Examining the Effect of Reduced Action Capabilities on Defensive Anticipation in a 1-vs-1 Task

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ABSTRACT

This study used small-sided games (SSGs) to induce fatigue and therefore, reduce the action capabilities of British Varsity soccer players (*n* = 20). The aim was to examine the effect of compromised action capabilities on the defensive movement response of players in a 1 vs 1 scenario. Action capabilities were assessed via countermovement jumps (CMJ), 5-m acceleration, 20-m sprint and a pre-planned Change of Direction (COD) Test. Defensive movement response was measured via a Soccer-Specific Anticipation Test (SSAT), which required players to anticipate the change of direction of an attacking player. Following the SSGs fatigue intervention, significant reductions were observed in jump (p = .04, d = .31), acceleration (p <.001, d = .98), and sprint (p < .001, d = .66) performance. Significantly, players tended to move earlier in the SSAT following the SSGs fatigue intervention than they had before the SSGs (p = .049, d = .66). Furthermore, to examine the distinct effect of reductions in each action capability, players were categorised according to whether the SSGs fatigue intervention had a worthwhile change in CMJ, acceleration, sprint or pre-planned COD. For each of the four measures, defensive movements tended to be initiated earlier following the SSGs fatigue intervention; although pre-/post-SSGs differences were not significant (p = .08-.51), moderate to large effect sizes were shown (d = .56-.84). The findings of this study intimate that reductions in action capabilities influence the timing of the movement response of defensive players in 1-vs-1 situations.

Keywords

Small-sided games, anticipation, action capabilities, representative design

INTRODUCTION

Soccer comprises of multiple 1-vs-1, attacker vs defender, interactions (Duarte, et al., 2012) and such interactions are not simply limited to instances when the attacker is in possession of the ball. In fact, most interactions do not involve the ball (Link & Hoernig, 2017). For example, 1-vs-1 encounters are a feature of corners, free-kicks and throw-ins, as well as general game play where attackers will attempt to evade defenders with the intention to gain or maintain possession of the ball. An extensive body of work has investigated the interpersonal coordination tendencies that emerge within attacker-defender interactions (Duarte, et al., 2010a). Soccer research has attributed successful defensive performance to defenders being able to adopt postures that actively influence an opponent's actions towards areas of the pitch that make it easier to recover possession of the ball (e.g., areas on the pitch where other defenders are positioned) (Duarte et al., 2012).

The defence-centred view of 1-vs-1 situations considered above compliments an extensive body of anticipation research, which has demonstrated how skilled players reduce their susceptibility of deception, when having to base their responses on information from an opponent's movements (Brault, Bideau, Kulpa, & Craig, 2012; Dicks, Button, & Davids., 2010). Specifically, recent research has begun to examine how experts control the timing of actions so that they arrive in the right place at the right time during 1-vs-1 anticipatory situations (van der Kamp, Dicks, Navia & Noel, 2018). In scenarios when a defender is susceptible to deceptive attacking actions, such as anticipating the direction change of an attacker, there is empirical evidence to suggest that moving later is associated with better performance (e.g., see Triolet et al., 2013 [tennis]). One interpretation of this finding is that this allows defenders the temporal capacity to utilise the most reliable and "honest" kinematic information, which emanates late in the opponent's movement, and thus limits the potential for deception (Brault et al., 2012; Dicks, Davids, & Button, 2010; van der Kamp, Dicks, Navia, & Noel., 2018; Wilson, Dicks, Milligan, Poolton & Alder., 2019). For instance, in rugby union, skilled defenders waited significantly longer than novices before initiating movement in a 1-vs-1 anticipation task and made significantly fewer anticipatory errors (Brault et al., 2012). Likewise, real-time soccer research on the 1-vs-1 interaction of a penalty kick (Dicks, Davids, & Button., 2010; Navia, Dicks, van der Kamp, & Ruiz., 2017), has shown that goalkeepers who base their dive direction on kinematic information emanating from the taker early in the movement (e.g., hip orientation during the run up) tend to have reduced response accuracy (Dicks, Davids, et al., 2010). However, goalkeepers who attend to information emanating later in the action (e.g., non-kicking foot placement) increase the likelihood of penalty save success (Dicks, Davids, et al., 2010; Navia et al., 2017).

