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Comparison of Agility Demands of Small-Sided Games in Elite Australian Football

Michael J. Davies, Warren Young, Damian Farrow, and Andrew Bahnert

Purpose: To compare the agility demands of 4 small-sided games (SSGs) and evaluate the variability in demands for elite Australian Football (AF). ***Methods:*** Fourteen male elite Australian Football League (AFL) players (mean ± SD; 21.7 ± 3.1 y, 189.6 ± 9.0 cm, 88.7 ± 10.0 kg, 39.4 ± 57.1 games) completed 4 SSGs of 3 × 45-s bouts each with modified designs. Video notational analysis, GPS at 5 Hz, and triaxial accelerometer data expressed the external player loads within games. Three comparisons were made using a paired *t* test ($P < .05$), and magnitudes of differences were reported with effect size (ES) statistics. ***Results:*** Reduced area per player (increased density) produced a small increase in total agility maneuvers (SSG1, 7.2 ± 1.3; SSG2, 8.8 ± 4.1), while a large 2D player load was accumulated ($P < .05$, ES = 1.22). A reduction in players produced a moderate (ES = 0.60) total number of agility maneuvers (SSG 3, 11.3 ± 6.1; SSG 2, 8.3 ± 3.6); however, a greater variability was found. The implementation of a 2-handed-tag rule resulted in a somewhat trivial decline ($P > .05$, ES = 0.16) in agility events compared with normal AFL tackling rules (SSG 2, 8.3 ± 3.6; SSG 4, 7.8 ± 2.6). ***Conclusions:*** SSG characteristics can influence agility-training demand, which can vary considerably for individuals. Coaches should carefully consider SSG design to maximize the potential to develop agility for all players.

Keywords: accelerometers, change of direction, game training

In Australian Football (AF) and other invasion sports, agility is important for an attacker to evade opposition players or for a defender to be in position to apply pressure to the ball carrier. Agility is defined as a rapid whole-body movement with change in velocity or direction in response to a stimulus.[1] Traditionally, coaches' training methods for agility have focused on physical components such as sprint speed and change of direction (COD). For example, they prescribe various preplanned COD running drills, requiring players to sprint certain patterns around stationary obstacles in an attempt to reproduce agility maneuvers that occur in competition.[2] However, COD movements can be nonspecific and have no perceptual and decision-making demand such as anticipating an opponent's movements.[3]

An alternative method is to use small-sided games (SSGs) for agility development.[4,5] These games involve fewer players than a regular competition match and are conducted on smaller fields with modified rules.[6] Proposed advantages of SSGs include specificity of movements, inclusion of decision making, and the potential to develop multiple fitness components all in conjunction with skills and tactical aspects.[6] However, a potential disadvantage of SSGs is the inability of the coach to control the workload of each individual player.

Research on SSGs has predominantly been focused in soccer and rugby codes[4,7–14] and indicates they are an acceptable supplement to aerobic-conditioning methods such as interval training. A number of variables such as playing area,[13] number of players,[9] coach encouragement,[8,15] rule changes,[12] bout duration,[10] and mode of SSGs[11] can be manipulated to achieve the desired training stimulus. However, there is no research on how the manipulation of SSG variables affects agility demands. It is possible that the average area on the field per player (density), number of players per team, and modified rules may influence agility demands. Therefore, the purpose of this study was to quantify and compare the agility demands of 4 SSGs in elite AF and to evaluate the variability between demands for individual players. From this information, suggestions can be made to coaches on prescribing SSG training to benefit all players equally.

Methods

Subjects

Fourteen male AF players from an Australian Football League (AFL) club participated in the study (mean ± SD; age 21.7 ± 3.1 y, height 189.6 ± 9.0 cm, weight 88.7 ± 10.0

Davies and Young are with the School of Health Sciences, University of Ballarat, Ballarat, VIC, Australia. Farrow is with the School of Sport and Exercise Science, Victoria University, Melbourne, VIC, Australia. Bahnert is with Adelaide Football Club Ltd, West Lakes, South Australia.

kg, games 39.4 ± 57.1). Players were randomly selected by the club on the basis that they were free of injury and illness at the time of testing. The project was approved by the university's human research ethics committee.

