

1. Casanova F, Garganta J, Silva G, Alves A, Oliveira J, Williams AM (2013). Effects of Prolonged Intermittent Exercise on Perceptual-Cognitive Processes. *Medicine & Science in Sports & Exercise* 45, 8: 1610-1617.
2. Casanova F, Oliveira J, Williams M, Garganta J (2009). Expertise and perceptual-cognitive performance in soccer: a review. *Revista Portuguesa de Ciências do Desporto* 9, 1: 115-122.
3. Dicks M, Button C, Davids K (2010). Examination of gaze behaviors under in situ and video simulation task constraints reveals differences in information pickup for perception and action. *Attention, Perception, & Psychophysics* 72, 3: 706-720.
4. Hugues C (1994). *The football association coaching book soccer tactics and skills*. Harpenden: Queen Anne Press.
5. Roca A, Ford PR, McRobert AP, Williams AM (2013). Perceptual-Cognitive Skills and Their Interaction as a Function of Task Constraints in Soccer. *Journal of Sport & Exercise Psychology* 35, 2: 144-155.
6. Roca A, Williams AM (2016). Expertise and the interaction between different perceptual-cognitive skills: Implications for testing and training. *Frontiers in psychology* 7.
7. Roca A, Williams AM, Ford PR (2012). Developmental activities and the acquisition of superior anticipation and decision making in soccer players. *Journal of Sports Sciences* 30, 15: 1643-1652.
8. Savelsbergh GJP, Onrust M, Rouwenhorst A, Van Der Kamp J (2006). Visual search and locomotion behaviour in a four-to-four football tactical position game. *37, 2-3: 248-248-264*.
9. Teoldo I, Garganta J, Greco PJ, Mesquita I, Seabra A (2010). Influence of relative age effects and quality of tactical behaviour in the performance of youth soccer players. *International Journal of Performance Analysis in Sport* 10, 2: 82-97.
10. Teoldo I, Garganta J, Mesquita I, Maia J, Greco PJ (2011). System of tactical assessment in Soccer (FUT-SAT): Development and preliminary validation. *Motricidade* 7, 1: 69-84.
11. Vaeyens R, Lenoir M, Williams AM, Mazyn L, Philippaerts RM (2007). The Effects of Task Constraints on Visual Search Behavior and Decision-Making Skill in Youth Soccer Players. *Journal of Sport & Exercise Psychology* 29, 2: 147-169.
12. Vaeyens R, Lenoir M, Williams AM, Philippaerts RM (2007). Mechanisms underpinning successful decision making in skilled youth soccer players: an analysis of visual search behaviors. *Journal Motor Behaviour* 39, 5: 395-408.
13. van Maarseveen MJ, Oudejans RR, Mann DL, Savelsbergh GJ (2016). Perceptual-cognitive skill and the in situ performance of soccer players. *The Quarterly Journal of Experimental Psychology*. 1-17.
14. van Maarseveen MJ, Oudejans RR, Savelsbergh GJP (2015). Pattern recall skills of talented soccer players: Two new methods applied. *Human Movement Science* 41, 0: 59-75.
15. Williams A, Davids K (1998). Visual search strategy, selective attention, and expertise in soccer. *Research quarterly for exercise and sport* 69, 2: 111-128.
16. Williams AM, Ford PR, Eccles DW, Ward P (2011). Perceptual-cognitive expertise in sport and its acquisition: Implications for applied cognitive psychology. *Applied Cognitive Psychology* 25, 3: 432-442.

## Perception and action in soccer: Performance comparison under different perceived effort intensities in Small-Sided and Conditioned Games

**KEY-WORDS:**

Visual search. Tactical behavior. Soccer.

**AUTHORS:**

Rafael Bagatin <sup>1,2,3</sup>  
 Maickel Padilha <sup>1,2,4</sup>  
 André Milheiro <sup>1,2</sup>  
 Guilherme Rodrigues <sup>1,2</sup>  
 Fernando Tavares <sup>1,2</sup>  
 Filipe Casanova <sup>1,2</sup>

<sup>1</sup> Center of Research, Education, Innovation and Intervention in Sport (CIFIID), Faculty of Sport (FADEUP), University of Porto, Portugal.

<sup>2</sup> Center of Studies of Sports Games, Faculty of Sport, University of Porto, Porto, Portugal.