The finding that successful anticipation appears to be associated with later movement times has been interpreted relative to an affordance-based account of expertise (Fajen, 2005; van der Kamp et al., 2018). According to this view, if response times are calibrated, then the timing of movements will be scaled relative to a performer's action capabilities. Thus, an individual's action capabilities co-determine the spatiotemporal demands of a given situation (Dicks et al., 2019). Physical action capabilities, such as change of direction ability (Dicks, Davids, et al., 2010; Brault et al., 2012) and power (Wilson et al., 2019) appear to influence anticipation skill. Support for such a suggestion was recently reported by Mecheri et al. (2019) who found that the superior *leg stiffness* of world-class tennis players contributed towards their better serve-return performance. Increased leg stiffness enables greater energy return at ground contact and enhances actions that require direct stretch-shortening cycle contributions, and these actions are usually performed under severe temporal constraints. Mecheri and colleagues (2019) concluded that increased leg stiffness may enhance serve-return performance, by affording players the option to delay their movement response and base their actions on later, more reliable information, such as ball flight. Such findings strengthen claims that action capabilities are scaled to response times and therefore, play a critical role in anticipation accuracy (Dicks, Davids, et al., 2010; Witt, Linkenauger, & Wickens, 2016; Mecheri et al., 2019; Wilson et al., 2019).

The relationship between action capabilities and initiation of movement in 1-vs-1 situations in soccer has been tested by administering interventions designed to enhance player action capabilities (Wilson et al., 2019). In the study of Wilson et al., skilled youth soccer players were assigned to either a change of direction (COD) or small-sided games (SSG) intervention. Initiation of movement was measured via a soccer-specific anticipation test (SSAT). The COD and SSG interventions resulted in an overall improvement in countermovement vertical jump (CMJ) performance. Moreover, this improvement in action capability was correlated with a delay in movement initiation in the SSAT. That is, in the context of a 1-vs-1 scenario, enhanced action capabilities were scaled to the situation, resulting in defenders moving later when anticipating the actions of an attacking player (Wilson et al., 2019; see also Brault et al., 2012; Dicks, Davids, et al., 2010).

Although Wilson et al. (2019) revealed that changes in action capabilities can be recalibrated over a 6-week time-frame, it is likely to be more prevalent that recalibration is required in sport across a shorter time-frame of minutes (e.g., during a game), with acute fatigue a common cause of changes in action capabilities (Krustrup et al., 2006; Krustrup, Zebis, Jensen, & Mohr, 2010; Oliver, Armstrong, & Williams, 2008). From a physical and technical perspective, it has long been acknowledged that fatigue has a detrimental effect on soccer performance (Mohr, Krustrup, & Bangsbo, 2003; Rampinini, Impellizzeri, Castagna, Coutts, & Wisloff, 2009; Reilly, Drust, & Clarke, 2008). For instance, fatigue reduces the sprint capabilities of both male (Krustrup et al., 2006), and female (Krustrup et al., 2010) soccer players, as well as the jump height of youth soccer players (Oliver 6, et al., 2008). If action capabilities are scaled to anticipation response times, it stands to reason that a reduction in action capabilities arising from prolonged task execution, will result in defensive players in a 1-vs-1 task making earlier responses, which may potentially lead to a decrease in anticipation accuracy (Brault et al., 2012). This study was designed to test this hypothesis. The primary aim was to reduce the action capabilities of soccer players in order to examine the acute effect on their defensive movement response in a 1-vs-1 scenario. It was hypothesised that fatigue would cause a holistic reduction in action capabilities, which would lead to the initiation of an earlier response to an attacker's change of direction (Dicks et al., 2019). A secondary aim of this study was to identify the task-specific action capability variable that had the greatest impact on movement initiation in a 1-vs-1 anticipation scenario.

METHODS

Participants

Twenty British male first-team varsity outfield soccer players (mean ± *SD*: age: 19.5 ± 1.5 years, mass: 73.4 ± 6.7 kg, and height 1.79 ± 0.06 m) were recruited for the study. Players averaged over 12 years playing experience (mean ± *SD:* 12.3 ± 2.4 years), most of which had previously played academy soccer for a professional club (*n* = 13). The players train twice weekly and compete in the top tier of the British University league system. The local university ethics board granted ethical approval (LB43566).

Tests and Intervention

Action Capability Assessments: Testing took place in the morning and players were advised to eat breakfast 2-hours prior to taking part in the study. However, food intake prior to taking part was not controlled. All players reported that the action capability assessments were equivalent to testing conditions that they had previously encountered. Despite this, prior to the testing sessions, all players underwent a process of self-paced familiarisation. A countermovement vertical jump (CMJ) was utilised to assess dynamic leg power. Jump height (cm) was measured using a Myotest accelerometer (Myotest SA, Sion, Switzerland), which has high reliability of repeated measures (ICC = 0.86; Bubanj et al., 2010). Three CMJ's were completed immediately after a 10-minute standardised warm-up. Players were instructed to keep their hands on their hips at all times and were permitted a 15-second recovery period between jumps. Following this, three 20-m sprints were performed, with the first 5-m acceleration split recorded (ICCs; 0.89-0.95; Moir, Button, Glaister & Stone, 2004) (Brower Timing Systems, Utah, USA). COD capabilities were assessed via a pre-planned COD test. This required players to run forward 2-m and make a pre-determined 90° change of direction and then run to a 5-m endpoint (Brower Timing Systems, Utah, USA). The pre-planned route of the COD test was designed to mimic the movements required in the soccer-specific anticipation test (SSAT, see below). The players performed both left (n = 3) and right (n = 3) trials. The dependent variable of interest for the sprint and COD test was the fastest recorded time (s), for acceleration it was (m/s^2), whereas for the CMJ it was the highest jump recorded (cm).

