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Factors relating to the decision-making performance of Australian football officials

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Abstract

Team sport officials are charged with the responsibility to enforce the laws of the game and their performance is based upon the quality of their decisions during a match. The current investigation examined the effects of positioning and retrospective physical demands had on the decision-making accuracy of Australian football officials. Match decision-making statistics and time motion data from 20 elite Australian football matches and the factors related to improved decision-making during match play were examined. Most decisions were made from a distance between 11-15 m, however distance from play had no significant effect on accuracy. There was no significant effect of movement velocity at the time of a decision on accuracy. There was a significant (P<0.05) difference between correct and incorrect decisions in the running speed across the 5 s prior to the decision being made. These findings determine that there is no effect of distance from play or instantaneous velocity on decision-making accuracy during match play. However, higher relative running speeds prior to a decision increases the likelihood of a decisional error. Superior anticipatory skill may reduce the running demands immediately prior to a decision, and therefore possibly improve the decision-making accuracy of umpires.

Keywords: Perceptual-cognitive demands, match analysis, technical performance, team sport officials

1. Introduction

Team sport officials have a significant role in the operation of competitive matches, and the decisions made during a match can have a potential impact on the match outcome (Mascarenhas et al., 2009). Existing research has reported that match play imposes high physical demands on team sport officials including soccer (Castagna et al., 2007; Weston et al., 2012), Australian football (Coutts and Reaburn, 2000; Elsworthy and

Dascombe, 2011), rugby league (Hoare, 2008; O'Hara et al., 2013) and rugby union (Kraak et al., 2011) officials. These studies have observed that team sport officials cover up to 12,000 m during a match. Several findings demonstrate a reduction in physical performance measures (distance covered, high-speed running distance, relative distance) towards the end of a match (Mallo et al., 2010; Elsworthy and Dascombe, 2011). Importantly, such a reduction in running ability may potentially impact on an officials decision-making performance due to a reduced ability to position themselves optimally around play when making a decision.

Despite the importance of the role, little is known as to the decision-making aspect of performance in team sport officials. Specifically, decision-making is considered their most important role during competitive matches, as it ensures that they are played in a fair and safe manner, whilst also upholding the integrity of the game (Helsen and Bultynck, 2004). Previously, the past studies that have examined the decision-making demands of soccer officials during match play have reported a global accuracy rates of 64% and 86% observed for national (Mascarenhas, et al., 2009) and international level referees (Mallo et al., 2012), respectively.

Specific to Australian football, no information exists on the decision-making performance of officials during actual match play. Video based assessment has observed that elite officials are correct in 92% of decision viewed on isolated video clips (Larkin et al., 2011). This however does not provide information regarding the actual match performance of officials, which is the key performance outcome in officiating. Further, the structure of officials in Australian football is unique compared to other team sports, with three 'field' officials in control of a match rather than one as commonly seen in soccer, rugby league and rugby union, with additional officials (i.e. boundary and goal officials) each having a specific assisting role. The increased number of officials in Australian football is due to the larger field size they are required to patrol (135-185 m in length; 110-155 m in width), and the greater number of players on the field (36) (Australian Football League, 2012). The three field officials all have an equal role in officiating a match, and in order to minimise accumulative physical fatigue, they regularly rotate between different areas of the playing arena, as play typically spends more time in the middle area of the field (commonly known as the mid-zone area). As such, the factors related to decision-making performance may not translate from other team sports given the uniqueness of officiating Australian football.

In applying the laws of the game, it is imperative that the official position themselves as to provide an unobstructed view of play, whilst also maintaining an appropriate distance to ensure they do not interfere with the ball or players (Mallo, et al., 2012). Given the dynamic environment of Australian football, the position and movement of the umpire is critical in enabling a correct judgement. In the study of Mallo et al. (2012) there was a strong relationship between the distance from the ball at an infringement, and the likelihood of a decisional error being made by the official. Specifically, the lowest error rate was associated with maintaining a distance of 11-15 m between the official and the ball. Therefore, it can be suggested that the distance at which play is observed by an official may be important in correctly perceiving player incidents. Further, given the relationship between movement speed and offside decision-making in soccer assistant referees (Oudejans et al., 2005), this may also be a factor related to decision-making

accuracy in team sport officials, yet this has only been examined briefly (Mascarenhas, et al., 2009). However, the available data is limited to soccer and further work is required to examine any such relationships in other sports, such as Australian football.

