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The Contribution of Perceptual and Cognitive Skills in Anticipation Performance of Elite and Non-Elite Soccer Players

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Abstract The purpose of the present study is to examine the contribution of perceptual and cognitive processes in anticipation performance of soccer players under low- and high-intensity exercise demands. Eight elite and eight non-elite players completed a soccer-specific protocol, while simultaneously viewing dynamic and realistic filmed simulations of a soccer game. Anticipation, gaze behaviours, and retrospective reports were assessed. Results indicated that elite players were more accurate in anticipation performance. Under low-intensity, gaze behaviours exhibited by elite players accounted for a significant association in performance, whereas non-elite performance was significant related with cognition and evaluation statements. Under high-intensity, evaluation and deep planning verbalizations had a significant influence on elite group performance; in contrast, cognition statements was the only process-tracing measure that contributed significantly with non-elite performance. These findings indicated that the superior performance of elite players was associated with the selectivity of the perceptual and cognitive resources according to low- and high-intensity demands, respectively.

Keywords Perceptual-cognitive processes, Response accuracy, Intensity demands, Soccer

1. Introduction

Soccer is a game with a tremendous complexity of decisions and the process of choosing the best option for a particular moment is crucial. In high-performance sport, the ability to “read” opponents’ actions, often while simultaneously disguising one’s own intentions is crucial to performance (Reilly, Williams, Nevill, & Franks, 2000). Furthermore, the ability to anticipate the actions of other players and select and execute the proper answer are affected by several task-specific constraints. Knowing where and when to look, and select the appropriate decision is crucial for successful sport performance, yet the visual display is vast and often saturated with information both relevant and irrelevant to the task that could be shaped by the constraints imposed by the organism, the task itself and the environment (Mann, Williams, Ward, & Janelle, 2007; Newell, 1986).

Normally, perceptual and cognitive skills are deduced from the quality, speed and accuracy of an individual’s performance, with minimal effort to describe the contribution of perceptual and cognitive processes with the anticipation performance of soccer players, in different exercise-specific intensities. Researchers have employed eye movement recording methods to identify the perceptual processes that discriminate skilled and less-skilled performers (North, Williams, Hodges, Ward, & Ericsson, 2009; Roca, Ford, McRobert, & Williams, 2011; Williams & Davids, 1998; Williams, Ward, Knowles, & Smeeton, 2002; Williams, Janelle, & Davids, 2004). Generally, this studies results highlight that elite players use different search strategies and fixate on further useful cues when compared to non-elite players. Although elite performers can identify relevant information early, they have the ability to make use of domain-specific knowledge that facilitates superior anticipation performance, when compared with non-elite (Ward, Williams, & Ericsson, 2003; Williams, Eccles, Ford, & Ward, 2010).

Therefore, researchers have used think-aloud protocols to gather information about the underlying knowledge structures and in-event thought processes, suggesting that skilled players employed more complex domain-specific memory representations to solve the task (Ericsson & Simon, 1993; North, Williams, Ward, & Ericsson, 2011; Roca et al., 2011). This assumption is sustained by the long-term working memory theory (LTWM) developed by Ericsson and Kintsch (1995), in which experts are able to acquire the necessary skills to index and encode information into an elaborate representation stored in long-term memory. This information remains accessible via the use of retrieval cues

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in short-term memory. Ward et al. (2003) proposed that these skills and underlying representations provide a dual function: (i) they provide memory support for performance, in the form of planning, monitoring and evaluations; (ii) while simultaneously enabling retrieval structures to be built and update "on the fly" that promote direct access to task pertinent options. This process allows experts to predict the occurrence and consequences of future events, and anticipate the retrieval demands likely to be placed on the system (McRobert, Williams, Ward, & Eccles, 2009).