Design

Overall agility demands of SSGs were established by quantifying external loads of 4 different games, using video notational analysis and global positioning system (GPS) tracking. Two games were performed in 1 training session in February, with the other games being conducted in a training session in March 2011.

To determine the effect of a game variable on agility demands, one variable was manipulated while the others were held constant. Consequently, game 1 was compared with games 2, 3, and 4 so that we could determine the effect of density (games 1 and 2), player number (games 1 and 3), and a rule change (games 1 and 4; Table 1). All games were performed over the same duration and comprised 3 × 45-second work bouts with 45-second passive rests between bouts.

Methodology

All SSGs were performed at the beginning of training, to ensure players were not fatigued. Before each game, players performed their normal warm-up conducted by the club's conditioning staff. Testing was conducted on a grass AFL standard outdoor surface at the home training venue of the club. The temperature ranged from 24 to 28°C with light winds and no rain during both sessions.

SSG Rules

The objective of the game was to score by either handballing or touching the ball over a 2-m-wide end zone marked with cones. Kicking was not allowed so that disposal of the ball was by handball only. Normal tackling was permitted, and a successful tackle resulted in an automatic turnover of possession. This tackling rule was changed for game 4 so that only a 2-handed tag was required to achieve a turnover. This rule was expected to encourage the attacker to evade opposition players and therefore increase the agility demands.

Table 1 Characteristics of the 4 Small-Sided Game (SSG) Designs

SSG	Field area	Field area	Players, n	Player density[a]
1	30 × 20 m	600 m^2	10, 5 vs 5	60
2	45 × 30 m	1350 m^2	10, 5 vs 5	135
3	23.2 × 20 m	360 m^2	6, 3 vs 3	60
4	30 × 20 m	600 m^2	10, 5 vs 5	60

[a] Area/(total number of players).

General Game Procedures

Players in session 1 alternated between bouts for games 1 and 2. This was done to reduce an order effect between the 2 games. If this were not done, game 2 would have been performed in a somewhat fatigued state. This alternating of bouts was not practical for the second training session involving games 3 and 4 due to the fewer number of players in game 3. This meant that all of game 3 had to be performed before game 4. To minimize the potential fatigue between these 2 games, a 2-minute recovery was allowed.

Measures of Agility Demands

To examine agility and technical actions, all SSGs were video recorded using a Sony HDV Handy Cam digital video camera (HDR-FX1E) at a 25-Hz sampling rate. The camera was fixed on a tripod and situated at a high vantage point so that all players could be seen within the field of view at any time. An agility maneuver was recorded for an attacker carrying the ball, for a defender who moved to apply pressure to the ball carrier, and for other players who produced maximum or near-maximum changes of direction or decelerations to influence a contest. These consisted of side-steps, shuffles, split-steps, hard stopping, and deceptive attacking actions such as a fake. Interrater reliability was also assessed for games 1 and 2 after the agility events. To determine the level of agreement between 2 researchers an intraclass correlation (ICC) was calculated. The descriptive terms associated with ICC were 0 to 0.20 *slight,* 0.21 to 0.40 *fair,* 0.41 to 0.60 *moderate,* 0.61 to 0.80 *substantial,* and 0.81 to 1.00 *almost perfect.*[16]

