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'Reading the Play' Situational Awareness and Performance of Australian Football League Players

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Running Head: SITUATIONAL AWARENESS AND AUSTRALIAN FOOTBALL

'Reading the Play', Situational Awareness, and Performance of Australian Football League Players.

By Craig Harms

A Report Submitted in Partial Fulfilment of the requirements for the degree of Bachelor of Science (Psychology) Honours Faculty of Community Studies, Education and Social Sciences, Edith Cowan University.

October 2001

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Abstract

'Reading the Play', Situational Awareness, and Performance of Australian Football League Players.

Many high-performing Australian Football (AF) players appear to be better at 'reading the play' than other AF players. One cognitive capacity that appears to be similar in nature to 'reading the play', and that has been associated with the performance of elite pilots, is Situational Awareness (SA). The principal focus of this study was to examine the extent to which individual differences in an AF-specific measure of SA and the PC-based WOMBAT™ test of SA were associated with individual differences in AF player performance, within the context of physiological and psychomotor capacities, using Multiple Regression Analysis. The results provide preliminary support for the notion that cognitive abilities such as SA are associated with individual differences in player performance in AF. There was a consistent association between the AF-specific measure of SA and performance in AF. However, the association between the PC-based measure of SA and performance in AF was less than clear. It would also appear that the association between SA and performance in AF should be considered within the context of individual differences in physiological and psychomotor capacities. While the research is still at an exploratory stage, the investigation of the relationship between SA and performance in AF has important implications for the understanding and assessment of cognitive processes in AF.

Author: Craig Harms

Supervisor: Dr Craig Speelman

Submitted: October 2001

Declaration

I certify that this thesis does not incorporate, without acknowledgement, any material previously submitted for a degree or diploma in any institution of higher education and that, to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature: [redacted]

Date: Sep 30, 2002

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One measure of expertise in sport is the extent of successful and influential performance under the stress of elite competition. Successful sporting performance at the elite level of competition depends upon a number of physiological, psychomotor, and psychological capacities. For example, in Australian Football (AF), successful sporting performance at the elite level of competition depends upon physiological factors such as aerobic fitness, speed, agility, and strength; and skill-related factors such as the ability to kick, mark and handball the football.

One of the key psychological factors that can impact on performance at the elite level of AF is cognitive skill. In the context of AF, cognitive skills are performance-related processes, such as decision-making, attention management and anticipation, which are important in the perception and processing of relevant environmental information before skilled motor movements can occur successfully.

Many high-performing AF players appear to be better at a cognitive skill known as ‘reading the play’ than other AF players are. These players, who better at ‘reading the play’, appear to have more time to dispose of the ball, are tackled less, take the right option when disposing of the ball (Speelman, McLean & Kirsner, 2000), can generally anticipate what is likely to happen when the ball is near them, and act appropriately to maximise useful outcomes. This capacity has characteristics that are common in other fields of expertise – that is, the ability to organise problem solving strategically to produce optimal solutions to problems in one’s domain of expertise (Anderson, 2000).

One cognitive capacity that has been shown to be associated with performance of elite pilots is Situational Awareness (SA). O’Hare (1997) has defined SA as the “ . . . the ability to search for relevant information, assess opportunities and priorities, and maintain performance under stress” (p. 540). The capacities described within this definition of SA seem to be similar to the capacities of those AF players described earlier who appear to be better at ‘reading the

play' than other AF players. That is, both conditions involve tasks performed in dynamic environments. Further, both conditions also involve keeping track of several variable sources of information simultaneously. The similarity of the two domains suggests that SA, as measured in pilots, may hold some relevance in predicting the performance of AF players.

At the elite level of AF competition, there is often a group of high-performing, influential players who consistently out-perform other less influential players. These influential players tend to receive more votes in competition awards voted on by umpires, team officials and in the media. The principal focus of this study was to examine the extent to which individual differences in cognitive capacities were associated with individual differences in player performance, and to examine this relationship within the context of physiological and psychomotor capacities.

What is Situational Awareness?

Various definitions of Situational Awareness (SA) in the field of aviation psychology have been offered in the literature (Adams, Tenney & Pew, 1995; Caretta, Perry & Ree, 1996; Endsley, 1995). Endsley (1987, as cited by Endsley, 1995) defined SA as "the perception of the elements in the environment, within a volume of space and time, the comprehension of their meaning and the projection of their status in the near future" (p. 36). Sarter and Woods (1991) defined SA as " . . . all knowledge that is accessible and can be integrated into a coherent picture, when required, to assess and cope with a situation." (p. 55). Roscoe, Carl and LaRoche (1997) defined SA as the ability to " . . . attend to multiple information sources, evaluate alternatives, establish priorities, estimate probable outcomes for different courses of action, work on whatever has the highest momentary urgency, re-order priorities as situations deteriorate or improve, and act decisively in the face of indecision by others" (p. 11). O'Hare (1997) has defined SA as the ". . . the ability to search for relevant information, assess opportunities and priorities, and maintain performance under stress" (p. 540).

Caretta, Perry, and Ree (1996) used the following definition of SA in their study that investigated the relationship between SA and performance of F-15 pilots:

> (SA is) . . . a pilot's ability to know where they are in time and space, keep track of other dynamic environmental events during the flight . . . (a) pilots continuous perception of self and aircraft in relation to the dynamic environment of flight, threats, and mission, and the ability to forecast, and then execute tasks based on that perception. SA is seen as a complex construct including perception, forecasting and behaviour. (p. 22)

For Durso and Gronlund (1999), there are two key issues in their definition of SA – a dynamically changing environment (the environment continues to change irrespective of any action taken by a person in that environment), and goal directedness of an operator in that environment. They also suggest that the highest levels of SA that can be achieved are related to the environmental demands that the operator faces, and the lowest levels of SA are related to the attentional capacities of the operator.