In recent years, researchers have established methods to evaluate the superior anticipation performance of elite players. The available methods range from film-based simulations of the performance context to data captured in the field setting using liquid crystal occlusion glasses, high-speed film analysis, and the collection of performance data using match analysis procedures (Carling, Reilly, & Williams, 2009). Rampinini, Impellizzeri, Castagna, Coutts, and WislØff (2009) reported that both physical, and technical performance decreased significantly among soccer players of different competitive levels or ranking positions during match-play. Other researchers using time-motion and performance analysis in soccer have suggested that reduced physical and physiological performance seems to occur at three different stages in the game: (i) after short-term intense periods in both halves; (ii) in the initial phase of the second half; and (iii) towards the end of the game (Mohr, Krustrup, & Bangsbo, 2005). Moreover, evidence from time-motion analysis shows that the amount of high-intensity running in the 5 min period immediately after the most intense 5 min interval recorded during the game was observed to be less than the average of the entire game (Mohr, Krustrup, & Bangsbo, 2003).

The present study includes video-based offensive scenarios, involving a near-life-size video simulation, and a prolonged intermittent exercise protocol, simulating soccer match specific demands, under controlled and reproducible laboratory conditions (Drust, Reilly, & Cable, 2000). The soccer-specific intermittent exercise protocol is performed on a motorized treadmill, and includes different exercise activities with varying intensities (e.g., walking, jogging, running, cruising, sprinting), as observed during a soccer game (Gregson, Drust, Batterham, & Cable, 2005). To increase the ecological validity of the simulation, treadmill speeds assigned to each activity category are based on the data of Van Gool, Van Gervan, and Boutmans (1988).

In sum, we tested the variance of anticipation performance between elite and non-elite soccer players under low- and high-intensity exercise. The literature states that the superior performance of elite participants is mediated by more appropriate visual search pattern (Williams & Davids, 1998; Williams et al., 2002), extensive task-specific retrieval structures (Ward et al., 2003; Williams et al., 2010), and strategically allocated compensatory resources at high-intensity exercise (Eysenck et al., 2007). We conjectured that elite players will demonstrate superior anticipation performance mediated by using a better compensatory resources strategy (as designated by gaze and think aloud data), under both low- and high-intensity demands, when compared to non-elite players.

We also observed the contribution of gaze behaviours and thoughts-processes in response to low- and high-intensity exercise for elite and non-elite players. Under low-intensity exercise demands, we predicted that elite players performance would be associated with the gaze behaviours employed around the visual display, whereas non-elite performance would be related to the contribution of verbalizing current actions or recalled statements about current events; whereas under high-intensity exercise demands, we expected that elite players anticipation performance would be based in a engagement of thought processing, verbalizing more evaluative and deep planning statements, and non-elite performance would still be related to their verbalizations on current events. Both assumptions were sustained by LTWM (Ericsson & Kintsch, 1995).

2. Methods

2.1. Participants

A total of eight elite and eight non-elite soccer players participated. Players in the elite group (mean age = 24.63 years, SD = 3.9) had played at a semi-professional or professional level (mean = 5.1 years, SD = 2.4) and had been involved in a professional club's training academy (mean = 3.5 years, SD = 2.7). The non-elite group (mean age = 26.25 years, SD = 2.9) had played soccer only at an amateur level (mean = 2.1 years, SD = 2.4). The visual function of the participants was reported as normal levels. The participants have been provided with written informant consent. Conforming to Helsinki declaration, this study was carried out with ethical approval by the lead institution.

2.2. Test Film

The film consisted of 40 video clips showing offensive sequences of play in soccer. Professional players from the Second National League in Portugal (N = 22) were requested to act out a number of realistic match scenarios that were representative of actual situations that would occur in a match. The footage was validated by four coaches with UEFA-A license, in which they had at least ten years of soccer coaching experience. The level of agreement between observers was high (α=0.889). To maintain the important information from all the positions, the sequences were filmed in a behind position (15 m) and above (5m) the goal with a 16:9 ratio camera (Sony DSR 570 DVCAM). The elevated filming position helped give participants some element of depth and width. Altogether, four test films were created each comprising of ten different offensive sequences. Each clip lasted approximately 5 s with an inter-trial interval of 5 s, as well. Moreover, just before the start of each clip, a small circle surrounding the ball appeared on screen to indicate the area of its first appearance. All the clips were occluded 120 ms before the player in possession of the ball was about to make a pass or shot at goal or maintain the possession of the ball.