All players were fitted with a GPS unit (MiniMaxX3, 3G, Catapult Innovations) sampling at 5 Hz located between the shoulder blades in the upper-thoracic-spine region. It was secured against the body in an elastic pouch, fixed to the inside of a harness underneath the training jersey. The GPS units were locked onto satellite signals before being fitted to each player. Three speed zones were chosen for this study: 0 to 14.99 km/h (walking to jogging), 15 to 19.99 km/h (running or fast running), and 20 to 36 km/h (sprinting). These zones were chosen rather than using speeds from previous AF match data, as players would not attain similar speeds to competition due to the restricted area and increased density of the games. Therefore, the researchers selected these zones to better discriminate between the SSGs. In addition, using fewer speed zones to analyze GPS data can increase the reliability of distances covered over greater speeds.[17] Acceleration and deceleration zones were adopted from previous research[18] and included high acceleration (3–8 m/s^2), moderate acceleration (1–3 m/s^2), low deceleration (–1 to 1 m/s^2), moderate deceleration (–1 to –3 m/s^2), and hard deceleration (–3 to –8 m/s^2). Speed, acceleration, and deceleration zones were expressed as percentage of time spent in each zone rather than total time. This was done because of slight differences between the total times of the chosen SSGs as a result of extracting the GPS data from the training sessions.

In addition, player load adopted from previous research[19] was measured by the built-in triaxial accelerometer in each GPS device. This feature allows monitoring of accumulated accelerations and decelerations across 3 dimensions (3D) of body movement expressed as arbitrary units (a.u.). The accelerometers sampled at 100 Hz and can be considered reliable in measuring player external workloads in AF.[19] The 3D player load was thought to be strongly influenced by the vertical component, due to foot strikes during running. Therefore, the mediolateral and anteroposterior directions were recorded (2D load) separately because we thought that these would be a good reflection of lateral changes of direction and stopping hard, respectively.

Statistical Analysis

A paired-sample *t* test with a significance level of $P < .05$ was used for each of the 3 comparisons. To determine the effect of density, games 1 and 2 were compared. The effect of player number was determined by comparing games 1 and 3, and the effect of the rule change was ascertained by comparing games 1 and 4. To determine the magnitude of difference between the SSGs, effect size (ES) calculations were performed. The descriptive terms associated with ES were 0.0 to 0.19 *trivial,* 0.2 to 0.59 *small,* 0.6 to 1.19 *moderate,* 1.2 to 1.9 *large,* and 2.0 to 4.0 *very large*.[20]

Results

Descriptive statistics (mean ± SD), minimum and maximum values, paired *t* test, and ES for the notational video analysis, GPS, and accelerometer variables measured for each comparison are shown in Table 2, 3, and 4. The interrater reliability for total number of agility events was a moderate level of agreement (ICC = .60) between researchers over 20 players analyzed.

Effects of Changing Density

Game 1 had slightly more agility maneuvers per player, but the difference was small and not statistically significant ($P > .05$). Game 2 involved player movements over greater speeds and total distance ($P < .05$). The 3D player load was moderate, in favor of game 1 (ES = 0.83), while the 2D player load was significantly greater for game 2 ($P < .05$, ES > 1.2).

Effects of Changing Player Number

The reduction in players in game 3 (3-a-side) produced a moderate (ES = 0.60) increase in the total number of agility maneuvers in comparison with the larger number of players (game 1, 5-a-side). However, the difference was small and not statistically significant ($P > .05$). In addition, players produced a substantially greater 3D ($P < .05$, ES = 1.53) and 2D ($P > .05$, ES = 1.44) player load when the number of players was reduced.

Effects of a Rule Change

The implementation of a 2-handed-tag rule showed a somewhat trivial decline in both the number of agility maneuvers and 2D player load recorded in game 4. However, a significant increase ($P < .05$) in the number of disposals did result due to the rule modification (Table 4).

Variability in SSGs

Large differences between the minimum and maximum values during all games for the notational video analysis, GPS, and accelerometer variables were found. For example, in game 1 one player performed a maximum total of 2 agility maneuvers, while another player performed 15.

Discussion

Although the interrater reliability was only moderate, this was not considered a problem for the purposes of this study because both raters reported a similar changes between the games—that is, greater agility demand in game 1. The following section will discuss the effect of density by comparing games 1 and 2, the effect of player number by comparing games 1 and 3, and the effect of the rule change by comparing games 1 and 4.