The majority of the available data has reported soccer officials during match play, the impact on the various factors that influence decision-making performance in other sports, such as Australian football, remains unknown. Thus, the current study aimed to examine the effect of positioning on the decision-making accuracy of Australian football field officials. Secondly, the study examined the physical demands associated with Australian football match play to determine how these demands impact on decision-making performance.

2. Methods

Twenty-nine elite-level Australian football field officials (age: 32.4 ± 6.1 y; body mass: 73.6 ± 5.4 kg; Σ7 skinfolds: 49.6 ± 7.4 mm) volunteered to participate in the current study. All participants were currently officiating in the Australian Football League (AFL), which is the highest level of performance within the sport. Participants provided informed consent and underwent typical health screening procedures, including an anthropometrical assessment of body mass and seven-site skinfold assessment prior to participation. The study methodology was approved by the University of Newcastle Human Ethics Committee (Approval Number: H-2012-0045) and supported by the AFL.

The assessment of the free kick decision-making was performed post-match by Australian Football League official coaching staff (n=3). Within three days after each match, the coaches individually viewed each match in full using the available television broadcast footage and three additional camera angles (full field from behind the goal, wide angle side view from halfway, and close up angle vision). Only free-kick decisions where complete agreement between coaches was achieved were included for analysis. Under the laws of Australian football, a free kick is "awarded to or against a player, as the case may be when an official considers any circumstances set out in Law 15" (Australian Football League, 2012, p. 47). Other decisions such as marks, out of bounds and scoring decisions were excluded from analysis as they represent general play scenarios that occur on a very frequent basis. Further, they are also part of the responsibility of the goal and boundary officials. Free kick decisions were analysed into the following categories according to the correctness of the decision: *Correct* (i.e. a free kick was awarded to a player who was infringed); *Missed* (i.e. a free kick was not awarded to a player who was infringed); *Unwarranted* (i.e. a free kick was awarded to a player who was not infringed. No free kick should have been awarded in these circumstances). For the purposes of this study, *missed* and *unwarranted* free kicks were combined and considered as incorrect decisions. For each free kick decision, several factors were recorded including: the type of infringement; the area it occurred on the playing arena (mid-zone or end-zone); time and quarter of the infringement, and; the players and officials involved. Throughout the study, 884 decisions were reviewed by the coaches across the 20 matches. Of these, 426 decisions were excluded because complete agreement was not reached by the coaches, or the position of the official

and/or ball could not be accurately determined. Therefore, 458 decisions were included for analysis.

To quantify the movement demands, each field official wore a global positioning system (GPS) device during matches (Firmware v6.59; Catapult Innovations, Scoresby, Australia). This was worn underneath their normal uniform and recorded longitude and latitude at 5 Hz. Following each match, data were downloaded to a personal computer using the Catapult Sprint software (v5.0.7, Catapult Innovations, Scoresby, Australia). The 5 Hz MinimaxX units have shown acceptable validity (SEE: 3.8 ± 0.6%), and reliability (CV: 3.6%) for measuring the total distance during simulated team sport exercise (Jennings et al., 2010). Match video and GPS data were aligned at the start of each quarter, and at the time (nearest second) of an infringement according to the official coach observations, the physical demands in relation to each free kick were examined. Specifically, the instantaneous speed (1 s average) at the time of the infringement, and relative speed was retrospectively calculated for 5 s, 30 s, 1 min, and 5 min prior to each free kick decision.

Using notational analysis (Kinovea v0.8.20; Kinovea Open Source Project, www.kinovea.org) from the available camera angles, the position of the official and the offending player at the time of an infringement was also determined. Using the distance of known field markings, the distance between the official and an infringement was determined and this was classified into one of the following categories: (i) 0-5 m; (ii) 6-10 m; (iii) 11-15 m; (iv) 16-20 m; (v) 21-25 m; (vi) >25 m (Mallo, et al., 2012). All notational analysis was performed by one researcher, and to assess inter-tester reliability of these methods, 100 decisions from outside the data collection period were reviewed prior to and following the data analysis period (intra-class correlation coefficient = 0.98, 95% CI: 0.98 to 0.99 m; typical error: 1.48 m; coefficient of variation: 7.4%).