2.3. Apparatus

The clips were presented onto a large screen (2.5 m x 2 m), ensuring the representativeness of real match play. The screen subtended a viewing angle of 44º in the vertical and 46º in the horizontal direction, respectively.

An Applied Science Laboratories (ASL®) 3000 eye-movement registration system was used to record the visual search behaviours. This is a video-based, monocular corneal reflection system that records eye point-of-gaze with regard to a helmet-mounted scene camera. The system measures relative position of the pupil and corneal reflection. These features are used to compute point-of-gaze by superimposing a crosshair onto the scene image captured by the head-mounted camera optics. The image was analysed frame-by-frame using the Pinnacle Software, Avid Liquid edition 7 (Pinnacle Systems, Inc., Mountain View, CA). System accuracy was ± 1º visual angle, with a precision of 1º in both the horizontal and vertical directions.

Verbal reports were collected with a lapel microphone, telemetry radio transmitter (EW3; Sennheiser, High Wycombe, UK), and telemetry radio receiver (EK 100 G2; Sennheiser). The reports were collected onto a mioniDV tape using a digital video camera (Canon Legria FS 200; Canon, Tokyo, Japan), converted into computer audio .wav files, and then transcribed before analysis.

2.4. Procedure

Before the beginning of the experimental task, the test procedure was explained to the participants and the eye movement system was placed onto the participant head. The eye-movement system was calibrated using a 9-point reference grid, so that the fixation mark corresponded precisely to verify point-of-gaze and four periodic calibration checks were conducted during the test (cf. Williams & Davids, 1998)._Subsequently, each participant was presented with six practice trials to secure familiarization with the procedure.

Prior to completing the experimental task, participants were instructed on how to provide retrospective verbal reports by solving generic and sport-specific tasks, for approximately 30 minutes (Ericsson & Kirk, 2001). The verbal reports were distinguished into natural speech and other syntactical markers. To ensure the familiarization with how to give retrospective verbal reports, each participant had the opportunity to experiment six trials. The retrospective verbal reports were collected directly at the end of each sequence. To anticipate the possible actions of the player in possession of the ball, the participants had to pointed one of the three actions bellow mentioned: *Pass (*i.e., a situation when the player attempted to play the ball to a team-mate); S*hot at goal (i.e.,* when the player makes an attempt to score a goal); R*etain possession (i.e.,* when the player has ball possession and attempts to move with the ball.

Participants completed an intermittent exercise protocol (Drust et al., 2000), simulating the soccer-specific categories of intensity demands (e.g., walking, jogging, running, cruising, sprinting). The exercise protocol lasted 119 min, and was divided into two halves with the same duration (52 min), interspersed by a 15 min interval for rest. A static recovery period was included, in which the participant remained stationary on the treadmill (H/P cosmos, Pulsar, Germany).