Effects of Changing Density

As density increased (game 1), so did the total number of agility maneuvers performed per player. This was due to a combination of more agility events occurring in attacking, defending, and off-the-ball situations. Therefore, to some extent, a greater agility demand was placed on players involved in the denser playing field. A possible explanation is that players are forced to consider the relative position of more opponents, within a confined area, before making a decision to move. This appeared to be the case as players in game 1 disposed of the ball more frequently, supporting earlier research in soccer that stated that increasing the density in SSGs allows for a greater player involvement with or without the ball.[21]

In game 2, player movement patterns (eg, average speed) were similar to those previously found for forwards and defenders during competition.[22] This was expected, as the larger area and lower player density of game 2 would allow players to spend a greater percentage of the game performing fast running and sprinting actions. This attributed to a higher vertical component and greater 3D player load. In contrast, a greater 2D player load, as expected, was found in the smaller area and denser field of game 1.

Game 2 had moderately greater 3D player load (ES = 0.82). It is likely that 3D player load is strongly influenced by the vertical component because of the foot strikes involved in running. Therefore, by removing

Table 2 Video Notation, GPS, and Accelerometer Data Analysis for Games 1 and 2

	Game 1			Game 2			Comparisons	
Variable	**Mean ± SD**	**Min**	**Max**	**Mean ± SD**	**Min**	**Max**	***P***	**Effect size**
Video notation, total n								
attacker agility maneuvers	2.7 ± 2.0	0.0	6.0	2.7 ± 1.6	0.0	5.0	1.000	0.00 (trivial)
defender agility maneuvers	3.1 ± 1.9	1.0	8.0	2.4 ± 1.3	1.0	5.0	.421	0.43 (small)
off-the-ball agility maneuvers	3.0 ± 1.7	1.0	5.0	2.1 ± 1.1	1.0	4.0	.134	0.63 (moderate)
agility maneuvers	8.8 ± 4.1	2.0	15.0	7.2 ± 1.3	5.0	10.0	.229	0.53 (small)
deceptive actions	0.1 ± 0.3	0.0	1.0	0.3 ± 0.5	0.0	1.0	.343	0.49 (small)
disposals (handballs)	3.6 ± 1.4	2.0	6.0	2.6 ± 1.0	1.0	4.0	**.042**	0.82 (moderate)
attacker tackled	2.5 ± 1.4	1.0	5.0	1.8 ± 1.7	0.0	6.0	.298	0.45 (small)
defender tackles	2.7 ± 1.3	1.0	5.0	1.9 ± 1.4	0.0	5.0	.168	0.59 (small)
GPS and accelerometer								
distance (m)	200.9 ± 25.8	132.0	228.0	265.3 ± 28.3	218.0	301.0	**.000**	**2.38 (very large)**
total 3D player load (a.u.)	25.2 ± 2.6	21.8	29.2	27.5 ± 3.0	22.3	32.4	.121	0.82 (moderate)
2D player load (a.u.)	10.7 ± 2.4	7.4	14.6	8.3 ± 1.4	6.3	10.9	**.010**	**1.22 (large)**
maximum speed (km/h)	19.2 ± 1.0	17.6	21.1	23.4 ± 2.3	18.9	26.1	**.000**	**2.37 (very large)**
average speed (m/min)	87.7 ± 11.1	58.0	99.0	115.3 ± 12.4	95.0	130.0	**.000**	**2.35 (very large)**
% walking/jogging (0–14.99 km/h)	87.7 ± 3.0	82.2	91.1	74.3 ± 13.3	49.5	89.7	**.009**	**1.39 (large)**
% running/fast running (15–19.99 km/h)	11.7 ± 2.9	6.4	16.7	15.1 ± 7.1	4.5	25.7	.024	0.63 (moderate)
% sprinting (20–36 km/h)	0.7 ± 1.4	0.0	4.0	10.6 ± 8.7	0.0	29.6	**.003**	**1.59 (large)**
% hard deceleration (–3 to –8 m/s^2)	2.4 ± 1.2	1.0	5.0	2.3 ± 1.1	0.8	4.2	.902	0.09 (trivial)
% moderate deceleration (–1 to –3 m/s^2)	11.8 ± 7.1	7.7	31.7	10.9 ± 7.2	5.1	31.0	.801	0.13 (trivial)
% low acceleration or deceleration (–1 to 1 m/s^2)	72.1 ± 8.1	51.5	83.0	73.5 ± 6.2	59.2	81.3	.672	0.19 (trivial)
% moderate acceleration (1–3 m/s^2)	10.9 ± 2.4	6.7	14.8	11.0 ± 3.1	6.3	15.9	.946	0.04 (trivial)
% hard acceleration (3–8 m/s^2)	2.8 ± 0.9	1.5	4.1	2.3 ± 1.5	0.9	4.8	.466	0.40 (small)