Data were initially analysed for normality and homogeneity of variances using the Shapiro-Wilk statistic and Levene's test, respectively. Some data was found to be non-parametric and therefore, non-parametric statistical methods were performed on these data. Further, non-parametric data is presented as the median ± interquartile range (25^{th} and 75^{th} percentiles). Comparison between two sets of data (i.e. correctness, velocity, distance from play) were carried out using Mann-Whitney U tests. To examine the effect of various distances on the correctness of each decision, the decision-making accuracy per category was calculated. Chi-squared goodness-of-fit tests (Nevill et al., 2002) were used to examine the number of decisions and decision-making accuracy distribution.

3. Results

Of the total 458 decisions assessed, 397 (87%) were considered correct and 61 (13%) were considered errors (47 missed, 14 unwarranted) by the official coaches. Given the small sample size of missed and unwarranted free kicks, these were grouped together as incorrect decisions for analysis to present more robust data.

The distance from play, and the velocity at the time of a decision are demonstrated in Figure 1 (A) and Figure 1 (B), respectively. There were no significant differences ($P>0.05$) between correct and incorrect decisions with respect to the distance from the infringement or instantaneous velocity at the time of the decision.

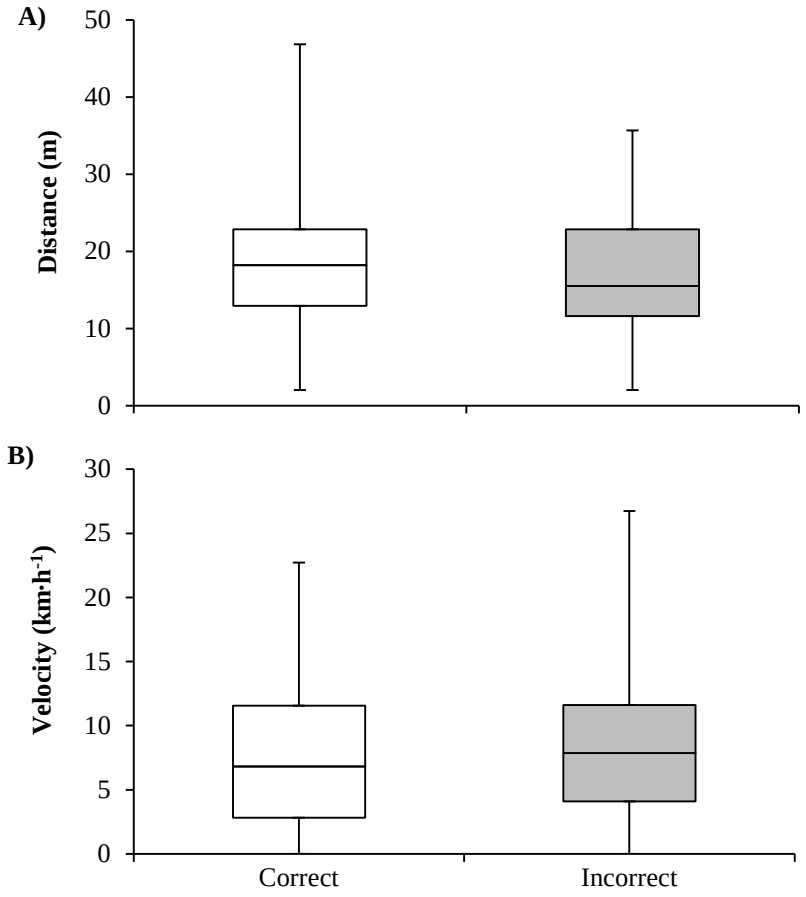

Figure 1. The distance from play (A) and instantaneous velocity (B) of the official at the time of a decision (median ± interquartile range)

The distance at which free kicks were awarded was not normally distributed ($\chi^2_{(5)}=84.23$, $P<0.001$), with most free kicks awarded at a distance between 11-15 m from the infringement. Chi-square analysis demonstrated that there was a normal distribution between decision-making accuracy and distance from play ($\chi^2_{(5)}=0.509$, $P>0.05$) (Figure 2).

