Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 72 (2014) 156 – 161

Procedia Engineering

www.elsevier.com/locate/procedia

The 2014 conference of the International Sports Engineering Association

Integrating Advanced Visual Information with Ball Projection Technology Constrains Dynamic Interceptive Actions

Stone, J.A[a]*., Panchuk, D[b]., Davids, K[cd]., North, J.S[e]. Maynard, I[a]

[a]*Centre for Sport and Exercise Science, Sheffield Hallam University, Colligate Hall, Colligate Cresent, S10 2BP, UK.*
[b]*Institute of Sport, Exercise, and Active Living, Victoria University, Victoria, Australia.*
[c]*Centre for Sports Engineering Research, Sheffield Hallam University, Sheffield, UK.*
[d]*FiDiPro Programme, University of Jyväskylä, Jyväskylä, Finland.*
[e]*School of Sport, Health and Applied Science, St. Marys University College, Twickenham, UK.*

Abstract

The role of advanced visual information in ball catching was investigated by integrating video images of action and ball projection technology in four different conditions: Integrated video and ball projection (VBP), Video-Only (VO), Ball Projection-Only (BPO) and Misleading Ball projection (MBP). Hand kinematics and gaze behaviour data were collected from participants who attempted to catch balls one handed in all conditions. During VBP, catching performance was more successful, tracking of the ball occurred earlier and lasted longer, with maximum grip aperture emerging earlier with a slower maximum velocity than in BPO. During VO, movement emerged later than VBP, with larger maximum and minimum grip aperture compared to VBP and BPO. Results provided evidence that advance information, prior to ball release, and vision of a ball's trajectory are essential for successful performance and integrated projection technology may provide a representative design for studying interceptive actions.

Selection and peer-review under responsibility of the Centre for Sports Engineering Research, Sheffield Hallam University

Keywords:Visual anticipation;Representive design;Ball projection machines;Perception-action coupling.

The concept of representative design provides a critical theoretical principle for studying human behaviour in sport (Pinder et al. 2011a). In order for perception-action coupling to be maintained, experimental task constraints need to accurately replicate those of the performance environment (Brunswik 1956). Recent empirical evidence has

* Joseph Stone. Tel.: +44 0114 225 5413.
E-mail address: Joseph.stone@shu.ac.uk

Selection and peer-review under responsibility of the Centre for Sports Engineering Research, Sheffield Hallam University
doi:10.1016/j.proeng.2014.06.027

demonstrated significant changes in both movement and gaze behaviours between laboratory and representative performance contexts (Dicks et al. 2010; Mann et al. 2007; Pinder et al. 2011b). For example, in their study on soccer goalkeepers, Dicks et al. (2010) showed how gaze behaviours of individuals were clearly constrained by manipulations of experimental task constraints. In conditions which required limited participant movements (verbal response, joystick maneuvering, simplified body micro-movement); gaze was directed to the penalty kicker, yet during *in-situ* tasks participant gaze switched between the ball and the penalty kicker's motion. Goalkeepers were also more successful in judging penalty kick direction when they were required to move, compared to verbally responding. The work by Dicks et al. (2010) suggests that experimental designs and applied interventions need to move away from traditional reductionist approaches when investigating performance of dynamic interceptive movements.

For new technology to meet the requirements of representative design, Pinder et al. (2011a) highlighted two critical features, *functionality of the research* and *action fidelity*. Functionality of the task constraints allows performers to regulate actions using information sources representative of their performance environment. Hence, when researchers and coaches design practice tasks or experiments, the key perceptual variables available within the performance environments, which regulate action, must remain so that the behaviours produced can be generalised or transferred to a specific performance environment. For example, catching a ball from a thrower requires advanced information from the thrower's movement kinematics, prior to ball flight, for successful interception (Panchuk et al. 2013). When studying or practicing catching behaviours these kinematic perceptual variables must be available for participants to use, which questions the role of ball projection machines in experiments or practice tasks. Functionality has to be coupled with *action fidelity,* which is the idea that performers must be allowed to organise their own functional actions to achieve performance outcomes (e.g., organise a catching action and not verbally respond on ball flight direction) (Pinder et al. 2011a).

Here we report data from a study of dynamic interceptive actions with an integrated technological system, which combined video images of advanced visual information synchronised with ball projection. Some systems like the ProBatter (ProBatter Sports, LLC) are already being used in elite sport programs, yet there is limited empirical evidence of the advantages of such integrated systems over ball projection machines only. To test this technology an apparatus was developed to be integrated with a VICON motion capture system (Panchuk et al. 2013). Panchuk et al. (2013) showed that catching accuracy decreased along with changes in gaze behaviour when the video component of the apparatus (providing advanced visual information of a thrower's actions) was removed, supporting the need to ensure perception-action coupling. Panchuk et al. (2013) proposed that further comparative experimentation was required to understand the benefits of the integrated technology over traditional ball projection machines without integrated video systems.

The aim of this study was to establish whether the integrated video and ball projection technological system altered behaviour during a one-hand catching task, compared to three other performance conditions; (i) use of traditional ball projection machine only; (ii) video images of an individual throwing a ball, without the ball being projected, with participants simulating a catching action to the video image to replicate previous work on perceptual training that used a micro-movement response; and (iii), a 'misleading' action condition performed with the integrated video and ball projection technology where participants viewed a throwing action, without a ball being projected. The last performance condition was included to examine how prior expectation to perform a movement response (simulated vs. "real") would affect gaze behaviours. Kinematic data from hand movements and gaze behaviours in skilled catchers were studied in all four conditions.

2. Methods

2.1. Participants

Fourteen (11 male, 3 female; mean age 24.1 ± 4 years) right handed participants with normal or corrected-to-normal vision volunteered for the study. Each participant was defined as a skilled catcher by meeting the following criteria: first, all participants had at least 5 years' experience in competitive sports which involved catching projectiles such as cricket, basketball or handball (obtained via a sport participation questionnaire). Second, during a pre-test they were required to successfully catch at least 16 out of 20 (M= 18.14 ± 1) balls. Skill level was confirmed by the overall success rate of catching during the experimental task (M= 91% ± 4%). Institutional