There have been a number of distinctions made in the literature to help define the nature of SA and integrate SA into an understanding of human cognitive functioning. Adams, Tenney, and Pew (1995) pointed out that SA can be viewed both as a state of awareness that is a product of a number of cognitive activities, and a process that involves the development, maintenance and revision of that awareness over time. Furthermore, the product and process of SA are interdependent. The development and maintenance of SA requires significant cognitive resources, and SA is necessary in environments where multiple tasks must be monitored, prioritised and managed.

In an extensive analysis of SA, Endsley (1995) described SA as a process of achieving an assessment of a particular dynamic environment at a certain time. Endsley presents a model of SA that emphasises three main processes – perception of environmental elements, comprehension of the current scenario, and the projection into the future of likely actions.

Further to this model, Endsley has suggested that SA in a given situation depends upon a set of unique elements (important 'things' that should be attended to), is related to temporal and spatial aspects of the environment, and may be shared with other individuals (team SA). Endsley also hypothesises that SA is likely to be restricted by attention and working memory capacity, and while automaticity may be helpful in overcoming attention deficiencies, automaticity may result in the individual missing unique aspects of the environment. Endsley explains the interaction between environmental stimuli and cognitive processes through the interaction of top-down and bottom-up processing models – SA is the outcome of top-down mental models, schemata, goals and expectations interacting with bottom-up recognition of salient environmental cues.

Endsley (1995) has emphasised that SA should be considered as a separate construct from important information-processing concepts such as decision-making and action, and separate from other processes that may impact on SA, such as attention, working memory and stress. Endsley and Bolstad (1994) have suggested that SA provides the interpretative framework between environmental cues and decision-making leading to the performance of actions. They also suggest that SA, decision-making and action performance are affected by workload and individual ability, experience and training. Individual ability, experience and training impact on preconceptions and goals, which in turn impact on decisions and SA. The results of action taken are then perceived as appropriate environmental cues.

In summary, SA appears to be a concept that has neither a clearly ascribed definition nor a clear theoretical grounding. It is a young, evolving field of study (Durso & Gronlund, 1999) that has important implications for the understanding of expertise in the field of aviation and other domains such as anaesthesiology (Gaba & Howard, 1995), the military (See & Vidulich, 1998), and air-traffic controllers (Jones & Endsley, 1996). The intent of this study was to

WOMBAT test is an assessment of attention management in complex and multitask environments. According to Roscoe, et al., the main assumption behind the WOMBAT test is that SA reflects a person's ability "to scan multiple information sources, evaluate alternatives, establish priorities, and select and work on the task that has the highest priority at the moment" (p. 11). If this assumption is correct, O'Hare has suggested that the WOMBAT test should provide a good predictor of performance on tasks that require high levels of SA for successful performance.

O'Hare (1997) found evidence to suggest that the SA scores generated by the WOMBAT test were independent of age, occupational background, experience with computers or computer games or abilities of any of the component tasks after one hour of testing. This finding suggests that the most important aspect of the WOMBAT test is the ability to manage the attention demands of the test rather than the performance on the tests of individual abilities.

Two general approaches have been used to investigate the validity of SA measures. In the first approach, researchers have used a concurrent validity approach to determine if SA abilities could be predicted from a battery of tests. For example, Endsley and Bolstad (1994) assessed the association between pilot's performance on tests of spatial abilities, attention, memory, perception, cognitive functions (such as comprehension and projection), cognitive complexity, field independence and locus of control, and their SA abilities. SA in this study was measured by the SAGAT technique (Endsley, cited in Endsley & Bolstad, 1994). The results suggested that spatial and perceptual skills were important for SA, as were attention sharing and pattern-matching skills to a lesser degree.

Caretta et al. (1996) also used a concurrent validity approach to determine if peer and supervisor ratings of SA could be predicted from general cognitive measures (such as working memory, velocity estimation and spatial ability), psychomotor skills (such as reaction time, aiming and multi-limb coordination) and measures of personality. The authors found

significant agreement between peer and supervisor ratings of SA, accounting for 92.5% of the variance after the first unrotated Principal Components Analysis. They also found flying experience (number of hours of flying) was the best predictor of SA. Only when flying experience was controlled, were measures of general cognitive abilities predictive of SA. Even when flying experience was controlled, tests of psychomotor and personality abilities were not predictive of SA.

In the second approach to determine the validity of the SA concept, O'Hare (1997) attempted to assess the predictive validity of SA measures by investigating the relationship between measures of SA abilities generated from the WOMBAT test (Roscoe et al., 1997) and performance of male soaring glider pilots. O'Hare found that high scores on the WOMBAT test were associated with superior glider-pilot performance – the elite pilot's WOMBAT scores were significantly higher than the scores of experienced pilots, and both the elite and experienced pilots scored significantly higher on WOMBAT than the age and occupation-matched control group.

In summary, the research would suggest that while the three main methods of measuring SA appear to be reasonable measures of SA, the least intrusive ways of measuring SA are by dynamic tasks that are computer controlled (e.g., O'Hare, 1997) or by supervisor ratings (e.g., Caretta et al., 1996). Further, while it has been argued that using the concurrent approach to determine validity of SA scores has shown little evidence that SA performance can be predicted from individual tasks in a battery of tests (O'Hare, 1997; Roscoe & North, 1980), the results do add to the understanding of the SA abilities by implying that SA appears to be unrelated to individual cognitive abilities, and that SA may be a relatively independent cognitive ability. However, if researchers were interested in assessing SA abilities in a predictive sense, multitask tests of attention management, such as the WOMBAT test, appears to be a promising approach.

