BALL SKILLS

Organized by Peter Beek and Reinoud Bootsma

Expertise and Attunement to Event Kinematics in Ball Sports

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Existing research on ball skills from an ecological perspective has focused primarily on how performers determine precisely the time-to-contact of a ball in flight. The time constraints of many ball sports however dictate that the pick-up of information from events preceding ball flight is also essential for successful performance, yet far less is known about the perceptual invariants which provide this kind of information. This presentation reports on a series of experiments which seek to (i) identify the minimal information required for anticipation of the direction and force of an opponent's stroke in the racquet sports of badminton and squash and (ii) understand perceptual skill development through comparison of the pick-up of information by experts and novices. Early experiments show, through the use of film simulations of the display available to the defending player and through the selective use of temporal and spatial masking procedures, that experts are characterized by information pick-up from earlier occurring, and more proximally located, features of the opponent's action, supporting the proposition that perceptual skill in these activities is linked directly to the kinematics of the event being viewed. To examine this proposition more fully, comparison was drawn in later experiments between the information pick-up of experts and novices viewing either film displays or point-light displays of the hitting action of an opposing player. The film displays were rich in contour, color, and shape information whereas the point-light displays, generated by animating the spatial co-ordinates of the major joint centers of the opponent's body, the ball, and five key landmarks on the racquet, provided only kinematic information. The important finding to emerge was that the same expert-novice differences in the temporal pick-up of information held regardless of the type of display presentation. This suggests that the superior perceptual performance of the experts is a direct consequence of their superior attunement to kinematic properties of the opponent's action.

The Optics and Actions of Catching Fly Balls: Zeroing out Optical Acceleration

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What optical variables might guide the locomotion of a would-be ball catcher to the right place at the right time? One possibility, regarding whether to run backward or forward, was suggested by Sanders (1968): The catcher should move in such a way as to cancel out any vertical optical acceleration in the rising trajectory of the ball. Five preliminary experiments sought to determine whether this particular invariant is, in fact, used by perceivers/actors. In Experiments 1-3, the positions of balls and catchers were videotaped and the associated optical patterns were reconstructed to see if indeed the movements of the perceivers did cancel out optical acceleration. The results were consistent with the use of optical acceleration, at least up to the last few tenths of a second before the catch (Experiment 1). This was shown to be true for both hand- and machine-thrown balls (Experiment 2) suggesting that watching the actions of the thrower did not account for performance. Since optical acceleration is a monocular invariant, it was hypothesized that the same results should obtain with both monocular and binocular viewing. This prediction was confirmed in Experiment 3. In Experiment 4, the trajectories of various throws were simulated on a computer screen and subjects were asked to judge whether the ball (represented by a single pixel of unchanging size) would land behind, at, or in front of their current position. Performance was well above chance although multiple regression analyses suggested that only some of the subjects actually used acceleration. Experiment 5 examined locomotor reactions to balls that were very light and, therefore, drastically affected by air resistance. Taken together, the experiments provide broad, though not unequivocal, support for the utilization of vertical optical acceleration in the guidance of the locomotor aspects of catching.

The Visual Guidance of Catching

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In order to explore the *nature* and *amount* of information in the optic array made use of by subjects required to carry out one-handed catching actions, direct manipulation of both the optical expansion pattern (by using a deflating ball) and the duration of viewing time (by using liquid crystal spectacles) of the ball were carried out. The results showed that the *time of the maximal opening velocity* and the *time of the maximal closing velocity* of the hand were later for the deflating ball than for the balls of constant size, thus confirming that the timing of the catching action was based on optical expansion information. Further, the *time of the maximal closing velocity* of the hand was later, while no effect was found on the *time of the maximal opening velocity* when the last 300 ms of the trajectory of the ball was occluded. Adjustments to the catching action in response to the different ball sizes under the 0 ms occlusion condition differed significantly from the adjustments under the 300 ms occlusion condition. Both findings point to the importance of relative optical expansion information—available between 300 and 200 ms before ball-hand contact—in maintaining a (relatively) continuous perception-action coupling in the act of catching.