Abbreviations: a.u. indicates arbitrary units; 3D, 3-dimensional; 2D, 2-dimensional. *P* of <.05 or effect size >1.2 (large to very large) listed in bold.

Table 3 Video Notation, GPS, and Accelerometer Data Analysis for Games 1 and 3

Variable	Game 1			Game 2			Comparisons	
	Mean ± SD	Min	Max	Mean ± SD	Min	Max	*P*	Effect size
Video notation, total n								
attacker agility maneuvers	2.5 ± 2.1	0.0	6.0	3.7 ± 2.7	0.0	8.0	.328	0.50 (small)
defender agility maneuvers	2.5 ± 0.8	1.0	8.0	4.0 ± 3.8	1.0	11.0	.443	0.55 (small)
off-the-ball agility maneuvers	3.3 ± 1.6	1.0	5.0	3.7 ± 1.8	1.0	6.0	.771	0.23 (small)
agility maneuvers	8.3 ± 3.6	2.0	15.0	11.3 ± 6.1	4.0	21.0	.421	0.60 (moderate)
deceptive actions	0.2 ± 0.4	0.0	1.0	0.0 ± 0.0	0.0	1.0	.363	0.71 (moderate)
disposals (handballs)	3.5 ± 1.4	2.0	6.0	3.8 ± 1.9	1.0	7.0	.801	0.18 (trivial)
attacker tackled	2.5 ± 1.8	1.0	5.0	2.5 ± 1.6	1.0	5.0	1.000	0.00 (trivial)
defender tackles	2.7 ± 1.0	1.0	5.0	3.2 ± 1.5	2.0	5.0	.542	0.39 (small)
GPS and accelerometer								
distance (m)	191.2 ± 29.0	132.0	228.0	195.7 ± 26.7	167.0	231.0	.828	0.16 (trivial)
total 3D player load (a.u.)	24.8 ± 2.0	21.8	29.2	28.6 ± 2.9	25.2	32.2	**.020**	**1.53 (large)**
2D player load (a.u.)	10.6 ± 2.7	7.4	14.6	13.9 ± 1.8	11.1	16.0	.086	**1.44 (large)**
maximum speed (km/h)	19.2 ± 1.3	17.6	21.1	18.9 ± 1.6	16.4	20.9	.804	0.21 (small)
average speed (m/min)	83.5 ± 12.5	58.0	99.0	86.3 ± 11.7	74.0	102.0	.752	0.23 (small)
% walking/jogging (0–14.99 km/h)	88.0 ± 3.2	82.2	91.1	91.3 ± 4.0	86.8	96.7	.204	0.91 (moderate
% running/fast running (15–19.99 km/h)	10.9 ± 2.7	6.4	16.7	8.0 ± 3.1	3.3	11.4	.131	1.00 (moderate)
% sprinting (20–36 km/h)	1.1 ± 1.7	0.0	4.0	0.8 ± 1.2	0.0	2.7	.760	0.20 (small)
% hard deceleration (–3 to –8 m/s^2)	2.2 ± 0.8	1.0	5.0	3.1 ± 0.8	2.1	4.3	.197	1.13 (large)
% moderate deceleration (–1 to –3 m/s^2)	9.7 ± 1.1	7.7	31.7	10.3 ± 1.5	7.8	11.8	.259	0.46 (small)
% low acceleration or deceleration (–1 to 1 m/s^2)	7 3.2 ± 2.3	51.5	83.0	72.4 ± 1.0	71.2	73.9	.497	0.45 (small)
% moderate acceleration (1–3 m/s^2)	11.6 ± 2.1	6.7	14.8	10.2 ± 2.6	6.6	13.4	.232	0.59 (small)
% hard acceleration (3–8 m/s^2)	3.3 ± 0.7	1.5	4.1	4.2 ± 1.3	2.8	5.7	.257	0.86 (moderate)