Situational Awareness-Like Concepts in Australian Football – 'Anticipation' and 'Reading The Play'

In their text on the scientific aspects of AF, Parkin, Smith and Schokman (1987) refer to the concepts of 'decision-making', 'anticipation', and 'reading the play'. They point out that AF players have to make a series of decisions during the game. For example, they felt that the global decision that each player had to make during the game was 'Can I contribute to the team effort, and how can this be carried out?' Other decisions were related to this decision. They also suggest that decision-making improves with degree of expertise, and that fast decision-making is essential for success in AF because players have an average of 1.35 seconds to dispose of the ball once they are in possession of the ball (Smith, 1981, cited in Parkin et al., 1987). Parkin et al. suggest that this time can be 'extended', or fully utilised, if anticipation and 'reading the play' skills are used prior to taking possession of the ball.

Parkin et al. (1987) define 'anticipation' as "… anticipating or predicting what is going to happen" (p. 42) during a game of AF. Although not stated by the authors, the examples of 'anticipation' that they provide in their text are best described as 'closed' or discrete aspects of a game of AF that require a narrow focus of attention. That is, the ball tends to be reasonably close (within the space of one disposal by hand or foot) to the player, such that the player is very likely to be directly involved in the next contest for the ball. Using the terminology to describe attentional styles in sport developed by Nideffer (1976, 1981), 'anticipation' would require a narrow focus of attention.

Parkin et al. (1987) define 'reading the play' as ability to 'read' or predict the general patterns of play that occur within a game of AF, so that a player can not only predict the likely path of the ball, they can also predict the likely movements of other players. Although not stated by the authors, the examples of 'reading the play' that they present in their text are best described as more 'open' or variable facets of a general game of football. That is, the ball tends

Football League (AFL) players have recognised the benefits of these abilities. Mainwaring expressed the opinion that players who can 'read the play' well can save much time and energy by not chasing the ball unnecessarily. Buckley stated that: "Being able to read the play is the biggest asset a player can have. Speed is important, but 'reading the play' gives a player a huge advantage." (p. 153). For Roos (1998), the biggest advantage to him of 'reading the play' was being able to 'drop-off' his opponent and help his team-mates to contest for the ball.

Review of Situational Awareness-Like Concepts in Australian Football

Interest in concepts of anticipation and 'reading the play' in AF is not new. Pyke and Smith (1975) noted that:

> ... top League footballers seem to be able to pay more attention to the development of the patterns of play around them ('reading the play') than players with less skill. These players have refined the skills such as handball and kicking to a stage where they can be executed without conscious awareness of the necessary movements. That is, the skills are automatic. Therefore when the champion gains possession of the ball, he is not so concerned with how he is going to kick it, but is more concerned with where he should kick it to the best advantage of his team. (p. 52-53)

O'Riley (n.d.) has made reference to issues of decision-making, 'awareness', 'reading the play', 'vision', 'positioning', and timing of movement in AF. He has noted that with many set plays, decisions are often taken out of the hands of the players. However, O'Riley has also noted that there are still many situations where the player has to decide what to do quickly because of pressure from opponents. He defines 'awareness' as the compression and perception of the meaning of events that are happening near the player at the time. O'Riley has described 'vision' as the ability to see what is around them and select the best option. He has noted that 'reading the play' often involves judging distances, positioning (knowing the best position to be in to gain possession – e.g., starting in front of an opponent), and that successful

timing of movements is essential, so that the player is in a good position to execute what they intended to do.

A number of issues have not been adequately addressed in the understanding of the cognitive components of expert performance in AF. For example, there are a number of terms that are used in the literature to describe the cognitive and perceptual processes occurring in a game of AF. Even if we use the terms suggested by Parkin et al. (1987) such as decision-making, 'anticipation' and 'reading the play' as the primary cognitive processes, neither they nor Riley (n.d.) clarify the relationships between decision-making, anticipation, and 'reading the play' in AF.

One way to clarify the cognitive components of AF is to consider them from information-processing and 'bottom-up-top-down' perspectives. The information-processing approach involves three basic processes (Anderson, 2000) – perception, decision-making and action. In this approach, perception can be seen as the end result of sensory processes (what does this input mean?). Decision-making (what am I going to do now?) then is linked to action (execution of the required movement). The results of action (what happened?) are perceived as input for further decision-making and action. Top-down processing refers to the influence of knowledge about the environment that influences perception of the environment. Bottom-up processing refers to information that is perceived from the environment and is used to make decisions and take action.

If the terms suggested by Parkin et al. (1987) are used, then 'anticipation' and 'reading the play' could be viewed as examples of perceptual processes, providing relevant information about the environment about what might happen. Experience, previous learning and game plans may act as top-down processes that influence the perception of environmental information for the purposes of 'reading the play' and 'anticipation'. The player then has to make a decision, and execute an appropriate action or movement. The type of action taken by

Summary

It would appear that there are a number of definitions of SA in aviation psychology, that SA has no clear theoretical grounding, and that there are several different methods used to assess SA. However, the study of SA potentially has important implications for the understanding of expertise in other domains such as sport. There has been some interest in exploring SA-like concepts in AF. The two main concepts that have emerged from the study of SA-like concepts in AF are 'anticipation' and 'reading the play' (Parkin et al., 1987). It has been suggested that many high performing, influential AF players appear to be very good at 'anticipating' and 'reading the play' (Speelman et al., 2000). Further, a number of ex-AFL players have suggested that there are a number of advantages of being able to successfully 'anticipate' and 'read the play'.

The goals of this study were to investigate the association between SA and AF performance within the context other important factors that influence successful sporting performance such as physiological and psychomotor abilities. Specifically, the extent to which individual differences in physiological, psychological and psychomotor capacities of a group of elite AF players are associated with individual differences in player performance was examined in this study using Multiple Regression Analysis.