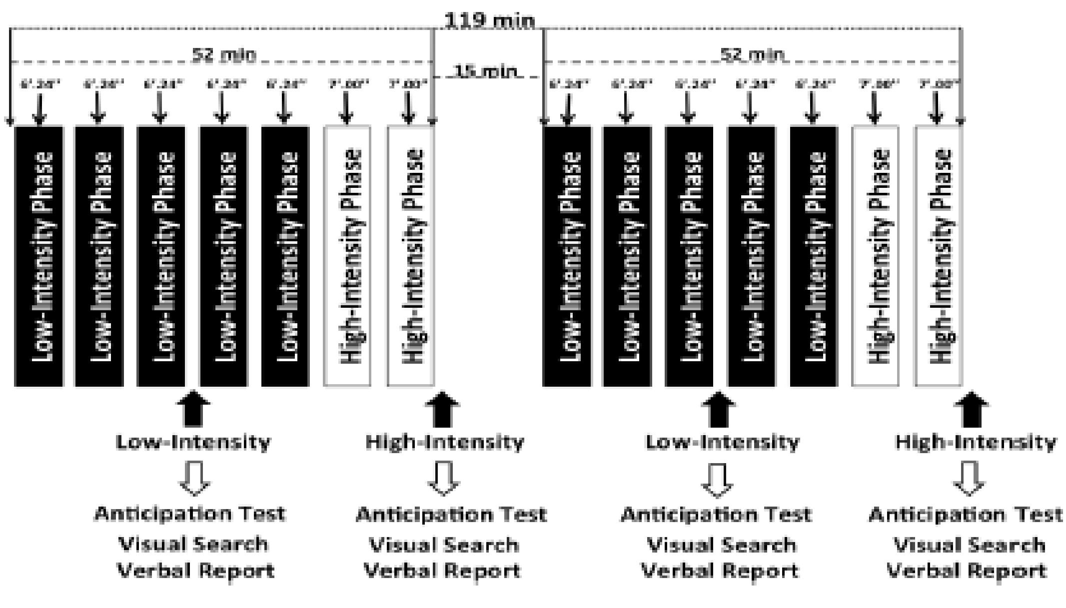

Figure 1. The representation of the Drust protocol and the four evaluations of data collection, collapsed according to low- and high-intensity demands

The treadmill speeds used for each activity pattern were as follows: walking 6 $km.h^{-1}$; jogging 12 $km.h^{-1}$; running 15 $km.h^{-1}$; cruising 18 $km.h^{-1}$; sprinting 23 $km.h^{-1}$. The protocol included two identical periods of seven running blocks (five low-intensity blocks and two high-intensity blocks), separated by a recovery period of 15 minutes (see Figure 1). The low-intensity phase consisted of five blocks of activity, with the same pattern: walking; stopping; jogging; walking; jogging and running. The total duration of each low-intensity block was six minutes and twenty four seconds, with this period including 18 seconds of walking, 18 seconds of stopping, 16 s of jogging, 18 seconds of walking, 14 seconds of jogging and 12 seconds of running, each cycle being repeated four times. The high-intensity phase consisted of two blocks of activity, with the same pattern of walking, sprinting, stopping and cruising. The duration of each high-intensity block was seven minutes, involving 13 seconds of walking, 10 seconds of sprinting, 15 seconds of walking, 10 seconds being stationary and 12 seconds of cruising. This pattern was repeated seven times. The duration of each period of seven blocks (first half) was 52 minutes. So, the soccer-specific protocol was 119 minutes (first half: 52 minutes + recovery: 15 minutes + second half: 52 minutes).

The data were collected after the third, seventh, tenth and fourteenth blocks, and then collapsed according to their intensity phase: low-intensity - third and tenth blocks; high-intensity - seventh and fourteenth blocks. In each assessment, the participants viewed 10 clips presented in a counterbalanced order. The total duration of the experimental protocol, including the period of familiarization with the procedures, lasted approximately 210 minutes. The study design is illustrated in Figure 1.

2.5. Anticipation

Anticipation performance was obtained by response accuracy (RA) scores, calculated based on the participants responses after viewing each clip. If the participants anticipate the best option for the player in possession of the ball it was given an accurate response. Response accuracy was reported as a percentage (%).

2.6. Perceptual and Cognitive Processes

For the visual search analysis, it was chosen the three most discriminating trials supported on group mean scores from the measures of response accuracy percentage. The visual behaviours were analysed to obtain search rate (i.e. mean number of visual fixations, mean fixation duration and total number of fixation locations). A fixation was defined as the period of time (120 ms) when the eye remained stationary within 1.5º of movement tolerance (cf., Williams & Davids, 1998). The display was divided into five fixation locations: ball; team-mate; opposition; player in possession of the ball; and undefined. To determine the percentage of agreement for search rate data, an inter observer agreement formula was used. The data revealed an inter observer agreement of 99%.

The cognitive processes were recorded using verbal report protocols. The verbal statements were categorically coded based on a structure originally adapted from Ericsson and Simon (1993) and further developed by Ward (2003) to identify statements made about cognitions, evaluations, and planning (including predictions and deep planning). Ward (2003) conceptualized cognitions as all statements representing current actions or recalled statements about current events and evaluations as some form of positive, neutral or negative assessment of a prior statement. Planning statements were divided into predictions and deep planning. Predictions reflected statements about what would and could arise next and deep planning statements concerned information about searching possible alternatives beyond the next move.