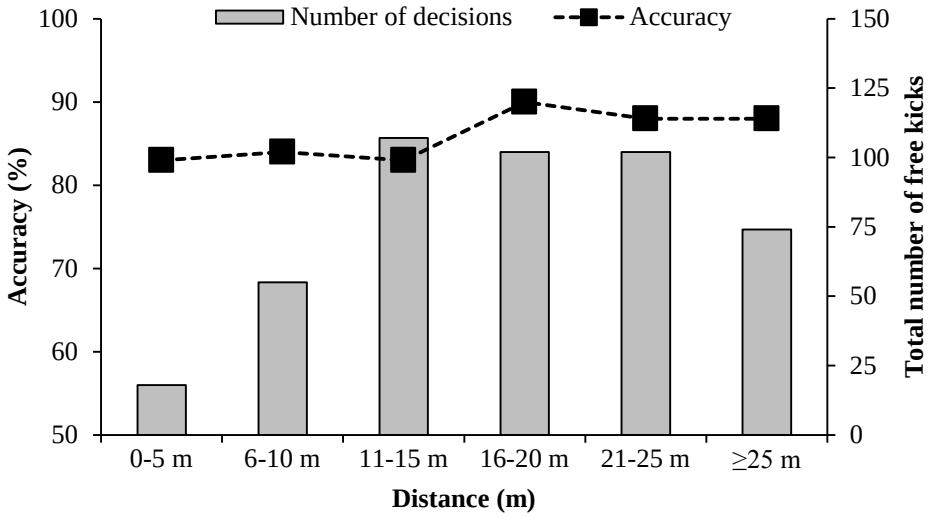

Figure 2. The decision-making accuracy and total number of free kicks in relation to the distance from the infringement.

Figure 3 shows the running speed calculated over 5 s, 30 s, 1 min and 5 min periods, prior to each decision. The 5 s running speed prior to correct decisions is significantly lower than for incorrect decisions (P=0.018). There were no significant differences in running speed across the other time periods between correct and incorrect decisions.

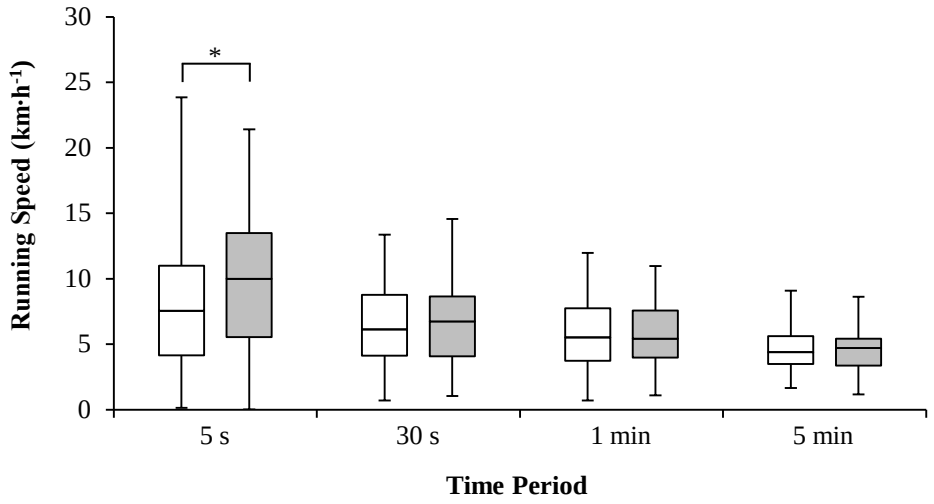

Figure 3. Running speed 5 s, 30 s, 1 min, and 5 min prior to each correct (no fill) and incorrect (grey fill) decision.
*-significantly different between correct and incorrect decisions (P<0.05).

4. Discussion

The aim of the current study was to examine the effect of positioning and physical demands on the decision-making accuracy of Australian football officials during a match. This was to determine how the activity of the official might impact on their decision-making performance. Although it does not appear that the distance from play had any significant effects on decision-making accuracy, the movement demands immediately prior to a decision may impact on the official's ability to make the correct judgement. The current study represents the largest examination of match decision-making associated with team sport officials (n=29; 458 decisions), with previous studies reporting on smaller sample sizes (144-380 decisions) (Mascarenhas, et al., 2009; Mallo, et al., 2012). Therefore, the outcomes of this research are important for a range of team sport officials and have the potential to impact of the perceived quality of match play.

The current findings suggest that the instantaneous demands of the official at the time of a decision have no significant effect on their free kick decision-making accuracy in Australian football. Specifically, the instantaneous speed undertaken at the time of a decision does not increase the likelihood of an error. This contradicts the findings of Oudejans et al. (2005) who reported that the accuracy of offside judgements decreased at higher running speeds in assistant soccer officials. However, in a similar cohort to the current study (i.e. the main official), Mascarenhas et al. (2009) reported no significant differences between movement speed of correct (6.9 ± 4.3 km·h^{-1}) and incorrect (7.0 ± 5.3 km·h^{-1}) decisions. Perhaps the findings of Oudejans et al. (2005) are specific to offside decision-making and may be more sensitive to changes in movement speed when a judgement is made. Specifically, focus may have shifted away from the position of players, towards their own movement and position in relation to play, rather than looking for cues of offside infringements. Free kick judgements such as those observed in the current study and (Mascarenhas, et al., 2009) require different processing of information, based around if the act committed by the player is within the laws of the game, thus these decisions become more focused around rule knowledge and interpretation. Therefore, free kick decisions may not be as sensitive to changes in speed, compared with offside decision-making.