Player performance was defined as performance in the team's best player award, and in the overall competition award (The Brownlow Medal). It is suggested that the player influence is closely related to performance in these awards – it is suggested that the most influential AF players tend to be awarded more votes in these awards. Tests of three physiological capacities (aerobic, anaerobic and strength) were included in a combined index that best represented the physiological status of the AF players. Psychomotor skill was assessed from a combined coach rating of four general psychomotor skills that are common to all roles within AF.

Method

Participants

A total of 27 current players from an elite intact Australian Football League (AFL) team based in Perth, Western Australia, were the participants in this study. Only 20 current players played a total of eight games or more AFL games in the 2000 season (just over one-third of a typical season). It was felt that eight games presented a player with a reasonable opportunity for obtaining competition votes from umpires and team officials.

27 of the current players played a eight or more AFL games in the 2001 season. Three participants who were part of the 2000 sample were not part of the 2001 sample – two of these players had long-term injuries, and did not play a single game in 2001, and the third player only played three games in the 2000 season. For the 2000 sample, the average age of the participants was 24.50 years (S.D. = 3.56) and they had played an average number of 102.10 AFL games (S.D. = 64.02) by the end of the 2000 season. For the 2001 sample, the average age of the participants was 23.59 years (S.D. = 3.42) and they had played an average of 79.85 AFL (S.D. = 65.53) games by the end of the 2001 season.

The participants submitted to this testing as part of the participating team's regular physiological and psychological testing.

Variables

The criterion variable was player performance. Player performance was operationalised in two separate ways. The first operationalisation of player performance was based on the number of votes that the participants received in the AFL's most prestigious annual best player award in the 2000 and 2001 seasons – the Brownlow Medal. The umpires for each game award votes for the best three players of the forty-four players (twenty two from each team) who played on that day. The best performing player is awarded three votes, the second best is awarded two votes, and the third best player is awarded one vote. The umpires are independent

observers, and scores are kept secret until the end of the season. The total number of votes awarded to a participant in a particular season was divided by the number of games the participant played in that season. By assessing number of votes per game played, it is possible to get an indication of player influence whether they played 8 games (because of injury or other reasons) or 22 games.

The second operationalisation of player performance was based on the number of votes that the participants received in the participating team's annual Club Champion award in the 2000 and 2001 seasons. The six coaches arrived at a consensus for the awarding of votes for a particular game. Up to five votes for every player could be awarded in a game. They could also decide not to award any votes. Total number of votes in a particular season was again divided by the number of games played in that season.

There were several predictor variables in this study. Scores that were derived from the PC-based WOMBAT-CS Situational Awareness and Stress Tolerance Test (Roscoe, Carl & LaRoche, 1997), or WOMBAT test, were used to indicate general SA abilities. Reaction time scores were measured by an experimental procedure designed by the author using the Superlab Experimental Laboratory Software (1997). A score from the Situation Awareness and Australian Football (SAAF) questionnaire was used to measure the participant's abilities on the Australian-Football-specific SA-like concepts of 'reading the game' and 'anticipation'. Demographic variables such as age and the number of AFL games played were used to indicate general maturity and experience in competing in the AFL. A physiological index was used to indicate the general physiological abilities of the participants. The physiological index was the result of averaging the participant's best z-scores from three of six physiological tests. A coach rating of psychomotor skill was used to represent the psychomotor abilities of the participants.

Apparatus

Demographic Questionnaire.

A demographic questionnaire was used to collect data on age and the number of AFL games played.

PC-Based Measure of Situational Awareness (SA).

The WOMBAT test was used to measure SA. The WOMBAT test was designed to measure the way in which individuals manage their attention – monitoring what is happening around them, and allocating attention to stimuli that are situational priorities in a complex and multi-task situation (Roscoe, Carl & LaRoche, 1997).

The WOMBAT test is a PC-based task where the participant must perform and maintain performance on a main task, switch to one of three secondary tasks whenever possible, and accrue as many points for successful completion as possible. The primary task is to accurately perform, with left and right hand, two separate tracking tasks. The primary task can be set on 'auto track' or autopilot. The secondary tasks, which the participant can choose to move to when the primary task is placed on 'auto-pilot', requires the participant to demonstrate spatial orientation, temporal and spatial pattern recognition, and short-term memory. The participant must remain vigilant with respect to the main task because the 'auto track' periodically fails, and must be repaired – a failure to repair the 'auto track' leads to a heavy loss of points. The participant can switch between the primary and secondary tasks at will.

The WOMBAT test produces scores after every ten-minute segment for the duration of the test. Three WOMBAT scores were considered to be most relevant for this study. The WOMBAT score after the first ten minutes may represent the participant's initial attempts at completing the task. The average score of the five ten-minute segments may represent the participant's general performance on the WOMBAT test. The participant's final predicted

score may represent the participant's performance after they had had sufficient time to master the strategies of the test.

Managing attention is essential in AF – there are many sources of information available to the senses during a game of AF, such as the trajectory and direction of the ball, how the opposition players are moving, and where other members of the team are positioned. Thus, it would appear that the WOMBAT test would have reasonable face validity as a measure of SA in AF. The ecological validity of the WOMBAT test as a measure of SA in AF is limited because the sensori-motor coordination requirements of the WOMBAT test are significantly different from that of AF, and the environmental conditions for testing on the WOMBAT test are significantly different from environmental conditions present when playing AF. However, the sensori-motor coordination requirements for performance of the WOMBAT test are relatively simple – what is measured in the WOMBAT test is attention management and not sensori-motor coordination (Roscoe, Carl & LaRoche, 1997).

Reaction Time.