Soccer-Specific Anticipation Test (SSAT): Anticipation was tested via a SSAT, which was adapted from a basketball anticipation test with a human stimulus, which has acceptable test-retest reliability (ICC = 0.89–0.99, Scanlan, Humphries, Tucker, & Dalbo, 2014). The test mimicked the typical responses required by defenders during corners, throw-ins and free-kick situations. Players responded to the movement initiation and directional changes of a *tester*. Players were required to move towards the tester and then match the direction taken by the tester. Once the direction change had been initiated, both the tester and the player were asked to race to the end, which was 5-m in either direction, see Figure 1. The tester was instructed by the lead investigator as to the required direction change prior to each trial and was asked to initiate the change in direction within a 6-m zone. The tester was not permitted to purposely deceive the player**.** The temporal and spatial constraints were such that in order to be successful, the players almost certainly had to initiate a response before the tester planted his outside foot to change direction. A pilot study (players; n = 10*)* found that players were successful in 49/300 trials and in all but 6 successful trials, the players initiated a response prior to the tester planting his outside foot to change direction (*Mdn* = -0.10 s, IQR = 0.08 s). Players completed six familiarisation trials and the SSAT comprised of six experimental trials. Each player also participated in the study as a tester. All trials were recorded on a high-speed camera (Fastec TS3, California, USA) at a frame rate of 240 Hz. Initiation movement time (IMT) was determined as the time interval from the first identifiable foot contact initiating directional change of the tester, until the first identifiable foot contact initiating the response of the participant (Gabbett, Kelly, & Sheppard, 2008). A positive value was recorded if the moment of initiation occurred after the first identifiable foot contact of the tester and negative value was recorded if initiation occurred before the first identifiable foot contact of the tester. As a result of the intermittent implementation of post-SSAT (see procedures below), to mitigate the effect of spurious trials the median IMT of the 6 SSAT trials was considered the best representation of central tendency. Video analysis was performed by the lead investigator who randomly re-analysed 250-trials from a 680-trial sample of pilot data and a high degree of reliability was found (ICC = 0.80–0.89).

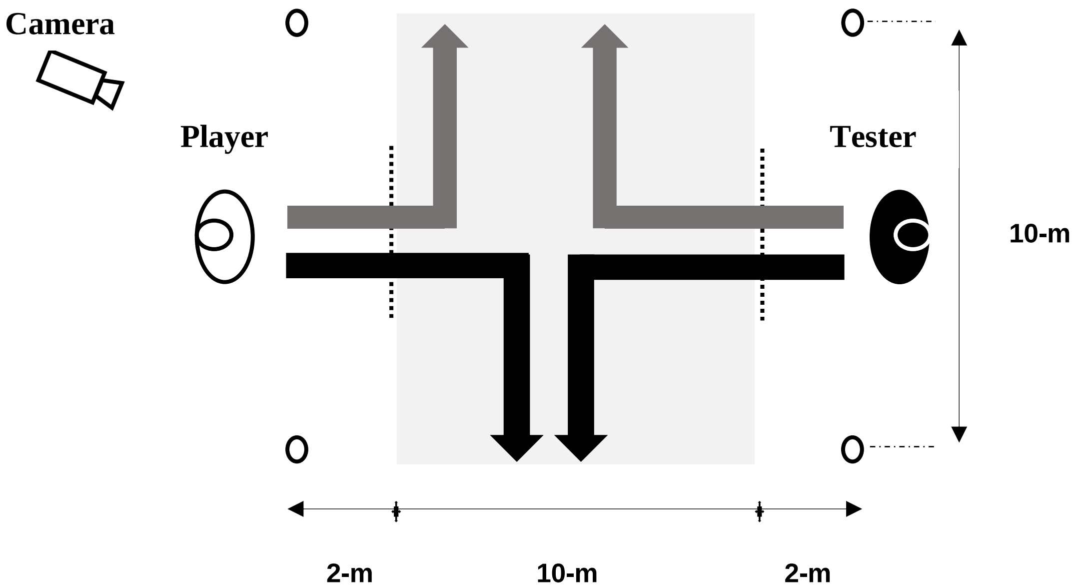

Figure 1. Soccer-Specific Anticipation Test. Shaded area denotes 6-m change of direction zone.