We collected retrospective verbal reports after every trial, and in each evaluation we used the three most discriminating trials between elite and non-elite players based on group mean scores from the anticipation task, converted into frequency data. Consequently, the trials identified were the 3, 7, 10, 22, 25, 27 (low-intensity demand), and 11, 16, 19, 31, 36 and 40 (high-intensity demand). An independent investigator established the figure reliability re-analyzing 100% of the data. For these variables the data reached an inter observer agreement of 98%.

2.7. Statistical Procedure

Response accuracy, perceptual and cognitive measures were analysed using separate factorial two-way ANOVA with group (elite/non-elite) as the between-participants factor and intensity exercise demand as the within-participants factor. Partial eta squared (η^2_p) values were provided as a measure of effect size for all main effects and interactions. To identify which perceptual and cognitive measures explained the variance in the response accuracy performance on elite and non-elite players, we conducted a multiple linear regression analyses, separated for each group and for each exercise demand (low- and high-intensity). For each group and intensity exercise analysis, the response accuracy percentage was set as the dependent variable and perceptual and cognitive measures were considered the independent variables. Stepwise method with forward selection was employed retaining the independent variables, with *p* value greater than 0.05 in the final model. The statistical software used was the SPSS Version 18.0 (SPSS Inc., Chicago, II).

3. Results

3.1. Anticipation

The response accuracy at low and high- intensities is presented in Table 1.

There were significant main effects for group ($F_{1, 60}$ = 33.82, $p < .0001$, $\eta^2_p = .36$) and intensity ($F_{2, 60}$ = 7.45, $p < .0001$, $\eta^2_p = .11$). Elite players were more accurate in anticipating the decision of the player in possession of the ball than their non-elite counterparts. Moreover, for both groups (elite/non-elite) accuracy in anticipating the judgment of the player in possession of the ball decreased significantly under high- compared to low-intensity demands ($p < .05$). There was no significant group * intensity interaction ($F_{2, 60} = .014$, $p = .91$, $\eta^2_p = .00$).

Table 1. Mean Response Accuracy Percentage (RA %) from Elite and Non-Elite Players, Under Low- and High-Intensity Exercise Demands (± SD)

	Group	Exercise Demands	
		Low-intensity	High-intensity
RA %	Elite	53.1 ± 6.9 a) b)	46.3 ± 12.3 a)
	Non-elite	38.1 ± 10.8 b)	30.6 ± 10.4

a) Significant difference between elite and non-elite ($p < .05$).
b) Significant difference between low- and high-intensity exercise ($p < .05$).

3.2. Perceptual and Cognitive Processes

The descriptive data from visual behaviours (number of fixations, number of fixation locations, and mean fixation duration), and type of verbal reports (cognition, evaluation, prediction and deep planning) under low- and high-intensity exercise demands are presented in Table 2.

Table 2. Mean Fixation Duration (FD), Number of Fixations (NF), Number of Fixation Locations (NFL) and Verbal Statements – cognition, evaluation, prediction and deep planning – Between Elite and Non-Elite Players, Under Low- and High-Intensity Exercise Demands (± SD)

Variables	Group	Exercise Demands	
		Low-intensity	High-intensity
FD	Elite	276.4 ± 70.9 a) b)	312.1 ± 86.9
	Non-elite	375.4 ± 92.4 b)	311.3 ± 75.0
NF	Elite	15.8 ± 2.2 a) b)	14.2 ± 2.2
	Non-elite	12.5 ± 2.2 b)	14.7 ± 2.8
NFL	Elite	3.2 ± 0.4 a) b)	2.8 ± 0.4
	Non-elite	2.5 ± 0.4 b)	2.9 ± 0.6
Cognition	Elite	2.6 ± 1.3	2.9 ± 1.6
	Non-elite	2.7 ± 1.2	2.9 ± 1.4
Evaluation	Elite	2.4 ± 1.5 a)	2.3 ± 1.4 a)
	Non-elite	0.8 ± 0.8	1.4 ± 1.2
Prediction	Elite	0.7 ± 1.1 a)	1.1 ± 1.3 a)
	Non-elite	0.3 ± 0.7	0.4 ± 0.7
Deep Planning	Elite	0.7 ± 0.9 a)	0.5 ± 0.7 a)
	Non-elite	0.1 ± 0.3	0.04 ± 0.2

a) Significant difference between elite and non-elite ($p < .05$).
b) Significant difference between low- and high-intensity exercise ($p < .05$).