Further, the distance from play when a free kick was awarded did not affect the accuracy of the decision in the current study. The current data failed to support the findings of Mallo et al. (2012). Numerous factors may explain these differences between these studies. This may reflect the more physical nature of Australian football, or alternatively the increased number of players around the ball when compared to soccer. Australian football permits more body-to-body contact (i.e. tackling) which may require the official to be positioned differently to soccer officials in order to perceive all relevant information related to foul play. Further, different free kick scenarios may require different positioning by the official (i.e. one on one marking contest v ground level contest between numerous players) in order to view potential infringements.

Given that there were no obvious effects of position or motion at the time of a decision, the physical demands prior to infringements potentially impede decision-making processes. In particular, the running speed recorded immediately prior (5 s) to a free

kick being awarded was significantly higher for incorrect judgements when compared to correct decisions. The increased physiological loads immediately prior to a decision may facilitate a reduction in the cognitive processes which are involved in decision-making. Previous research has described the relationship between exercise intensity and cognitive function as an inverted-U (McMorris, 2009; Chmura and Nazar, 2010; Lambourne and Tomporowski, 2010). The mechanisms behind this trend appear related to changes in cerebral blood flow.

Compared to resting levels, the increase of exercise intensity results in a linear increase of cerebral blood flow (middle cerebral artery velocity) due to increase aerobic metabolism of the brain (Moraine et al., 1993; Nybo and Rasmussen, 2007; Ogoh and Ainslie, 2009; Seifert and Secher, 2011). This is reflected by improved cognitive performance at similar intensities (Chmura and Nazar, 2010). Further, it has been suggested that when exceeding ventilatory threshold, cerebral blood flow declines towards resting levels (Nybo and Rasmussen, 2007; Seifert and Secher, 2011), as does cognitive function potentially as a response of this change (Chmura and Nazar, 2010). As such, it could be suggested that when completing exercise above the ventilatory threshold immediately prior to a decision (i.e. 5 s), changes in cerebral blood flow may result, and therefore decision-making ability may be reduced. However further research is required to examine the changes in cerebral blood flow during intermittent exercise to support these suggestions.

Although not reported in this study, the position of the official prior to the decision being made may also contribute to the likelihood of an error. This also relates to the anticipatory skill of the official. Specifically, given that the instantaneous speed at the time of a decision (Figure 1B), compared to the 5 s running speed (Figure 3) demonstrate quite large differences (instantaneous speed: [correct: 6.8 $km \cdot h^{-1}$; incorrect: 7.9 $km \cdot h^{-1}$]; 5 s running speed: [correct: 7.5 $km \cdot h^{-1}$; incorrect: 10.0 $km \cdot h^{-1}$]) it could be suggested that the official is having to move more quickly to get into position to make their decision, before being able to slow down when making their judgement. In the case of errors, it may be that they are initially further from play, therefore must work harder (i.e. greater 5 s running speed) to obtain a better position for their decision. On the other hand, the official can afford to move at lower speeds prior to their decision as they are initially in a more ideal position where an infringement may occur in correct decisions.

A limitation of the current study was that only a select number of decisions were able to be analysed from the original data pool (n=884) due to the inability in identifying the position of the ball and/or official at the time of a free kick. However, to communicate this error to the reader, we included the reliability of these methods earlier in the manuscript. As such, future studies should examine other methods of calculating the position of players/officials to allow a greater number of decisions to be examined.

5. Conclusion

This study provides novel data regarding the decision-making performance of team sport officials, specifically in Australian football, and adds to the small amount

available in the literature. While the results do not demonstrate any significant difference in physical performance measures (i.e. distance from play and instantaneous speed) between correct or incorrect judgements at the time of a free kick, perhaps the activity performed prior to a decision may limit the ability to correctly perceive information and adjudicate on an act of play. This has important applications for improving the decision-making abilities of all team sport officials. Future studies should continue to examine all factors related to improved decision-making in team sport officials.

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