S*mall-Sided Games (SSGs) Fatiguing Intervention*: Research has revealed that soccer-specific variables, such as decelerations, changes of direction, backwards running, jumping, kicking, tackling and contacts all likely contribute to match-induced fatigue (Nedelec et al., 2012, 2013; Rampinini et al., 2011). Small-sided games (SSGs) include all aforementioned variables and can be considered a representative fatiguing protocol. Exercise intensity of SSGs is increased with the reduction in player number and increase in relative pitch area (Hill-Haas et al., 2011). Therefore, with the aim of reducing the physical action capabilities of the players, the SSGs fatigue intervention comprised of six x 2 minutes of a 2-vs-2 game format on a 30 x 20 m pitch, which was adapted from the 35 x 25 m, 3-vs-3 game format employed by Impellizzeri et al. (2006)[1].

[1] The intensity of the small-sided games (SSG) protocol was measured in accordance with recommendations (Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011), via a combination of internal and external measures. Heart rate (HR_{Mean} %) for each SSG was captured via Polar team monitoring system (Kempele, Finland). Perceived exertion was captured using the Borg 20-scale (Borg, 1982) immediately after each SSG. To determine external load, time motion analysis data were collected using 10-Hz GPS units embedded with 100 Hz tri-axial

Procedure

This study employed a within-subject pre-/post-test design, in which the sample were tested in 5 groups of 4 players. An overview of the experimental procedure is presented in Figure 2. Prior to the SSGs fatigue intervention, players undertook all action capability assessments and completed 6 SSAT trials. The SSGs fatigue intervention phase comprised of SSGs that were intermittently followed by SSAT trials. An intermittent implementation of the post-SSAT was chosen because pilot testing found that the time taken to complete a set of six SSAT trials was highly likely to be sufficient for some players to effectively recover from the exertions of the SSGs; that is, players action capabilities might not have been compromised throughout the set of six SSAT trials. To reduce recovery time, games were divided into three parts, games 1-3 (SSGsA), games 4-5 (SSGsB) and game 6 (SSGsC). There was a one-minute recovery between games. Recovery between parts was dependent on the time taken for all players to complete two trials of the SSAT (*M* = 11.1 ± 1.1 min). Consequently, the post-SSGs IMT test trials were pooled (post-IMT). Following the final two SSAT trials, players repeated all action capability assessments.

1. Pre-SSGs Fatigue Intervention

CMJ (*n* = 3)

20-m Sprint/5-m Acceleration (*n* = 3)

COD Test (*n* = 6 [3 x left & 3 x right])

Soccer-Specific Anticipation Test (n = 6*)*

accelerometers (PlayerTek, UK), as recommended by Lacome, Simpson, Cholley, Lambert and Buchheit (2017). To determine external load for each SSG, the sum of accelerations and decelerations was used, which was defined as changes in velocity as >3 m/s. This was calculated along with total distance. This data is available from the lead author upon request.

2. SSGs Fatigue Intervention
SSGsA (2 min)
SSGsA (2 min)
SSGsA (2 min)
Soccer –Specific Anticipation Test (*n* = 2)
SSGsB (2 min)
SSGsB (2 min)
Soccer-Specific Anticipation Test (n = 2)
SSGsC (2 min)
Soccer-Specific Anticipation Test (n = 2)
3. Post-SSGs Fatigue Intervention
CMJ (n = 3)
20-m Sprint/5-m Acceleration (n = 3)
COD Test (n = 6 [3 x left & 3 x right])

Figure 2. Timeline of Experimental Protocol. SSGs = Small-Sided Games, CMJ = countermovement jump test, COD = change of direction, *n* = number of trials.

Statistical Analyses

To determine the player-specific effect of the SSGs as a fatigue intervention, the change in performance on each action capability test was assessed following recommendations for calculating the smallest worthwhile change (SWC) in physical performance tests (Hopkins, Marshall, Batterham, & Hanin, 2009). SWC was defined as a 5% performance reduction on a physical test (Turner et al., 2015). On examination of the data, it was apparent that the physical action capability of two players (11 & 20, see Table 1) was not compromised by the SSGs fatiguing protocol; that is, there was no evidence of a worthwhile reduction in CMJ, acceleration, sprint or COD performance. Therefore, these two players were removed from all statistical analyses.

Initial inspection of the distribution of the data (Boxplot, Histogram, Q-Q plot) showed that one player (9, see Table 1) was an extreme outlier for the crucial IMT measure pre-SSGs fatigue intervention. The extreme value of Player 9 was thoroughly investigated, and it was found most likely that the value was a result of measurement error. Consequently, the player was removed resulting in a final sample of 17 players. Shapiro-Wilk tests of normality confirmed that all action capability and initiation movement time dependent variables met assumptions of parametric tests.