Two reaction-time scores were measured for each participant using a task designed by the author using the Superlab Experimental Laboratory Software (1997). Reaction time is a key method of assessing individual differences in cognitive processing speed associated with human performance (Kremer & Scully, 1994). The first activity was a simple reaction task. The participant was asked to press the 'B' key on a standard PC keyboard as quickly as possible when the letter 'B' appeared on the PC screen. The 'B' was the only stimulus that ever appeared on the screen for this task. Reaction time was measured in milliseconds. Each participant completed 10 trials. The average time of the ten trials was used as an indicator of simple reaction time.

The second activity was a choice reaction time task. The participant was asked to push the 'Z' or '/' keys on a standard PC keyboard when the 'Z' or '/' appeared on the PC screen.

The order of appearance of the 'Z' or '/' keys on the screen was randomised. Reaction time was measured in milliseconds. Each participant completed 10 trials. The average reaction time of the 10 trials divided by the number of correct answers was used as an indicator of choice reaction time. Participants were prompted during the experimental instructions for both tasks to respond as quickly as possible to the cues on the PC screen.

Coach Rating of 'Reading The Play' – Situational Awareness and Australian Football (SAAF) Questionnaire.

The six coaches at the participating AFL team were asked to rate each player on the Situation Awareness and Australian Football (SAAF) questionnaire (See Appendix 1). The SAAF is a seven-item questionnaire, with each item requiring a response on a five point likert scale (1 – very poor to 5 – very good). The SAAF was developed by the author in consultation with the sport scientists at the participating AFL team. The goal for developing the SAAF was to develop a method of measuring the participant's abilities on the AF-specific SA-like concepts of 'reading the game' and 'anticipation'. The SAAF was modelled on the questionnaire developed by Caretta et al, (1996) to measure SA for F-15 fighter pilots and was influenced by the work of Parkin et al. (1987) and O'Reilly (n.d.). The author and the sport science staff at the participating AFL team developed several drafts of the SAAF before agreeing on the final version.

The SAAF was made up of three sections – 'general abilities', 'positioning', and 'in possession'. In a fashion that was similar to the Caretta et al. (1996) questionnaire, the 'General Abilities' section included three general SA-traits that were generally required for successful performance in AF, such as the decisiveness of action and the ability to adjust to various situations in the game. The 'Positioning' section referred to three typical situations in AF where the player positioning could be judged by the coaches. For example, player positioning can be judged by the way the player positions themselves when the ball is in

dispute (the ball is kicked in a general fashion to a group of players, and the outcome of the contest for the ball is very uncertain). The 'In-Possession' section referred to the quality of choices that the player makes after they have possession of the ball. Standard definitions were developed for each item, and six coaches rated each player. The participant's score for each section was summed, averaged across the assessments for each participant by the six coaches, and then that score was converted to a percentage.

Coach Rating of Psychomotor Skill – Australian Football Skills Assessment (AFSA) Questionnaire.

The six coaches at the participating AFL team were asked to rate each participant on their level of psychomotor skill in AF (see appendix 2). The author, in consultation with two of the sport science staff at the participating AFL team, developed this rating scale of psychomotor skill. Four skills of AF were evaluated – kicking, handballing, marking and tackling. The rating of each skill was done on a seven-point likert scale (1 – very poor to 7 – very good). The coaches were asked to rate each player on the four skills in comparison to the skills typically displayed by an AFL footballer. The specific criteria for judging kicking performance were accuracy and consistency of kicking the ball to the desired targets, such as team-mates or goals. The specific criterion for judging handballing performance was accuracy and consistency of handballing the ball to a team-mate. Marking performance was judged on the player's ability to take marks against one opposition player ('one-on-one' marks). Tackling performance was judged on the player's ability to tackle an opponent so that there was poor or no disposal of the ball by the player they were tackling. A total score of psychomotor skills was generated for each player by adding the ratings from the four skills assessed in this questionnaire. The participant's score for psychomotor skill was generated by averaging the assessments of each participant by the six coaches, and then converting that score to a percentage.

Physiological Measures.

Six tests of physiological capacities were included in the physiological index – two tests of aerobic fitness (two kilometre run and a 'beep test'), two tests of anaerobic fitness (10 and 40 metre sprints) and two tests of strength (bench press and 'cleans'). The scores for the participants were converted to z-scores. The z-scores for the two kilometre run and the 10 and 40 metre sprints were negatively scored, and were recoded so that a negative score indicated a poor performance. The final physiological index, then, was an average of the participant's best adjusted-z-scores for aerobic, anaerobic and strength capacities. Information on participant physiological and skill performance was supplied from the results of regular fitness testing conducted by the participating AFL team. Unfortunately, not all participants completed all the physiological tests prior to the 2001 AFL season. Scores from testing done prior to the 2000 AFL season were used as an indicator of the typical levels of fitness exhibited by this group of participants.

Procedure

Testing of the participants took place at the home ground for the participating team. A room was divided so that two testing stations could be established. Two participants were scheduled to complete the testing. The experimenter was sitting between and behind the two testing stations at all times. A period of two hours was allocated per testing session. The testing times for Mondays, Wednesdays and Fridays were from 9 to 11 am, 11 am to 1 pm, and from 2pm to 4 pm. Testing times for Tuesdays and Thursdays were 10am to 12 mid-day.

Upon entering the testing room, participants read the information sheet, signed the consent form, and completed the demographic questionnaire. The experimenter then explained the testing protocol. The first test that the participants completed was the Reaction Time Tasks, which usually took three to five minutes to complete.

discussed generally amongst the coaches. The coaches were given two weeks to complete the ratings.

Coach Ratings of Psychomotor Skill – Australian Football Skills Assessment (AFSA) Questionnaire.

