batter.
- Different angles of run-up to facilitate all the above.

Coaches argued strongly that it was the game and tactical imperatives that drove emerging technical changes during performance. Coaches also spoke of the time required to alter the technical changes that have occurred due to playing in one format and prepare them for a change to a different format of the game.

DISCUSSION: There are clear implications within these findings for biomechanical research in investigating fast-bowling specifically, and for biomechanics research for sport in general.

Firstly, it is seen that representative design principles (Araújo, Davids & Passos, 2007) are not being met in biomechanical research due to the lack of contextual and tactical environment that is experienced in fast-bowling, being replicated in studies. The findings here support ideas of Fox et al (2013) who found that techniques are altered and contextualised due to game situations.

Secondly, as fast-bowling techniques are proposed to be highly individualistic, research comparing kinetic and kinematic elements *across* individuals in groups of bowlers is sometimes inappropriate. The same can be said about building coaching recommendations from the results of such comparative research; these results cannot be implemented, by the coach as they may not be relevant.

Suggestions are offered for future biomechanical research design:

- Have umpires standing. (Renshaw & Davids 2006 have demonstrated that fast-bowlers modulate their run-up approach in relation to the position of an umpire)
- Create a 'protected area' where a bowler cannot go in a game context, and have umpires remind bowlers of this in, laboratory settings if the bowlers enter it.
- Crucially, a provide a batter to bowl at! While this brings obviously physical dangers to researchers, participants and equipment, a batter is an essential element of the fast-bowing process.
- Game-like scenarios, for bowlers to bowl in rather than being directed to either *"bowl as fast as possible"*, or to *"bowl at competition speeds",* as game context create suitable variations within technique.
- If portable and/or outdoor-worthy equipment can be used, without reduction in precision, then analysis would be better taking place on the cricket square of an actual cricket field rather than indoors in a laboratory.

CONCLUSION: The structure of different competition types, and the tactical imperatives that are afforded in these contexts, all impact on the techniques used by sports performers. These findings have implications for biomechanical research of any sport technique, with researchers needing to consider the representative experimental design of their work, to include not only the physical environment (e.g., equipment and officials) but also the tactical context and psychological environment of the athlete(s) under study, as all impact upon the resultant technical movement patterns. Biomechanical analyses with greater representative experimental design, will in turn provide coaches with more appliable data to enhance their coaching practices.

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ACKNOWLEDGEMENTS: The lead author wishes to thank the tireless support of the two co-authors as part of the supervisory team for this doctoral thesis. Sheffield Hallam University is also acknowledged for the time and resource given for this project.