The effect of the SSGs fatigue intervention on action capabilities was tested by a multivariate analysis of variance (MANOVA) that included each of the four measures of action capability and was followed by separate univariate tests of within-subject effects for each dependent measure. A paired-samples t-test was conducted to analyse the differences in IMT between pre-and-post SSGs. To examine the distinct effect of reductions in each action capability, players were selected for four separate paired-samples t-tests according to whether the SSGs fatigue intervention had a worthwhile change in CMJ, acceleration, sprint or pre-planned COD (i.e., *intervention responders*). All data are presented as mean ± *SD* and significance was accepted at $p \leq .05$ for all statistical tests. Effect sizes are reported as Cohen's *d*, with 95% confidence intervals (CI) of the observed effect calculated[2]. Effect sizes are interpreted according to Cohen's recommendations; small (0.2), moderate (0.5) and large (0.8).

Results

Action capability assessment

The MANOVA showed that the small-sided games (SSGs) fatigue intervention had a significant overall effect on the action capabilities of the sample (F (4, 13) = 5.067, p = .01,

[2] 95% confidence intervals (CI) were determined using the spreadsheet developed by Wuensch (2012) for calculation of the 95% CI of Cohen's *d* effect sizes for within-subject study designs.

η_p^2 = .60). Specifically, observation of the means and univariate analysis showed that compared to before the SSGs fatigue intervention: players countermovement jump (CMJ) tended to be lower (pre-SSGs fatigue intervention: *M* = 46.25 ± 4.53 cm; post-SSGs fatigue intervention: *M* = 44.85 ± 4.37 cm; *F* (1, 16) = 5.12, *p* = .04, *d* = .31, 95% CI [.07, 1.00]); players 5-m acceleration tended to be slower (pre-SSGs fatigue intervention: *M* = 4.19 ± .42 m/s^2); post-SSGs fatigue intervention: *M* = 3.97 ± .37 m/s^2); *F* (1, 16) = 13.74, *p* < .01, *d* = .98, 95% CI [.13, 1.09]); player 20m sprint time tended to be slower (pre-SSGs fatigue intervention: *M* = 3.09 ± .11 s; post-SSGs fatigue intervention: *M* = 3.17 ± .13 s; *F* (1, 16) = 17.54, *p* < .01, *d* = .66, 95% CI [.44, 1.53]); but change of direction (COD) test completion time was not different *(*pre-SSGs fatigue intervention: *M* = 4.30 ± .29 s; post-SSGs fatigue intervention: *M* = 4.28 ± .36 s; *F* (1, 16) = .18, *p* = .68, *d* = .06, 95% CI [-.32, .53]).

Initiation Movement Time (IMT)

Following the SSGs fatigue intervention, players tended to initiate movement significantly earlier in the soccer-specific anticipation test (SSAT) (pre: *M* = .18 s ± .05 s; post = *M* = .15 s ± .04, *t*(16) = 2.13, *p* = .049, *d* = .66, 95% CI [.00, .92]). Examination of the distinct effect of reductions in each action capability had on IMT showed a non-significant effect for players who showed reduced CMJ (*n* = 10, *t*(9) = 1.61, *p* = .14), 5-m acceleration (*n* = 15, *t*(14) = 1.88, *p* = .80), 20-m sprint (*n* = 15, *t*(14) = 1.49, *p* = .15) and COD (*n* = 6, *t*(5) = .70, *p* = .51) capabilities, respectively; however, all *intervention responders* initiated an earlier movement response following the SSGs (see Table 1, IR IMT). Moreover, effect sizes were moderate to large for all action capabilities (see Figure 3).