Two members of the Sport Science staff from the participating AFL team met with the coaches and asked the coaches to complete the questionnaire. The specific criteria for assessing each of the skills, and directions for completing the questionnaire, were discussed with each coach. The questionnaire was administered approximately one month after the completion of the SAAF questionnaire.

Physiological Measures.

For the two-kilometre run, a 400-metre track was measured on a grass running surface. Participants completed five laps of the track. The participant's time after one trial was recorded.

For the beep test, two lines, twenty metres apart, were marked on a rubber indoor running surface. Participants, in groups of eight, ran back and fourth between the two lines in time with the sound of a metronome beat. The speed of the running between the two lines incrementally increased at different stages (up to stage 21) throughout the test. The participants competed the test when they could no longer travel between the two lines at the incrementally increasing speed. The stage number, and number of shuttles completed within that stage, was recorded for each participant.

For the Ten and forty metre time trials, participants sprinted over a forty metre marked course on a wooden indoor running surface. They were self-started from a standing start. Their times were recorded electronically to 0.01 seconds by an automatic timing system. The player breaking an infrared beam between two timing gates activated the timing system. The gates were placed at the start, at ten metres and at forty metres along the course.

For the one repetition maximum test, the score recorded was the greatest weight lifted for one repetition using the standard technique of an Olympic Power Clean. Participants were given unlimited attempts, after a warm-up, to achieve their best lift.

For the one repetition maximum (1 R.M.) bench press, the score recorded was the greatest weight lifted for one repetition using the standard bench press technique. Participants were given unlimited attempts, after a warm-up, to achieve their best lift.

Results

Data Screening of the Criterion Variable

Initial data screening of the two operations of the criterion variable indicated that normality could be assumed for the distribution of the 2000 and 2001 Club Champion variable but not for the 2000 and 2001 Brownlow Medal variable. It was decided to not transform the Brownlow variable for the 2000 and 2001 seasons because any transformation would compromise the interpretation of the results.

WOMBAT Results

Performance on the WOMBAT test can be scored in several ways, because the WOMBAT test generates a score for SA every ten minutes of the test. O'Hare (1997) used the score from the final ten-minute segment of the test as the pilot's SA score. However, AF players may not reach close to their optimal performance towards the end of the WOMBAT test for several reasons – the AF's may not be as familiar with using the WOMBAT test equipment as participants from an aeronautics background; AF's may not be as used to maintaining their concentration on this equipment as participants from an aeronautics background; and the Australian footballers may quickly lose interest in a task that is likely to be outside of their typical sporting interests. Therefore, it was decided to explore the WOMBAT results to determine which of the WOMBAT scores was most associated with the two separate operationalisations of the criterion variable for the year 2000 and 2001 results.

Several different WOMBAT scores, and their correlation with the two separate operationalisations of the criterion variable for the year 2000 and 2001 results are presented in Table 1. The WOMBAT score after the first ten-minute segment may reflect the participant's initial reaction to the challenge of the testing protocol. The score after the final ten-minute segment may reflect the participant's ultimate performance once they have gained mastery of the test. The average score of the five ten-minute segments may represent the participant's

typical score on the test. The participant's final predicted score may represent their performance after they had gained mastery of the test. Mastery may not necessarily occur at the end of the test. The participant may gain mastery of the test at various stages of the test – performance may then decline because of fatigue or lack of concentration skills, because the participant uses different, less effective test strategies, or because the participant loses interest in the task.

Table 1

Correlations Between the WOMBAT scores and Club Champion and Brownlow Medal Variables for the 2000 and 2001 Seasons

WOMBAT Scores	2000 Club Champion Variable	2000 Brownlow Medal Variable	2001 Club Champion Variable	2001 Brownlow Medal Variable
First 10 Minutes	.45*	.32	-0.39*	-0.21
Final Score	.25	.24	-0.31	-0.20
Best Score	.19	.17	-0.44*	-0.31
Average Score	.28	.21	-0.36	-0.25

* $p < .05$.

The WOMBAT score after the first 10-minute segment was used as the score for the WOMBAT variable for the rest of the analysis for two reasons: The WOMBAT score after the initial 10-minute segment was the only WOMBAT score that was significantly associated with the 2000 Club Champion variable; and the WOMBAT score after the first 10-minute segment was the only WOMBAT score that was significantly correlated with Club Champion variable in both 2000 and 2001 seasons. While the direction of the association for the 2001 Club Champion variable is a cause for concern, all WOMBAT scores were negatively associated with the 2001 Club Champion variable.

Table 2

Correlations Between the Predictor Variables and the 2000 and 2001 Club Champion and Brownlow Medal Variables

Variable	SAAF	WOMBAT	Physiological Index	Psychomotor Skill	Simple Reaction Time	Choice Reaction Time
2000 Club Champion Variable	.56*	.45*	.34	.32	.19	.14
2000 Brownlow Medal Variable	.49*	.32	.33	.26	-.34	-.09
2001 Club Champion Variable	.44*	-.39*	.15	.54**	.05	-.01
2001 Brownlow Medal Variable	.28	-.21	.46*	.27	-.00	.01

* $p < .05$. ** $p < .01$.

Multiple Regression Analysis (MRA)

There should be a minimum of fives cases per predictor variable when conducting MRA (Coakes & Steed, 1997). As there were only 20 participants in the 2000 sample, and 27 in the 2001 sample who met the eligibility criteria, only four of the six predictor variables described in Table 2 were used for further analysis using MRA. The four predictors that most correlated with both operationalisations of the criterion for the 2000 and 2001 results were the WOMBAT, SAAF, Physiological Index and Psychomotor Skill variables. Therefore, the MRA for the 2000 and 2001 operationalisations of the criterion were conducted using these four predictor variables. For the MRA's of the 2000 Club Champion and Brownlow Medal variable, WOMBAT, SAAF, and Psychomotor Skill variables measured in 2001 were used.