Abbreviations: a.u. indicates arbitrary units; 3D, 3-dimensional; 2D, 2-dimensional. *P* of <.05 or effect size >1.2 (large to very large) listed in bold.

Table 4 Video Notation, GPS, and Accelerometer Data Analysis for Games 1 and 4

	Game 1			Game 2			Comparisons	
Variable	Mean ± SD	Min	Max	Mean ± SD	Min	Max	*P*	Effect size
Video notation, total n								
attacker agility maneuvers	2.5 ± 2.1	0.0	6.0	2.3 ± 1.2	0.0	4.0	.872	0.12 (trivial)
defender agility maneuvers	2.5 ± 0.8	1.0	8.0	2.0 ± 0.9	1.0	5.0	.296	0.59 (small)
off-the-ball agility maneuvers	3.3 ± 1.6	1.0	5.0	3.5 ± 2.6	1.0	8.0	.867	0.09 (trivial)
agility maneuvers	8.3 ± 3.6	2.0	15.0	7.8 ± 2.6	4.0	12.0	.795	0.16 (trivial)
deceptive actions	0.2 ± 0.4	0.0	1.0	0.5 ± 0.5	0.0	1.0	.363	0.66 (moderate)
disposals (handballs)	3.5 ± 1.4	2.0	6.0	5.5 ± 1.4	3.0	9.0	**.041**	**1.43 (large)**
attacker tackled	2.5 ± 1.8	1.0	5.0	0.8 ± 1.0	0.0	3.0	.093	1.17 (moderate)
defender tackles	2.7 ± 1.0	1.0	5.0	1.8 ± 0.4	0.0	3.0	.141	1.18 (moderate)
GPS and accelerometer								
distance (m)	191.2 ± 29.0	132.0	228.0	233.8 ± 25.4	204.0	266.0	.074	**1.56 (large)**
total 3D player load (a.u.)	24.8 ± 2.0	21.8	29.2	25.8 ± 3.4	21.1	38.1	.521	0.36 (small)
2D player load (a.u.)	10.8 ± 0.8	9.5	12.7	11.2 ± 1.5	9.2	16.5	.565	0.33 (small)
maximum speed (km/h)	10.6 ± 2.7	7.4	14.6	10.2 ± 2.1	5.9	12.8	.739	0.17 (trivial)
average speed (m/min)	19.2 ± 1.3	17.6	21.1	17.5 ± 1.4	15.4	19.7	.060	**1.26 (large)**
% walking/jogging (0–14.99 km/h)	83.5 ± 12.5	58.0	99.0	102.3 ± 13.2	88.0	119.0	.066	**1.46 (large)**
% running/fast running (15–19.99 km/h)	88.0 ± 3.2	82.2	91.1	88.6 ± 5.5	83.8	96.6	.767	0.13 (trivial)
% sprinting (20–36 km/h)	10.9 ± 2.7	6.4	16.7	11.0 ± 5.2	3.4	16.2	.968	0.02 (trivial)
% hard deceleration (–3 to –8 m/s^2)	2.2 ± 0.8	1.0	5.0	1.9 ± 0.8	0.9	3.0	.583	0.38 (small)
% moderate deceleration (–1 to –3 m/s^2)	9.8 ± 1.1	7.7	31.7	8.8 ± 0.5	8.0	12.6	.087	1.17 (moderate)
% low acceleration or deceleration (–1 to 1 m/s^2)	73.2 ± 2.3	51.5	83.0	76.9 ± 2.0	74.0	80.5	**.010**	**1.66 (large)**
% moderate acceleration (1–3 m/s^2)	11.6 ± 2.1	6.7	14.8	9.8 ± 1.3	8.0	13.1	**.028**	1.03 (moderate)
% hard acceleration (3–8 m/s^2)	3.2 ± 0.7	1.5	4.1	2.8 ± 1.1	1.4	5.0	.594	0.43 (small)