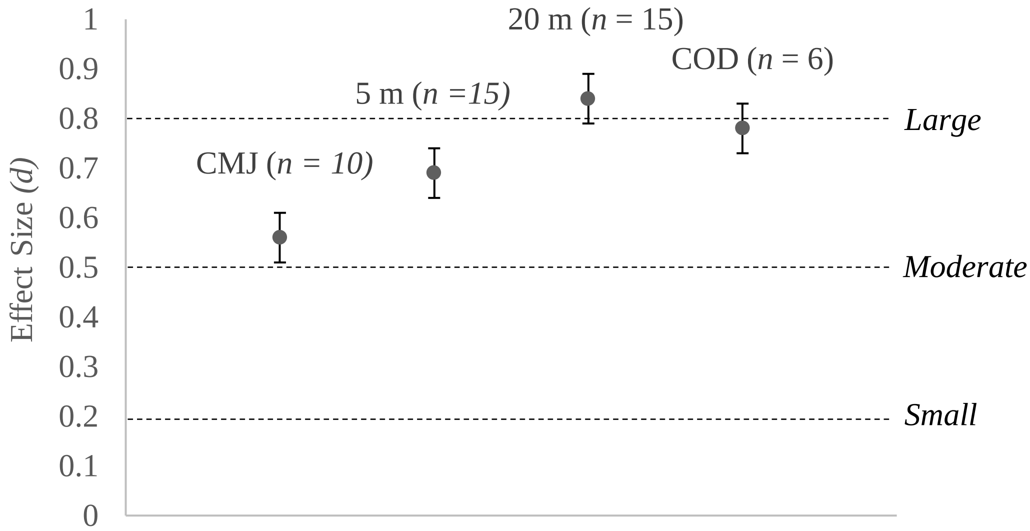

Figure 3. Effect Sizes for *intervention responders* to small-sided games on initiation movement time in a defensive 1-vs-1 scenario. Effect sizes are interpreted according to Cohen's recommendations; small (0.2), moderate (0.5) and large (0.8) effects. *n* = Number of *intervention responders*. 95% confidence intervals (CI) (CMJ [-0.11, .80], 5-m [-0.08, 1.43], 20-m [-0.12, .77], COD [-0.29, .58]).

Table 1. Individual physical and initiation movement time performance pre-and-post small-sided games. All reported as Mean ±

Player	CMJ (cm)		5-m (m/s^2)		20-m (s)		COD (s)		IMT (s)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	43.4	44.6	4.62	4.45	3.07	3.12	4.04	4.21	0.08	0.19
2	44.9	44.9	4.54	4.71	3.02	2.95	4.05	4.20	0.26	0.12*
3	45.6	44.9	4.21	4.06	3.05	3.05	4.39	4.40	0.21	0.12*
4	39.8	38.5	4.06	3.92	3.17	3.32	4.27	4.42	0.20	0.12*
5	43.4	44.1	4.62	3.72	3.14	3.15	3.99	3.81	0.16	0.10*
6	50.2	48.7	4.81	4.62	2.95	3.04	3.88	3.76	0.20	0.16*
7	55.0	52.6	4.13	4.45	2.97	3.03	4.20	4.12	0.20	0.22
8	42.7	42.0	4.37	3.30	3.04	3.33	4.18	4.19	0.20	0.14*
9	*49.4*	*47.1*	*3.30*	*3.78*	*3.08*	*3.25*	*4.28*	*4.24*	*-0.03*	*0.01*
10	41.3	39.6	3.59	3.42	3.32	3.38	4.46	4.46	0.20	0.25
11	*33.2*	*33.2*	*3.25*	*3.78*	*3.33*	*3.19*	*4.24*	*4.16*	*0.21*	*0.12**
12	44.9	40.5	4.37	3.92	3.02	3.05	4.15	3.77	0.23	0.20*
13	55.0	51.0	4.71	4.06	3.06	3.22	4.83	4.94	0.17	0.17
14	46.4	49.4	3.99	3.59	3.07	3.18	4.45	4.28	0.16	0.12*
15	43.4	37.1	4.13	3.59	3.33	3.38	5.00	5.15	0.17	0.13*
16	49.4	44.9	4.13	4.06	3.07	3.18	4.56	4.44	0.15	0.20
17	42.0	44.9	4.21	4.06	3.09	3.18	4.22	4.44	0.13	0.15
18	51.0	48.7	4.62	4.06	3.11	3.18	4.32	4.17	0.15	0.19
19	47.9	46.2	4.13	3.85	3.20	3.28	4.18	4.13	0.29	0.13*
20	*38.5*	*38.7*	*3.92*	*3.99*	*3.35*	*3.23*	*4.55*	*4.30*	*0.26*	*0.22**
IR	47.9 ± 4.80	44.9 ± 5.00	4.19 ± 0.42	3.97 ± 0.37	3.08 ± 0.10	3.18 ± 0.10	4.40 ± 0.30	4.56 ± 0.30	0.18 ± 0.04	0.15 ± 0.04
IR IMT	0.19 ± 0.04	0.17 ± 0.03	0.17 ± 0.04	0.16 ± 0.05	0.18 ± 0.04	0.15 ± 0.03	0.17 ± 0.05	0.14 ± 0.02		

Player 9 = initiation movement time outlier, italicised text = players excluded from statistical analysis, greyscale = responders, CMJ = countermovement vertical jump, 5-m = 5-m acceleration, 20-m = 20 m sprint, COD = change of direction test, IR = intervention responders, IR IMT = intervention responders, initiation movement time, IMT = initiation movement time, * = earlier movement initiation.

