THE APPLICATION OF A SPORT-SPECIFIC 3D STEREOSCOPIC STIMULUS TO EXAMINE PRE-PLANNING TIME AND GAZE CHARACTERISTICS DURING EVASIVE SIDE-STEPPING MANOEUVRES.

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INTRODUCTION: It is well established that anterior cruciate ligament (ACL) injuries are serious, debilitating and costly for an individual, while also creating a significant public health burden at a societal level. ACL injuries occur when inappropriate external loads are applied to the knee and most commonly occur during the performance of a side-stepping (Ssg) manoeuvre (Besier et al., 2001a). Previous laboratory based investigations of evasive Ssg have employed generic light or mannequin visual stimuli in an effort to simulate the time and space constraints experienced by athletes, in the preparation and execution of the Ssg manoeuvre (Besier et al., 2001b; Besier et al., 2003; Mclean et al., 2004). However, a possible outcome of attempts to impose these constraints in lab environments is that the use of unrealistic visual stimuli may not accurately reflect or identify the relationship of the perceptual demands of the task with injury risk variables, during a sidestep in game based situations. This study proposes that the presentation of a three dimensional (3D) stereoscopic stimulus (3DSS), featuring a 3D video based sport specific reconstruction of an opposing defender(s) simulating a tackle, may improve the ecological validity of laboratory based investigations. Additionally, the incorporation of the 3DSS tool with eye tracking will allow for the subject's gaze characteristics (fixations, durations on the 3DSS image) to be assessed. The general aims of this study were to:

Technical

- develop a 3DSS that delivers realistic sport-specific constraints to footballers during evasive Ssg manoeuvres,
- create 3DSS scenarios that incorporate realistic game based variations of imposed time and space constraints (e.g. 3DSS tackle scenarios with one or two defenders),
- develop an interface and protocol that integrates the 3DSS system with a commercial eye tracking system (ASL Eye Tracking Recorder), for the purpose of quantifying the lab based subject's gaze characteristics on the projected stimulus during a Ssg manoeuvre,

Experimental

- identify differences in biomechanical variables (kinematic, kinetic and neuromuscular) associated with increased injury risk during Ssg manoeuvres, using a traditional light (light emitting diode) based stimulus (LBSS) compared with a 3DSS stimuli.

METHOD: The 3DSS, featuring scenarios of single and multiple tacklers on a football field, was developed in collaboration with the Western Australian Supercomputer Program (Mr Paul Bourke). While stereoscopic projection is not a new technology, the developed projection format allowed for the scaling of two converging fields of view (FOV). The first FOV was the 3D stereoscopic projection (stimuli) of an oncoming opponent performing a tackle, while the second converging FOV comprised a 'real' lab based footballer performing an evasive Ssg manoeuvre of the 3DSS stimuli.

Two stimuli conditions were examined: 1) the developed 3DDS and 2) an LED based stimuli (LBSS) consisting of a panel of three lights, one of which was illuminated to indicate the required direction of sidestep to be performed. A 12 camera Vicon motion capture system operating at 250 Hz and a 1200 mm x 1200 mm AMTI force plate sampling at 2000 Hz were

used to collect 3D kinematic and kinetic data. A wireless Noraxon EMG system collected surface EMG from selected musculature of the upper and lower body while an ASL Eye Tracking Recorder was calibrated to each subject's field of view and recorded eye gaze fixations and durations on the projected tackler. 3D Kinematic and kinetic data was modelled in Vicon Nexus software using the customised marker set and model of Besier et al, 2003.
Eight healthy, male football players, aged 18-30 years old with no history of major lower limb injury or disease were recruited to take part in the study. Participants performed a planned and unplanned side step using both the light based and stereoscopic stimuli. In the planned scenarios for both stimuli, the participants were told prior to trial commencement the required direction of the Ssg manoeuvre. In the unplanned LBS scenario, the participants were required to react to one of two lights which was illuminated only after the participant triggered the timing gate positioned immediately in front of the force plate. The light was illuminated if the participant's approach velocity met a threshold of $4.5ms^{-1}$ (± 0.2). In the unplanned 3DSS scenario, the projection of the defender/defenders tackling scenario commenced once the timing gate was triggered and the approach velocity threshold range was confirmed. Participants were then required to sidestep to avoid the oncoming 3DSS tackler (e.g. sidestep to the left when the tackler(s) is coming from the right). The presentation order of the stimuli condition (3DSS v LBS and planned v unplanned) was randomised as was the requirement for the subject's to perform sidesteps to the left or right. Three trials were collected for the left and right leg during a Ssg manoeuvre across all four stimuli conditions, comprising 24 trials in total.

RESULTS: Initial results revealed an increase in knee joint moments with trends toward lower levels of co-contraction of the knee stabilising musculature in the unplanned condition for both the LBS and the 3DSS stimuli. Across stimuli conditions, an increase in the number of gaze fixations and accompanying decrease in the duration of fixations was found in the 3DSS stimuli condition. This finding was accompanied by a trend toward slightly earlier muscle activation firing patterns in the 3DSS condition.

CONCLUSION: This study outlines a method for improving the ecological validity of lab based visual stimuli to study ACL injury mechanisms. This was achieved via the presentation of 3D stereoscopic projections of game specific opponents. It appears that the introduction of more realistic stimuli may affects spatial and temporal pre-planning of various neuromuscular biomechanical variables associated with increased knee loading and therefore inferred ACL injury risk. Additionally, the introduction of a more game realistic visual stimulus was shown to affect the athlete's visual search patterns and therefore, by inference, alter their cognitive processing of environmental cues. These findings may be of importance when designing injury prevention training programs.

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