Abbreviations: a.u. indicates arbitrary units; 3D, 3-dimensional; 2D, 2-dimensional. *P* of <.05 or effect size >1.2 (large to very large) listed in bold.

the vertical component, the 2D player load should be a better reflection of agility demands. The data presented here provide indirect evidence that a significantly greater 2D player load is accumulated in a denser playing field ($P < .05$, ES > 1.2) and a somewhat greater reflection of hard accelerations, decelerations, and lateral COD. This highlights the difference between these 2 player's load measures and the ability to distinguish between different movement demands for SSGs. Furthermore, it illustrates the potential of using the built-in accelerometer (100 Hz) in GPS units to quantify the demands of SSGs and to provide a player load value that reflects agility demands. This is because agility maneuvers occur often in a confined space, over a short period of time, and with a number of players in the vicinity of the ball. It is possible that important movement patterns may have been missed by the GPS units (5 Hz) and therefore they failed to provide a true reflection of the game.[17,23]

Effects of Changing Player Number

When the number of players was reduced to 3-a-side in game 3, a moderate increase in the total number of agility maneuvers was found. This suggests that having fewer players in an SSG, when all other variables remain constant, slightly increases the agility demand. A possible reason for this is that players may become more involved, due to regular contact with the ball,[24] and by restricting the number of possessions per player a more even training stimulus is created.[25] The disposal of the ball requires the ball carrier to respond to movements of his teammates who are creating space to receive the ball while trying to avoid the opposition. Greater involvement around the ball may increase the agility load on players.

Similar to previous reports in soccer, total distance and speeds covered by players in both games 1 and 3 were quite similar.[12] This suggests that a reduction in player numbers had little effect on the overall movement demands of the games. In contrast to this, players in game 3 recorded somewhat greater 2D and 3D player loads. This discrepancy can be explained by the fact that the GPS units used for this study (5 Hz) may not have been sensitive enough to pick up the higher acceleration, deceleration, and lateral directional movements recorded by the built-in accelerometer (100 Hz).

Effects of a Rule Change

Recent studies have shown that rule changes can be a simple and effective procedure to manipulate the overall intensity and movement demands in soccer.[12] It was thought that implementing a 2-handed-tag rule (game 4) would encourage players to be more evasive. For instance, players often allow themselves to be tackled in a game of AF by "riding" the tackle, to dispose of the ball to a teammate in the space that has been created. It was thought that the 2-handed-tag rule would reduce this behavior and players would be more likely to take on the direct opponent, resulting in a greater need to perform an agility maneuver and maintain possession of the ball.

However, results showed that the rule modification did not produce a greater number of agility maneuvers when the playing area, density, and number of players remained constant. In fact, there was a somewhat trivial decline ($P > .05$, ES = 0.16) in the total number of agility maneuvers compared with game 1. This was also supported by the average 2D player load for each player showing a trivial decline in SSG 4 as a result of the rule change. Furthermore, players involved in game 4 spent a greater percentage of time performing low-acceleration and -deceleration movements ($P < .05$, ES > 1.2), while, conversely, players in game 1 spent a small to moderately greater time performing moderate to hard accelerations and decelerations. This demonstrates again that the rule change may have been ineffective in producing a greater agility demand.