Psychomotor Skill variable was significantly correlated with performance for one of the four operationalisations of the criterion variable.

The results of the initial standard and sequential MRA for the 2000 Club Champion votes are presented in Tables 4 and 5. The scatter plot of the residuals for the criterion variable was consistent with the assumption of normality. Using $p < .001$ criterion for Mahalanobis distance, no multivariate outliers were observed at any stage of the analysis. There were no cases of missing data, $N = 20$.

Table 4

Results of the Standard Multiple Regression Analysis of 2000 Club Champion Variable

Variable	B	SE B	β	sr_i^2(unique)
SAAF	2.56 E-02	.01	.50*	.19
WOMBAT	4.24 E-03	.00	.38***	.14
Physiological Index	1.66 E-02	.17	.02	.00

* $p < .05$. *** $p = .06$

The standard MRA indicated that the predictor variables taken together explained a significant 46% (35% adjusted) of the variance in 2000 Club Champion votes per game, $R = .68$, $R^2 = .46$, adjusted $R^2 = .35$, F (3, 16) = 4.47, $p < .05$. Interpretation of the regression coefficients in Table 4 indicated that the SAAF variables accounted for a significant portion of the variance in the 2000 Club Champion variable. The amount of variance in the 2000 Club Champion variable accounted for by the WOMBAT variable approached significance. As some of the predictor variables were significantly correlated, interpretation of the semi-partial partial correlations (sr_i^2) indicated that the SAAF variable was a more important predictor of the 2000 Club Champion variable than the WOMBAT variable.

Order of entry for the sequential MRA of the 2000 Club Champion variable was based on the apparent importance of the predictor variables evident from the results of the standard

MRA. Thus, the SAAF variable was entered first, the WOMBAT variable second, and the Physiological Index variable third. This order of entry was used for all sequential MRA's.

Table 5

Results of the Sequential Regression Analysis of the 2000 Club Champion Variable

Variable	B	SE B	B
Step 1			
SAAF	2.84 E-02	.01	*.56
Step 2			
SAAF	2.60 E-02	.00	.51*
WOMBAT	4.26 E-03	.00	.39*
Step 3			
SAAF	2.56 E-02	.01	.50
WOMBAT	4.24 E-03	.00	.38
Physiological Index	1.67 E-02	.21	.02

Note. $R^2 = .31$ for Step 1, $\Delta R^2 = .15$ for step 2 (ps $< .05$), $\Delta R^2 = .00$ for step 3.

For the Sequential MRA of the 2000 Club Champion variable, R was significantly different from zero at the end of each step. After step 3, with all IV's in the equation, $R = .68$, $F\ (3, 16) = 4.47$, $p < .05$. After step 1, with the SAAF variable in the equation, $R^2 = .31$, $F_{inc}\ (1, 16) = 8.05$, $p < .05$. After step 2, with the WOMBAT variable added to the equation, $R^2 = .46$, $F_{inc}\ (1, 16) = 4.58$, $p < .05$. Addition of the WOMBAT variable to the equation with the SAAF variable resulted in a significant increase in R^2. After step 3, with the Physiological Index variable added to the equation, $R^2 = .46$, $F_{inc}\ (1, 16) = .00$, $p > .05$. The addition of the Physiological Index variable to the equation did not result in a significant increase in R^2. Therefore, the equation at the second step for the sequential MRA of the 2000 Club Champion variable was the most efficient set of predictor variables. At this step, both the SAAF and

As part of the analysis, the predictor variables were examined using SPSS Regression for accuracy of fit between their distributions and assumptions of multivariate analysis. Interpretation of the results from the Collinearity Diagnostics for the MRA of 2001 Club Champion variable indicated that the criteria for multicollinearity (Tabachnick & Fidell, 1996) were met. Inspection of the correlation matrix of the predictor variables indicated that the correlation between the SAAF and Psychomotor Skill variables was the likely source of the multicollinearity problem – the Psychomotor Skill variable was significantly associated with the SAAF variable, R = 68, p <. 01. Consistent with the rationale outlined for the analysis of the 2000 operationalisation of the criterion, the Psychomotor Skill variable was dropped from MRA's of the 2001 operationalisation of the criterion variable.

Table 9.

Descriptive Data and Correlations Between the Predictor Variables For the Multiple Regression Analysis of the 2001 Club Champion Variable

Variable	2001 Club Champion Variable	SAAF Ratings	WOMBAT	Physiological Index	Psycho-motor Skill
SAAF	.44*				
WOMBAT	-.39*	-.10			
Physiological Index	.15	.21	-.19		
Psychomotor Skill	.54**	.68**	-.08	-.14	
M	.44	72.81	196.04	.24	67.53
S.D	.32	10.01	40.95	.47	7.42

* p < .05. ** p < .01.

The results of the standard and sequential MRA for the 2000 Club Champion votes are presented in Tables 10 and 11. The scatter plot of the residuals for the criterion variable was

The results of the standard MRA for 2000 Brownlow Medal votes are presented in Tables 12. Using $p < .001$ criterion for Mahalanobis distance, no multivariate outliers were observed at any stage of the analysis. There were no cases of missing data, $N = 27$.

Standard regression analysis indicated that the predictor variables taken together explained a non-significant 26% (16% adjusted) of the variance in Brownlow Medal votes in 2001, $R = 0.51$, adjusted $R^2 = 0.16$, $F(3, 23) = 2.61$, $p > .05$. Inspection of the regression coefficients in Table 13 indicated that only the Physiological Index variable explained a significant amount of the variance in 2001 Brownlow Medal votes per game. The portion of variance in the 2001 Brownlow Medal variable accounted for by the SAAF and WOMBAT variables was negligible. Hence, the most important predictor of 2001 Brownlow Medal votes per game was the Physiological Index variable.