3.3. Visual Search Behaviours

To fixation duration there was a significant main effect for group ($F_{1, 188} = 17.32$, $p < .0001$, $\eta^2_p = .08$). Elite players demonstrated significantly shorter fixations compared with non-elite participants, under low-intensity exercise. There was a significant group * intensity interaction ($F_{2, 188} = 17.87$, $p < .0001$, $\eta^2_p = .09$). Elite players employed significantly shorter fixations under low-intensity exercise, and significantly longer fixations when the exercise was performed in a high-intensity demand (p □.05), comparing to non-elite players. In contrast, non-elite group employed longer fixations under low-intensity exercise, and decreased significantly their fixation time when performed under high-intensity exercise. There was no significant main effect for intensity ($F_{2, 188} = 1.45$, $p = .23$, $\eta^2_p = .008$).

In the number of fixations we had a significant main effect for group ($F_{1, 188} = 16.12$, $p < .0001$, $\eta^2_p = .08$). Elite players employed a significantly higher number of fixations than non-elite performers, under low-intensity exercise. There was a significant group * intensity interaction ($F_{2, 188} = 29.97$, $p < .0001$, $\eta^2_p = .14$). Elite players decreased the number of fixations between low- and high-intensities demands, whereas the non-elite participants increased the number of fixations from low- to high-intensity exercise demands. Additionally, elite participants showed a significantly higher number of fixations in low-intensity exercise, compared to their counterparts. There was no significant main effect for intensity ($F_{2, 188} = .83$, $p = .36$, $\eta^2_p = .004$).

Also in the number of fixations per location there was a significant main effect for group ($F_{1, 188} = 16.12$, $p < .0001$, $\eta^2_p = .08$). Elite participants fixated on more locations compared with non-elite performers, under low-intensity exercise. There was a significant group * intensity interaction ($F_{2, 188} = 29.97$, $p < .0001$, $\eta^2_p = .14$). Elite players employed more fixations in different locations under low-intensity than high-intensity exercise demands. In addition, non-elite participants increased the number of fixation location between low- and high-intensity exercise demands, when compared with elite participants. There was no significant main effect for intensity ($F_{2, 188} = .83$, $p = .36$, $\eta^2_p = .004$).

3.4. Verbal Reports

There were no significant main effects for group ($F_{1, 188} = .11$, p = .92, $\eta^2_p = .000$) and intensity ($F_{2, 188} = 1.8$, p = .18, $\eta^2_p = .009$), and no significant group * intensity interaction ($F_{2, 188} = .17$, p = .68, $\eta^2_p = .001$).

In the evaluation parameter there was a significant main effect for group ($F_{1, 188} = 46.79$, $p < .001$, $\eta^2_p = .199$. There was a significant group * intensity interaction ($F_{2, 188} = 4.05$, $p = .046$, $\eta^2_p = .021$). Elite participants verbalized significantly more evaluation statements under both intensity demands compared to non-elite group (p □ .05). There was no significant main effect for intensity ($F_{2, 188} = 1.75$, $p = .188$, $\eta^2_p = .009$).

To the prediction verbalization there was a significant main effect for group ($F_{1, 188} = 17.32$, $p < .001$, $\eta^2_p = .084$). Elite participants provided more prediction statements than their non-elite counterparts. There was no significant group * intensity interaction ($F_{2, 188} = 1.41$, $p = .236$, $\eta^2_p = .007$), and no significant main effect for intensity ($F_{2, 188} = 3.73$, $p = .055$, $\eta^2_p = .019$).

Also in the parameter of deep planning there was a significant main effect for group ($F_{1,188} = 35.16$, $p < .001$, $\eta^2_p = .158$). Elite participants made significantly more deep planning statements (p □ .05). There was no significant group * intensity interaction ($F_{2,188} = .98$, $p = .324$, $\eta^2_p = .005$), and no significant main effect for intensity ($F_{2,188} = 2.19$, $p = .140$, $\eta^2_p = .012$).

