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CONFERENCE PAPER

A Wearable Inertial Sensor for Improved Measurement of Exploration Behaviour in Sport Compared to Notational Analysis

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ABSTRACT

A single subject study was completed to compare a wearable inertial sensor with first person and third person video footage, to measure the number of head turns of a participant while he explored his surroundings. Results showed that the inertial sensor was more sensitive and accurate than both types of video footage for measuring head turns. Further development of the inertial sensor for measurement of exploration behaviour is recommended, which may provide a simple tool for researchers and practitioners to measure exploration behaviours of athletes in situ.

Keywords: Gaze; Inertial Measurement Unit; Decision Making; Perception; Visual Search

INTRODUCTION

In order for athletes to make appropriate decisions, they must perceive their surroundings in order to prospectively (ahead of time) control their movement to act in the appropriate way [(1)]. Skilled perception in dynamic and complex competitive team contexts, such as football, is critical for high-level performance. Positions, movements, and intentions of teammates and opponents need to be perceived to make effective and accurate decisions for action. This coupling of perception and action is an integral part of prospective control of movement and effective decision making in team sport, as one cannot function without the other [(1)]. In order to perceive ones surroundings, an athlete must manoeuvre their body in a way that allows exploration of information relevant for decision-making. Exploration may include movement of the eyes, head, and/or body. Without exploration through movement of the eye-head-body system, athletes are unable to visually perceive their surroundings, which ultimately limits their ability to control their actions, and make effective decisions.

Visual exploration is typically assessed through the measurement of eye movements by means of eye-movement registration techniques. However, eye-movement research has a number of methodological shortcomings [(2)] which limit the conclusions that can be made for applied, in-game situations. Typically, studies have been performed in laboratory-based settings. These tasks determine where subjects search for information, as information is displayed only in front of the participant. During live play, athletes are typically completely surrounded by potentially relevant information, and they are able to determine themselves where to explore for information. Therefore, it is questionable whether much of the

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current research can be generalised to actual visual search and exploration behaviours as employed in a natural setting. Due to the above methodological trends and reliance on eye-tracking technology, research investigating the head movements that support exploration is slim.

A very small amount of research has utilised head turns as a measure of visual exploration, with a higher rate of head turns representing an increase in exploration behaviour [3]. In these studies exploration was measured using notational analysis in which an analyst watches recorded video footage of games while recording the number of head turns completed. This research provides an initial understanding of in game exploration behaviour, however notational analysis is typically time consuming and prone to errors [4]. Technological advances present a unique alternative to the current methods of data collection. Wearable inertial sensors may provide a reliable, easy to use method to measure the head movements of athletes in situ. The aim of the current research was therefore, to compare inertial sensor data with video footage (captured from first person and third person perspectives) for the measurement of exploration behaviour. It was expected that an inertial sensor would measure head turns of athletes more accurately than notational analysis of both first person and third person video footage.

METHODS

Ethical approval was attained from the Human Research Ethics Committee of Australian Catholic University. A single participant (male, 25 y/o) was involved in data collection, which occurred during one data collection session. The participant was situated on a sports field, surrounded by four research assistants. He was asked to verbally identify the number of fingers presented by the research assistants whilst being free to choose where and when to shift his gaze between the research assistants. After the number of fingers were identified, the research assistants would randomly change the number of fingers presented. This process was repeated for 20 seconds. Three devices

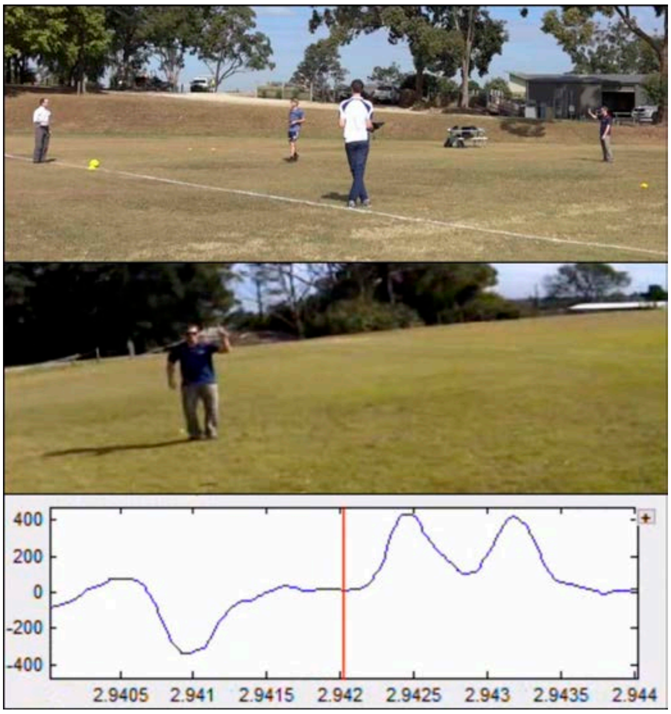

Figure 1. Screenshot of each data analysis source. From top to bottom: third person video, first person video, inertial sensor data plot.