<sup>3</sup> Federal University of Paraná, Paraná, Brazil.

<sup>4</sup> Scholarship CNPq – Brazil

**ABSTRACT**

The aim of this study was to compare defensive tactical behavior and the visual search behavior according to different levels of perceived effort in small-sided and conditioned games (SSCG). Ten universities (24.25±2.51yrs) were evaluated. The field tests consisted of 2 vs 1+GK SCCG. Players' tactical behavior was assessed based on core tactical principles of soccer. Visual search data was recorded using a Tobii Pro Glasses 2 eye-movement registration system in which the following categories were defined; the fixation duration per locations and number of fixations per locations, such as ball, space, spaceplayer, play-erball and undefined. The participants were separated in two groups, high intensity group and low intensity group according their perceived exertion. There were no significant differences in defensive tactical performance and number of fixations per location. A statistical significant decreased was found in fixation duration in space of the player in ball possession between first and second moment in high intensity group.

Corresponding Author: Rafael Bagatin. (rafabagatin@hotmail.com)

## Percepção e ação no futebol:

### Comparação da performance em diferentes intensidades de esforço percebido em jogos reduzidos condicionados

#### RESUMO

O objetivo do presente estudo foi comparar o desempenho tático e a procura visual de acordo com diferentes níveis de esforço percebido em Jogos Reduzidos e Condicionados de Futebol. Dez universitários ( $24.25 \pm 2.51$  anos) foram avaliados. O teste de campo consistiu na realização de JRC na situação de 2 vs 1+GR. A performance tática defensiva dos jogadores foi avaliada com base nos princípios táticos do futebol. O sistema de registo do movimento ocular de marca Tobii Pro Glasses 2 foi utilizado, tendo-se considerado as seguintes categorias: duração da fixação por local (bola, espaço, espaço portador e portador) e número de fixações por local. Não foram encontradas diferenças estatísticas na variação do desempenho tático defensivo na análise intra-grupo nos dois momentos de avaliação, bem como no número de fixações por local. Ao invés, foi encontrada uma diminuição significativa na duração da fixação no espaço do portador entre o primeiro e o segundo momento de avaliação no grupo de alta intensidade.

#### PALAVRAS CHAVE:

Procura visual. Comportamento tático.  
Futebol.

#### INTRODUCTION

Perceptual-cognitive skills (i.e. visual search behavior) and tactical behavior (i.e. defensive tactical performance) are related as the key to players achieve the high level performance (3, 5, 19). Regard with visual search behavior, it is one of the perceptual-cognitive skill in which is comprehended to be the ability to extract relevant cues from the environment, aiming to solve the problems which appear during the game, selecting an appropriate action (5, 13). The tactical behaviors are the operationalization of the tactical principles emerged from theoretical conceptualization of the game logical purpose (15).

Thus, regardless of several skills required by players face on a problem, their performance can be influenced by the effort spent either during drills or matches, promoting changes on tactical and visual search behavior (2, 4). In this vein, a variety of different methodological designs have been used to verify tactical and visual search behavior of soccer players, from different levels and skills (4, 18). Studies have focused in analyzing the perception-action from the quality, speed and accuracy of an individual's soccer performance, in different intensities and on-field (2, 4, 18).

In a recent study, the authors assessed the visual search behaviors of sixteen soccer players (8 elite and 8 non-elite) under low- and high-intensity exercise demands characterizing a soccer-specific protocol in a motorized treadmill (10). The study found that in low-intensity exercise, elite players showed significantly shorter fixations. Furthermore, in high-intensity they demonstrated significantly longer fixations compared with their counterparts. Other study conducted by van Maarseveen et al. (18) examined perceptual-cognitive skill in laboratory tests and tactical performance of soccer players *in situ* conditions. The researchers concluded that was not possible to predict players' performance on-field based by performance on the set-ups typically used to test perceptual and cognitive skill.

Tactical behavior has typically been measured using on-field tests (15). Among the field tests, the tactical behaviors have been assessed based on core tactical principles, allowing to assess with more accuracy the players' performance, comparing the players' performance from the different positional role (11), as well as comparing defensive and offensive tactical behavior (7). Literature also showed perception-action have been measured separately, namely perception-cognitive skills and tactical behavior (18). Nevertheless, to investigate in conjunction how players perform their tactical behavior and visual search *in situ* situation, as well as to understand whether the effort spent may influence such behaviors is required an elaborate and novel research design.