We conducted a multiple linear regression to identify which perceptual and cognitive measures explained the variance in performance between elite and non-elite players, under low- and high-intensity exercise demands (see Table 3).

Table 3. Multiple Linear Regression Model for the Perceptual and Cognitive Measures Estimation of Response Accuracy Percentage on Elite and Non-Elite Players, Under Low- and High-Intensity Exercise Demands

Exercise Demands	Group	Measures	β	95% Confidence Interval
Low-intensity	Elite	NF	1.5**	0.7; 2.4
	Non-elite	Cognition	3.5**	1.1; 5.9
		Evaluation	4.4*	0.9; 7.9
High-intensity	Elite	Evaluation	2.9**	0.8; 5.2
		Deep Planning	6.8**	2.2; 11.4
	Non-elite	Cognition	2.1*	0.1; 4.2

* p □ .05; ** p □ .01.

Under low-intensity exercise demands, the number of fixations employed by elite players accounted for a significant contribution of the anticipation performance ($R = .48$, $R^2 = .23$, $F_{1,46} = 13.98$, $p = .001$). In contrast, cognition and evaluation statements were significant related to non-elite group performance ($R = .49$, $R^2 = .24$, $F_{1,45} = 6.23$, $p = .016$).

When we analyzed the contribution of visual search rate and types of verbal statements in the anticipation performance under high-intensity exercise demands, the results revealed that for elite group the verbal statements coded as evaluation and deep planning had a significant influence on their performance ($R = .52$, $R^2 = .27$, $F_{1,45} = 7.56$, $p = .009$). In contrast, for non-elite group performance the only process-tracing measure that had a significant influence was the verbal statement coded as cognition ($R = .29$, $R^2 = .09$, $F_{1,46} = 9.32$, $p = .043$).

4. Discussion

In this study our focus was (i) to examine the perceptual and cognitive processes underlying anticipation performance under low- and high-intensity exercise demands, with elite and non-elite soccer players. Thereafter, we hypothesized that elite players would present better performance in anticipation, under both intensities. We believe they will present more appropriate visual search strategies, more extensive task-specific retrieval structures and by their strategy to allocate compensatory resources at high-intensity demands. Besides that, (ii) we examined the contribution of visual search behaviors and cognitive processes, under low- and high-intensity exercises in both group of players. We hypothesized that elite players performance would be associated on gaze behaviors employed around the visual display, while non-elite players performance would be related to verbalize current actions or statements about the events under low-intensity demands. Under high-intensity demands we expect that the performance of elite players will be more based on evaluative and deep planning statements and the non-elite would even be related to verbalization on current events.

The intermittent exercise protocol aims to mimic the physical demands of full 90-minute soccer game has been continuously improved in research, the heart rate and blood lactate concentrations were controlled and they present similar levels with those observed in other laboratory-based studies (cf. Drust, Atkinson, &Reilly, 2007) and with real soccer matches (Bangsbo, 1994; Kintsch, 1998). Although some “real-world” displacements (backwards and sideways) were not included as a result of the technical limitations of the ergometer (Drust et al., 2000), and both activity pattern and speed duration were slightly different from a real soccer match (for review, see Bradley, Sheldon, Wooster, Olsen, Boanas, & Krustrup, 2009). In real matches, players have not predictable activity patterns and need to make decisions as required to the specific situation. Intermittent exercise protocol was the instrument to reproduce the control, safety and reliability in this experimental design.