An interesting finding was a moderate increase (ES = 0.66) in deceptive maneuvers used by attacking players trying to disguise their intended movement. Although this finding was not significant ($P > .05$), it does support previous assumptions[5,26] that SSGs have the potential to assist in the development of perceptual and decision-making skills. Moreover, this demonstrates that there may have been greater cognitive stress placed on players to make rapid decisions about whether to dispose of the ball or attempt an agility maneuver and take on their opponent to avoid being tagged. These events are specific to the nature of AF, and although the agility volume was shown to be quite low for these 2 games, movements were very specific to the sport and cannot be replicated in planned COD-speed training.

In spite of game 4's producing a somewhat lighter agility load, players did cover greater distances and average speed (ES > 1.2) as a result of the rule change. The 2-handed-tag rule appeared to create a faster style of play, with a greater number of handballs ($P < .05$, ES > 1.2) where players worked harder off the ball to get into position to provide an option for their teammate. However, this faster style of play did not allow players to reach similar maximum running velocities or similar time spent performing fast running and sprinting movements observed in competition ($P < .05$, ES > 1.2). Therefore, this suggested that the rule change is more beneficial for placing players under a great time stress to make quick decisions to dispose of the ball, contributing to the slightly fewer agility maneuvers observed.

Variability in SSGs

A secondary aim of this study was to determine the variability between individual players in each game. To the our knowledge, this is the first study to quantify the variability in agility demands in SSGs. Previous research has shown that sport-specific training allows a greater transfer from training to competition.[27] Regardless of the specificity of SSGs, skill development is considered to strongly depend on repetition.[28] It was found that in all 4 games, a relatively low agility demand was produced and at least 1 player may have been underloaded. As a result, the agility demand may not have been suitable for agility improvements to occur. For example, in games 1 and 2 a certain player performed a maximum of 5 and 2 agility maneuvers, respectively, while in the same game another player performed a maximum of 10 and 15 maneuvers, respectively. A similar trend was found between the minimum and maximum values in the GPS and accelerometer data for individuals.

Previous studies have shown that coaches have greater control over the intensity of the game, in general, when fewer players are involved.[7,8,29] It might be expected that game 3 (involving 3-a-side) would reduce the likelihood of any individual performing a relatively low work output, compared with a game involving more players, 5-a-side (game 1), with the same player density. This was not supported by the results since game 3 produced a larger range in total number of agility maneuvers (min = 4, max = 21). This supports previous suggestions[2,4] that a limitation of SSGs is their failure to provide an adequate training overload for all individuals. A logical method for overcoming this variability is through the coach. It has been shown that when players receive consistent coaching and direct supervision during practice, the overall training quality improves due to more contact with the ball and increased training intensity.[8,30]

In spite of the large variability, the quality of the agility maneuvers should be taken into account. There was a fairly equal spread of attacking, defending, and off-the-ball agility maneuvers in all games, resulting in players were exposed to a variety of evasive and deceptive movements all in a single game. Nevertheless, from a practical perspective, the difference between the minimum and maximum values was considerable for all games.

There was a meaningful difference in AFL senior game experience between the participants: 8 players had played 18 or fewer games, and 1 player had yet to play a senior game. Furthermore, players of different positional groups—backs, forwards, and midfielders—were all involved in each SSG. Previous research has shown that conditioning for rugby and AF should reflect the different positional running demands observed in competition.[6,19] Equal allocation of backs, forwards, and midfielders in each team and matching players of similar physical attributes and playing abilities increases the potential for an even agility demand for all individuals.

Practical Applications

- SSGs can be used to create a suitable agility demand for AF, but game characteristics should be thoughtfully designed.
- SSGs that are performed in a relatively small area with few players per team are likely to provide a suitable agility demand.
- Coaches are encouraged to modify rules to further enhance agility demands.
- Coaches should provide encouragement and supervision to players in an attempt to maximize involvement from all players.

Conclusions

Collectively, the current results show that density, player number, and rule changes can influence the agility demands in AF. High variability between individuals is a current limitation of SSG training. Implementing rules such as limiting players to a minimum number of possessions could overcome players performing a low work output and allow them to achieve a minimum agility demand to overload all players.

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