Thereby, our main interesting was to perceive how perception-action is influenced within two groups separated by the perceived effort, during the Small-Sided and Conditioned Games (SSCGs). In this way, rates of perceived exertion have been used to determine the intensity during different exercises (e.g. SSCG) (6, 8) due to being a reliable, inexpensive, simple and non-invasive test comparing with other methods (8). In the current study, we

sought to compare the visual search behavior and tactical behavior (i.e. defensive tactical performance) within two groups of different perceived intensity during a SSCG situation.

We hypothesized that in high intensity group, the defensive tactical performance would decrease from first to the second moment <sup>(8)</sup>. Based on the study of Casanova et al. <sup>(2)</sup> we expected that players, of both groups, would spend more time fixating in player in ball possession compared with other locations and they would spend less time fixating the ball compared with all other locations.

## METHODS

### SUBJECTS

Ten universities male soccer players (24.25±2.51yrs) without professional experience were assessed. Participants reported normal or corrected to normal levels of visual function. This research was conducted according to the ethical approval of the lead institution, which conforms to the Helsinki Declaration.

### FIELD TEST

The field test consisted of game sequences in the format of one SSCG – 2 vs. 1+GK (27mx20m; see Figure 1). The standardization of field measures used was based on the number of players' proportion <sup>(9)</sup>. The field area was determined by calculating the game space ratio used by soccer players according to the maximum length and width dimensions, established by the International Football Association Board for international games <sup>(14)</sup>.

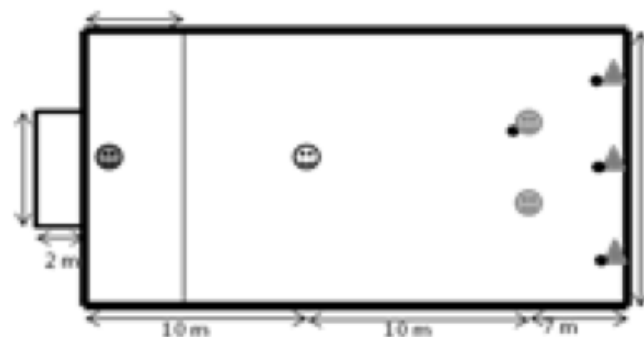


FIGURA 1. Representative picture of the SSCG (Gk + 1 vs. 2)

### APPARATUS

Subjects wore a *Tobii Pro Glasses 2*, this apparatus involves a video-based binocular corneal reflection system that records point of gaze with regard to glasses scene cameras. SSCGs were recorded using a Rollei Ac415 actioncam (Rollei GmbH & Co. KG, Norderstedt, Germany). The video clips were used to evaluate the tactical performance of soccer players.

### PROCEDURE

Before the SSCGs, was made a participant's familiarization with the game situation, eye tracker and Borg category ratio (Rate Perception Effort scale – RPE) were used during the testing protocol. To ensure that players were familiar with the test procedure, they were subject to three practice trials on the field <sup>(12)</sup>, they used the eye tracker throughout the field test, which was calibrated (Eye Tracker) before and between each test trial, just as the field game dimensions measurements.

RPEs were obtained through by registering in specifics spreadsheets. After each game period (1'40") the subjects informed their perceived exertion, according to Borg Scale ranged from 6 to 20 <sup>(1)</sup>. The RPE was used to separate the subjects in high intensity group and low intensity group.

### ANALYSIS METHODS

**Perceived exertion:** To separate the groups we used the Borg Rating of Perceived Exertion Scale with verbal anchors (RPE) comprehended in a 15-grade scale that ranges from 6 (minimum effort) to 20 (maximum effort) <sup>(1)</sup>. **Defensive Tactical performance:** The player's defensive tactical performance was assessed based on core tactical principles of soccer <sup>(5)</sup>. Performance values were calculated adapted with Teoldo, Garganta, Mesquita, Maia and Greco <sup>(16)</sup> which considers the tactical actions, with or without the ball, individually executed by the players. **Visual search:** We analyzed the fixation location data, fixation duration location (FDL) and number of fixations per location (NFL), from the onset of each game sequence. A fixation was defined as the period starting from 100 ms when the eye remained stationary within 0.5° of movement tolerance <sup>(20)</sup>. Thereby, we divided the fixation settings into five locations: (i) player in possession of the ball (i.e. body parts; PlayerBall), (ii) ball, (iii) space of player in ball possession (i.e. space around player and between legs; SpacePlayer), (iv) free space on the pitch (Space), and (v) undefined. The undefined category was excluded.