Discussion

This study used small-sided games (SSGs) with the aim of reducing the action capabilities of soccer players in order to examine the acute effect on their defensive movement response in a 1-vs-1 scenario. It was hypothesised that if players were fatigued as a consequence of SSGs, this would lead to a reduction in action capabilities. This would then in turn result in an initiation of an earlier movement response to an attacker's change of direction. In general, small-sided games (SSGs) compromised players jump (countermovement jump, CMJ), acceleration (over 5-m) and sprint speed (over 20-m). Furthermore, as hypothesised, the reduced action capabilities of the players led to the initiation of an earlier response to an attacker's change of direction in a 1-vs-1 scenario. This original finding reinforces claims that the timing of movement initiation is scaled relative to a defender's action capabilities (Dicks, Davids, et al., 2010; Brault et al., 2012; Wilson et al., 2019). Thus, a defender's action capabilities co-determine the spatiotemporal demands of 1-vs-1 scenarios and reduced action capabilities will likely have negative implications on the perception-action relationship (Dicks et al., 2019).

As a more stringent test of the hypothesis, players who showed action capability decrements, which satisfied smallest worthwhile change (-5% performance reduction) (Turner et al., 2015) in any of the four action capability assessments (CMJ, acceleration, sprint, COD) were classified as *intervention responders*. The subsequent analysis of IMT data for responders found pre-/post-SSGs effects. Specifically, large effects were observed for sprint and COD responders, moderate to large effects were observed for acceleration responders and moderate effects were observed for CMJ responders, showing all responder groups initiated an earlier movement response post-SSGs. Taken together, while the findings from this study were not conclusive, they do intimate that anticipation may be influenced by physical action capabilities, and thereby, further supports the suggestion that the timing of anticipation may be action-scaled (Dicks, Davids, et al., 2010; Wilson et al., 2018; Mecheri et al., 2019).

In soccer, fatigue will reduce physical action capabilities and disturb the motor system (Krustrup et al., 2010; Oliver et al., 2008). Given that reduced action capabilities seem to influence anticipatory processes, "getting used to the fatigue" (Brand & de Oliveira, 2017, p. 54) requires the rescaling of both the perceptual and motor system, and the ability to contend with such disturbances is associated with perceptual-motor re-calibration (Brand & de Oliveira, 2017). Thus, practitioners may wish to consider training under fatigue in order to provide players opportunities to develop their capacity to effectively re-calibrate (Brand & de Oliveira, 2017) to the performance environment (Alder, Broadbent, Stead & Poolton., 2019).

The finding that players who demonstrated reduced CMJ performance tended to move earlier in response to their opponents' actions, supports the proposition that reductions in power capabilities may influence movement initiation in short and explosive anticipation tasks (Wilson et al., 2019; Mecheri et al., 2019). In previous tennis research, it has been revealed that the return of a fast serve is performed under severe spatiotemporal constraints and that a highly dynamic, fast stretch-shortening cycle movements appears to meaningfully contribute to world-class tennis players serve-return performance, as it affords players the time to wait and exploit more reliable information (e.g. early ball flight) (Mecheri et al., 2019). Such benefits may extend to any sporting context that requires athletes to perceive and act under severe spatiotemporal constraints (Dicks et al., 2019). However, the findings of the current study also imply that the rigors of competitive match play may compromise power output and find players more susceptible to the deceptive actions of their opponents.

In contrast to previous work (Brault et al., 2012; Dicks, Davids, et al., 2010; Wilson et al., 2019; Mecheri et al., 2019), we report a relationship between a reduction in acceleration performance and the initiation of an earlier response in the SSAT. The SSAT required players to initiate a COD response and perform a 5-m acceleration in response to an opponent's action. For tasks that require defenders to anticipate the direction/action of the attacker and require defenders to perform a short acceleration in response, it seems feasible that reduced acceleration capabilities, may implicitly influence anticipation. This novel finding highlights the importance of an understanding of the specific action capabilities required to execute a given task.

It was hypothesised that a reduction in action capabilities would cause players to initiate an earlier movement response in the SSAT. In general, players action capabilities were compromised post-small-sided games (SSGs); the exception was players pre-planned change of direction (COD) capability. Upon reflection a number of concerns around the pre-planned COD test utilised in this study have become apparent. The improved COD capability observed post-SSGs contradicts the reduced capabilities associated with countermovement jump (CMJ), acceleration (over 5-m) and sprint speed (over 20-m). Albeit a pre-planned route, the COD test was designed to mimic the SSAT. The rationale being that a reduction in performance, may have had the closest relationship to changes in IMT within the SSAT. However, it seems that task familiarisation may have masked any negative fatiguing effects of the SSGs on COD capability. In addition, a pre-planned, high intensity 90° change of direction, requires efficient deceleration (Hewitt, Cronin, Button & Hume et al., 2011), which was not a feature of the SSAT. Players advanced slowly in response to the tester and, in almost all cases, no discernible deceleration occurred prior to the participant changing direction. It seems that within the context of the SSAT, power (CMJ) and acceleration may have been the physical attributes that had the greatest influence on anticipation.