As predicted, in this study the results show superior performances in elite soccer players under low- and high-intensity exercise compared with non-elite. Our findings are in agreement with other researchers that examined groups from different competitive levels (North et al., 2011; North & Williams, 2008; Roca et al, 2011; Ward & Williams, 2003; Ward et al., 2003; Williams & Davids, 1998). Other researches revealed that elite’s superior performance were underpinned by a more refined underlying process-tracing highlighted by skill-based differences in gaze behaviors, and retrospective verbal reports, when compared to performance in simulated real-world situations between participants skilled levels (McRobert et al. 2009; North et al., 2011; Roca et al., 2011; Ward et al., 2003; Ward & Williams, 2003; Williams & Davids, 1998; Williams et al, 2012). Roca et al. (2013) reported that elite players activate more elaborated domain and task-specific memory representation when compared with non-elite players. Vaeyens et al. (2007) concludes that elite players have greater declarative, procedural and strategic knowledge than non-elite players. In this sense, visual and cognitive data from elite participants, compared to the non-elite group, present that they used significantly ($p<0.05$) more fixations of shorter duration in more informative visual cues, and activated more elaborated domain-specific memory representations (i.e. verbalized more evaluative, predictive and deep planning statements, $p < .05$), under low-intensity demands.

Throughout the program, the nature of the search behaviors was not similar and across the exercise protocol it changed in both groups. At the beginning of each half, the elite players fixate on significantly more locations in the visual display, and had fixations of shorter duration compared to low-level players. Williams and Davids (1998) reported that strategies that involve more fixations and with short duration is an advantage, particularly during dynamic open-play situations involving 11 versus 11 players. At the end of each half, as the physical demands increase, elite players start to use lesser fixations of long duration, and this is accompanied with a decline of the anticipatory accuracy.

Furthermore, in both groups, we observed a significant decrease in anticipation skills between low- and high-intensity demands. This findings support studies that have explore the quiet eye period of biathlon athletes after a stressful effort. For example, in biathlon the progressive increase of effort had various responses across individuals with in most cases stress decreases the quiet eye period while the most skilled shooters increased their quiet eye period (Vickers & Williams, 2007). Such as Roca et al. (2013) reported that elite players had superior performance, compared to non-elite players, even in stressful exercise demands by using compensatory resources strategies such as increased use of processing resources.

The present study brings another methodological improvement, which is the contribution of both visual and cognitive processes, in low- and high-intensity exercise, under different competitive levels of players. As expected, elite players performance was associated on gaze behaviors employed around the visual display, probably due by using more appropriately the various sub-components of the visual field, such as fovea, parafovea and visual periphery (Williams & Ford, 2008). In the other hand, the performances of non-elite players was connected to the contribution of verbalizing current actions and evaluate statements, under low-intensity demands, and cognitive statements under high-intensity exercise. Our findings suggested that non-elite players performance faced to a fewer semantic concepts or templates impaired them to pick up important relational information and to employ more distinctive surface features, when making such judgments. Despite this, non-elite players presented more statements coded as evaluation, maybe because these players used search processes to lookout the more effective option in advance of making a decision based on the action (Ward, 2003). Despite of increasing the exercise intensity, non-elite players only think about instantly available information and commenting on present events to do the primary task, instead of planning ahead based on anticipated future developments.

Moreover, in high-intensity exercises, the results demonstrated that elite players were supported on prediction (beginning of the second half) and deep planning verbalizations (during first and the fourth test session). Our findings provide support for LTWM theory (Ericsson & Kintsch, 1995). This theory states that skilled participants' complex retrieval structures permit anticipatory encodings, allowing skilled participants to dynamically update their cognitive representations and verbalize these forward planning thoughts. Besides that, elite players can combine different process-tracing processes under low- and high-intensity exercise demands improved the importance of experts bypass the limitations of short-term memory. This means that elite players own advanced skills that enable both rapid encoding of information in long working memory and access to this information when is needed, namely being more proactive. Although, processing efficiency from elite players might be affected during high-intensity exercise (Eysenck et al., 2007), evidence suggests that even when the situational demands change elite participants are able to restructure, reorganize, and refine their representation of knowledge so they are able to adapt rapidly (Feltovich, Prietula, & Ericsson, 2006).

5. Conclusions

In summary, we showed evidences that elite players demonstrate superior anticipation performance intermediated by a more appropriate gaze behavior, and a more extensive task-specific retrieval structures than non-elite players, independently the intensity be low or high. Additionally, the perceptual and cognitive resources of elite players alternated and adapted according to exercise intensities demands, while in distinction, the performance of the non-elite group was connected with processing current ongoing events. A prolonged intermittent exercise influences negatively the perceptual cognitive processes, like anticipatory accuracy.

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