Table 12

Descriptive Data and Correlations Between the Predictor Variables for the Multiple Regression Analysis of 2001 Brownlow Medal Variable

Variable	2001 Brownlow Medal Variable	SAAF	WOMBAT	Physiological Index
SAAF	.28			
WOMBAT	-.21	-.01		
Physiological Index	.46*	.21	-.26	
M	7.27 E-02	72.81	196.04	.24
S.D	.17	10.01	40.95	.47

* $p < .05$.

correlated with performance in four of the five operationalisations of the criterion variable whereas the Psychomotor Skill variable was significantly correlated with performance in two of the five operationalisations of the criterion variable.

The results of the standard MRA for the Average Club Champion variable are presented in Table 17. The scatter plot of the residuals for the criterion variable was consistent with the assumption of normality. Using $p < .001$ criterion for Mahalanobis distance, no multivariate outliers were observed at any stage of the analysis. There were no cases of missing data, $N = 17$.

Standard regression analysis indicated that the predictor variables taken together explained a statistically significant 61% (56% adjusted) of the variance in the Average Club Champion variable, $R = 0.78$, adjusted $R^2 = 0.56$, F (2, 14) = 10.98, $p > .01$. Inspection of the regression coefficients in Table 17 indicated that only the SAAF variable explained a significant portion of the variance for the Average Club Champion variable. The amount of variance of the Average Club Champion variable explained by the Physiological Index variable approached significance. Interpretation of the beta weights indicated that the SAAF variable was substantially more important than the Physiological Index variable for predicting variance in the Average Club Champion votes per game for the 2000 and 2001 seasons.

Table 17

Results of the Standard Regression Analysis of the Average Club Champion Variable

Variable	B	SE B	β
SAAF	2.44 E-02	.01	.62*
Physiological Index	.23	.13	.32***

* $p < .05$. *** $p = .09$

Discussion

The focus of this study was to explore the relationship between Situational Awareness (SA) and player performance in Australian Football (AF), within the context of other measured abilities, such as physiological and psychomotor capacities, using Multiple Regression Analysis (MRA).

The findings of this study provide preliminary support for the notion that cognitive abilities such as SA are associated with individual differences in AF player performance. Consistent with expectations, the AF-specific measure of SA was a significant predictor of participant performance in four of the five analyses – Club Champion votes per game in the 2000 and 2001 seasons, the Brownlow Medal votes per game in the 2000 season, and average Club Champion votes per game for those participants who played eight games or more in both the 2000 and 2001 season. Also, the questionnaire measure of AF-specific SA was a more important predictor of performance in the same four analyses than the PC-based measure of SA and the measure of physiological capacities. The finding that AF-specific SA, as measured by the SAAF questionnaire, was associated with elite performance in AF is consistent with the findings of the research conducted on supervisor ratings of SA for F-15 fighter pilots by Caretta et al. (1996).

The relationship between the PC-based measure of SA and individual differences in AF player performance was less clear. As hypothesised, the PC-based measure of SA was a significant positive predictor of 2000 Club Champion votes per game, and was a more important predictor of performance in this award than the measure of physiological capacities. The finding that SA, as measured by the WOMBAT test, was associated with elite performance in dynamic, complex, and multitask environments is consistent with the previous research of O'Hare (1997) conducted with elite glider pilots. However, contrary to expectations, the PC-

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Situational Awareness & Australian Football (SAAF)

Player name: ________________

Assess what the players generally display on the following qualities by circling the appropriate number:

1. General Abilities.

	Very Poor	Poor	Aver age	Good	Very Good
Adheres to our game plan and their own individual role.	1	2	3	4	5
Decisiveness of action.	1	2	3	4	5
Tactical Knowledge – able to adapt & adjust to various situations.	1	2	3	4	5

2. Situations where the player is positioning himself to get the ball.

The ball is in dispute – eg, ball kicked to a pack near the player.	Very Poor	Poor	Aver age	Good	Very Good
Good position (eg, 'front & square'), to anticipate where the ball might go 'off hands'.	1	2	3	4	5
A team-mate has the ball and is clear of other players. We have the ball.	Very Poor	Poor	Aver age	Good	Very Good
Leading to the right 'spot', according to team rules & available space.	1	2	3	4	5
An opposition player has the ball and is clear of other players. They have the ball	Very Poor	Poor	Aver age	Good	Very Good
Denies immediate opponent the best option and/or 'reads the play' as to where the ball is most likely to go.	1	2	3	4	5

3. Options that player takes after they have possession of the ball

Player has time to 'size up' options for effective disposal further up the ground.	Very Poor	Poor	Aver age	Good	Very Good
Kicking or handballing the ball to the best option, according to team rules & available leads/space	1	2	3	4	5

Australian Football Skills Assessment (AFSA) Questionnaire.

Circle the score that best represents the player's skill level in comparison to a typical AFL player:

Player: ________________

Kicking

Main criteria – accuracy and consistency of hitting targets

1	2	3	4	5	6	7
Very Poor	Poor	Below Average	Average	Above Average	Good	Very Good

Handball

Main criteria – accuracy and consistency of hitting targets

1	2	3	4	5	6	7
Very Poor	Poor	Below Average	Average	Above Average	Good	Very Good

Marking

Main criteria – ability to take one-on-one or contested marks

1	2	3	4	5	6	7
Very Poor	Poor	Below Average	Average	Above Average	Good	Very Good

Tackling

Main Criteria –Poor or no disposal by player they are tackling

1	2	3	4	5	6	7
Very Poor	Poor	Below Average	Average	Above Average	Good	Very Good

Appendix C – Raw Data for the Multiple Regression Analysis of the 2000 Club Champion and Brownlow Medal Votes Per Game.