There was a deliberate attempt in the design of this study to uphold the representative design of both the test of anticipation (SSAT) and the intervention (SSGs) (Pinder, Davids, Renshaw, & Araujo, 2011). It has long been acknowledged that running performance is not the sole cause for post-induced match fatigue in soccer (Nedelec et al., 2012, 2013; Rampinini et al., 2011). Other variables such as changes of direction, accelerations and decelerations all contribute to fatigue (Hill-Haas et al., 2011), and small-sided games include most tasks that are a feature of competitive match play (Hill-Haas et al., 2011). The findings of the present study partially support the use of SSGs as a representative task to induce fatigue in soccer players. The physical performance reductions observed in this study support previous findings (Krustrup et al., 2010; Oliver et al., 2008), in showing that fatigue reduces acceleration, sprint and jump capabilities, respectively. Based on these physical performance reductions, it is recommended that, where possible, researchers and practitioners utilise SSGs instead of treadmill protocols (Oliver et al., 2008).

Study Limitations

It is noteworthy that the SSGs did not seem to provide a stimulus to fatigue for *all* players in the sample. Two players showed no evidence of reduced action capabilities and, subsequently, were removed from the statistical analysis. This afforded the purposeful testing of the hypothesis that a reduction in action capabilities would lead to the initiation of an earlier response to an attacker's change of direction. The failure of SSGs to elicit meaningful reductions in action capabilities of these two players can be attributed to a number of factors. For example, technical capability has been shown to influence the intensity of SSGs (Hill-Hass et al., 2011). More capable dribblers of the ball are more likely to expend energy running with the ball than less capable players who might prefer to pass (Reilly & Ball, 1984 cited in Rampinini et al., 2007). Similarly, tactical preferences and motivation to engage in the SSGs may have influenced the intensity of the game for individual players (Rampinini et al., 2007). Alternatively, fitness levels may have mediated the effect the SSGs had on the capability of a player to act in the SSAT (Hill-Hass et al., 2011). In order to reduce the variability in player responses to SSGs, coaches can use coach behaviours (e.g., verbal encouragement) to motivate players (Rampinini et al., 2007) and/or manipulate the constraints of the SSGs; for example, the use of line goals (i.e., players need to run past a line with the ball to score a goal) rather than conventional goals (Duarte et al., 2010). The SSAT necessitated interaction with an opposing player thus forcing players to respond to game-specific situations (Navia et al., 2017), however, the adoption of a representative design was at the expense of repeatability. Given the complex and variable nature of sport performance environments, parameters are rarely precisely repeated and as such, the SSAT samples the inherent natural variation of sport. Whilst it is recognised that a common approach in sport science research is systematic designs, which emphasises control and repeatability of experimental conditions, it is our view that task representativeness should not be compromised without due consideration (Dicks et al., 2009). However, with representative design comes unsystematic variance, which may have masked pre-/post-SSGs differences and/or relationships between action capabilities and movement initiation. Future work in the area of perception-action in sport, may be best served by adopting hybrid research designs. Representative and systematic design should not be treated as antagonistic strategies but should be treated as complimentary experimental tools (Dhami, Hertwig & Hoffrage., 2004). Further exploration of the relationship between action capabilities and anticipation may benefit from adopting a more pragmatic approach. For example, the use of an acute manipulation of action capabilities, which can be implemented and removed at will, would reduce the noise associated with the more holistic manipulation of action capabilities (Brand & de Oliveira, 2017).

Practical Implications

To our knowledge this is the first study to reduce the action capabilities of soccer players to examine the impact on defensive movement response in a 1-vs-1 task. Although the findings were not conclusive, many aspects of this study highlight the need for further investigation and appreciation of the relationship between changes in action capabilities and anticipation. Soccer coaches and conditioning trainers may wish to consider the impact of fatigue on not only physical performance outcomes but also the anticipatory (perceptual-motor) skill of players. It is suggested that practitioners allow players sufficient opportunity to train under reduced action conditions (Alder et al., 2019). This would allow players to learn to better contend with disturbances of the perceptual-motor system at the later stages of a match. Furthermore, findings of this study support the use of small-sided games as a representative task to reduce the action capabilities of soccer players. Where possible, practitioners and researchers should utilise representative design protocols such as small-sided games. Soccer-specific variables, such as decelerations, changes of direction, kicking and tackling all likely contribute to match-induced fatigue (Nedelec et al., 2012, 2013; Rampinini et al., 2011). Small-sided games (SSGs) include all aforementioned variables and can be considered a representative fatiguing protocol. We acknowledge the need for work to advance our understanding of the relationship between physical action capabilities and anticipation, but what is becoming increasingly evident is the need for practitioners to better appreciate how changes in physical capabilities can influence anticipation in tasks characterised by severe spatiotemporal constraints.

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