### STATISTICAL ANALYSIS

Independent *t*-test was performed to compare tactical behavior and visual search, within group intensity (high/low), and for the number of fixation locations and mean fixation duration per location (player in possession of the ball, ball; space of player in ball possession, space and undefined). The significance level was set at .05.

## RESULTS

### DEFENSIVE TACTICAL PERFORMANCE

The defensive tactical performance at high- and low- intensities is presented in Table 1. There were no significant differences in such variable of the performance between the two moments of evaluation within the two intensity groups (high  $t= 2.31$ ,  $p= .08$  and low  $t=1.48$ ,  $p= 2.12$ ) (SEE TABLE 1).

TABLE 1. Mean and standard deviation for defensive tactical performance according intensity group level and moments of evalua

	GROUP	1 <sup>ST</sup> MOMENT	2 <sup>ND</sup> MOMENT
TACTICAL PERFORMANCE	High Intensity	83.4 ( $\pm 9.83$ )	63.0 ( $\pm 25.81$ )
	Low Intensity	79.4 ( $\pm 8.38$ )	76.0 ( $\pm 5.83$ )

### PERCEPTUAL

The descriptive data from visual search behaviors (number of fixations location, NFL and mean fixation duration per location, FDL) of the high- and low-intensity exercise groups and in the two moments of evaluation are presented in Table 3.

In the number of fixations per location (NFL) there were no statistical differences between the two moments of the evaluation, in both groups.

There was found a statistical significant difference, within high-intensity group, in the fixation duration per location, particularly in Space of player in ball possession between 1<sup>st</sup> and 2<sup>nd</sup> moment of the evaluation ( $t_{(1)} = -3.47$ ,  $p= .04$ ) (SEE FIG. 2).

There were no significant differences, within low-intensity group, in fixation duration location (SEE FIG. 2).

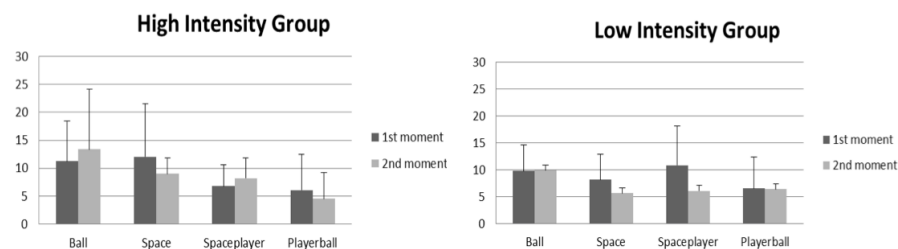


FIGURE 2. Mean total fixation duration spent to each location across group level. (PlayerBall: player in possession of the ball; SpacePlayer: Space of the player in ball possession; Space: free space on the pitch). Mean total fixation duration spent to each location across group level. (PlayerBall: player in possession of the ball; SpacePlayer: Space of the player in ball possession; Space: free space on the pitch).

\*Significant difference between high performance level and low performance level groups ( $P > .05$ ).

+ Significant difference between PlayerBall and Ball Fixation Location for low performance level group

## DISCUSSION

The aim of this study was to compare tactical behavior (i.e. defensive tactical performance) and visual search behavior and within two groups of perceived intensities in SSCG. We expected defensive tactical performance would decrease from 1<sup>st</sup> to the 2<sup>nd</sup> moment in high-intensity group due to the increasing quantity of sequences under numerical inferiority. Thereafter, we hypothesized the players would spent more time fixating PlayerBall and smaller time fixating the ball compared with other locations <sup>(19)</sup>.

Contrariwise our hypothesis, there were no found differences in defensive tactical performance of the soccer players in both groups. Despite the results in tactical behavior showed no statistical differences, absolute values decreased, it seemed the high intensity group performed better during the first moment than the second. The literature showed changes in intensity and in number of players in SSCGs can affect significantly the players' performance <sup>(4, 8)</sup>. Recently researches have shown that is not possible to predict performance on-field based by performance on habitual sets used to test perceptual and cognitive skills <sup>(12)</sup>.