were used to collect data; an inertial sensor (IS) (SABEL Sense, SABEL Labs, Brisbane, Australia) attached to the back of the participants head with adhesive tape, a mobile eye tracking device (Mobile Eye, Applied Sciences Laboratories, Bedford, MA) which provided first person video (FPV) footage, and a tripod mounted video camera (Canon Legria HV40, Canon Inc., Tokyo, Japan) which provided third person video (TPV) footage (Figure 1).

Notational analysis was completed for each data source, with the total number of head turns completed as the outcome measure. Each video data source was analysed independently by three researchers familiar with the study. For each video-source, each researcher was asked to count the number of head turns completed by the participant. The IS data was visually analysed by one researcher to obtain the total number of head turns completed. The IS provided a graphical data feed of head movement over time. As the IS was very sensitive to movement, a head turn was defined as an obvious peak or trough in the data.

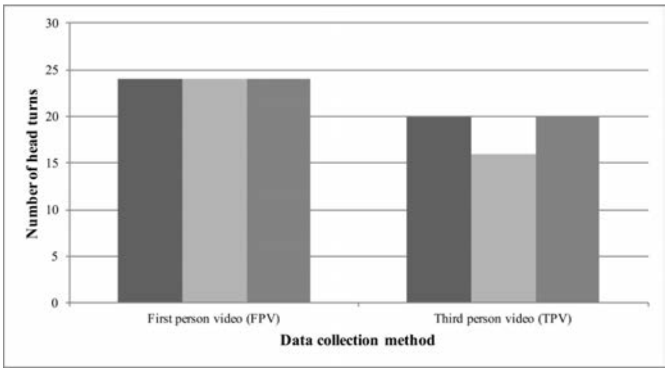

Figure 2. Total number of head turns captured by each researcher in the first person video and third person video conditions.

RESULTS

Analysis revealed the IS was able to detect 25 head turns. The TPV detected the least number of head turns (M = 18.67, SD = 2.31), while the FPV showed one less head turn than the IS unit (M = 24, SD = 0) (Figure 2).

DISCUSSION

With the aim of comparing inertial sensors to video footage for the measurement of exploration behaviour, head turns were counted through three different measurement techniques. Of the three methods used, the TPV condition provided the least sensitive measure of head turns, and the IS provided the most sensitive measure.

There was a large amount of variability between researchers in the TPV condition, showing that this method is prone to errors in data collection. A possible reason for this variability may come from the difficulty in obtaining quality video footage which clearly shows the orientation of the participants head. This is a known issue with notational analysis, and illustrates the need for alternative data collection methods for this type of behaviour. In addition, notational analysis is typically time consuming [(4)], limiting the practicality of its use in research and applied settings.

The difference between the FPV and the IS was one head turn. Reviewing the FPV and IS data together clearly shows a major benefit of the use of IS units for the measurement of exploration. In the video footage, the participant appears to do a single head turn from right to left. However, as the participant turns from right to left, there is a slight pause which was not detected by the researchers. This pause causes two peaks in the IS data plot (Figure 1), and suggests the participant momentarily paused in order to perceive additional information, indicating two head movements. The IS was sensitive enough to pick up the pause, showing a major benefit in the use of IS units compared to current notational analysis methods.

CONCLUSIONS

The inertial sensor provides a more sensitive, accurate and user friendly method for detecting head movements associated with exploration in sport than has previously been utilised. Further development is recommended to fully validate and implement these units to assist with research investigating exploration behaviour in sport.

PRACTICAL APPLICATION

Monitoring the amount of exploration behaviour being utilised by athletes in training.

Using inertial sensors to encourage and develop exploration behaviour in training contexts.

Comparing the exploration behaviour of athletes within a team, enabling more informed training practices.

REFERENCES

1. Gibson J.J. (1979). *An Ecological Approach to Visual Perception*. Boston MA: Houghton-Mifflin.
2. Mann D., Williams M., Ward P., Janelle C. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology, 29*, 457-78.
3. Jordet G., Bloomfield J., Heijmerikx J. (2013). The hidden foundation of field vision in English Premier League (EPL) soccer players. *MIT Sloan Sports Analytics Conference*.
4. Barris S., Button C. (2008). A review of vision-based motion analysis in sport. *Sports medicine, 38*(12), 1025-43.