According to the visual search behavior, data showed no differences in NFL. However, in FDL, data showed a difference which contrast our expectation, high intensity group employed longer fixation duration in Space of player in ball possession during the second moment compared with the first moment. It can be inferred the players tried to fixate on certain location to pick up information using the peripheral vision due to the challenge to play in numerical inferiority. In a study carried out assessing perceptual-cognitive skills of soccer players based on SSCG film tasks, the authors found a higher time spent fixating on the PlayerBall and on the Ball than other locations <sup>(17)</sup>. However, previous studies <sup>(2, 10, 17)</sup> reported player did not necessarily need to look directly to the ball to get relevant sources to solve problems during the game.

In this way, Casanova et. al. <sup>(2)</sup> sought to identify how visual search behavior was influenced during an intermittent exercise. The authors compared visual search of 16 soccer players (elite and non-elite) which were separated in two groups of 8 players each according their competitive level. They concluded that intermittent exercise induced changes in visual search of both groups; however, at the end of the exercise the high-level used fewer fixations of longer duration to a lower number of locations.

Nevertheless, we are suggesting a new proposal in methodological standards in order to facilitate comparisons and greater applicability of knowledge. We also suggested future researches with different SSCG configurations, as well as assessing other performance variables, such as offensive tactical performance.

We conclude that different levels of perceived effort can influence visual search behavior.

## REFERÊNCIAS

1. Borg GA (1982). Psychophysical bases of perceived exertion. *Med sci sports exerc* 14, 5: 377-381.
2. Casanova F, Garganta J, Silva G, Alves A, Oliveira J, Williams AM (2013). Effects of prolonged intermittent exercise on perceptual-cognitive processes. *Med Sci Sports Exerc* 45, 8: 1610-1617.
3. Casanova F, Oliveira J, Williams M, Garganta J (2009). Expertise and perceptual-cognitive performance in soccer: a review. *Revista Portuguesa de Ciências do Desporto* 9, 1: 115-122.
4. Clemente FM (2016). *Small-Sided and Conditioned Games in Soccer Training: The Science and Practical Applications*: Springer.
5. Costa ITd, Silva JMGd, Greco PJ, Mesquita I (2009). Princípios Táticos do Jogo de Futebol: conceitos e aplicação. *Motriz rev educ fís(Impr)* 15, 3: 657-668.
6. Coutts AJ, Rampinini E, Marcora SM, Castagna C, Impellizzeri FM (2009). Heart rate and blood lactate correlates of perceived exertion during small-sided soccer games. *Journal of Science and Medicine in Sport* 12, 1: 79-84.
7. Gonçalves E, de Rezende ALG, Teoldo I (2015). Comparação entre a performance tática defensiva e ofensiva de jogadores de futebol Sub17 de diferentes posições. *Revista Brasileira de Ciências do Esporte*.
8. Hill-Haas SV, Dawson B, Impellizzeri FM, Coutts AJ (2011). Physiology of small-sided games training in football. *Sports medicine* 41, 3: 199-220.
9. Hughes CF (1980). *The Football Association coaching book of soccer: tactics and skills*: British Broadcasting Corporation.
10. Martins F, Garganta J, Oliveira J, Casanova F (2014). The contribution of perceptual and cognitive skills in anticipation performance of elite and non-elite soccer players. *International Journal of Sports Science* 4, 5: 143-151.
11. Padilha MB, Moraes JC, da Costa IT (2013). O ESTATUTO POSICIONAL PODE INFLUENCIAR O DESEMPENHO TÁTICO ENTRE JOGADORES DA CATEGORIA SUB-13?-DOI: <http://dx.doi.org/10.18511/0103-1716/rbcm.v21n4p73-79>. *Revista Brasileira de Ciência e Movimento* 21, 4: 73-79.
12. Padilha MBB, Rafael Toshio; Milheiro, André; Tavares, Fernando; Casanova, Fernando; & Garganta, Júlio. (in press.). Visual search behavior and defensive tactical performance during small-sided conditioned soccer games. *Revista Portuguesa de Ciências do Desporto*.
13. TAVARES F, CASANOVA F (2013). A atividade decisional do jogador nos jogos desportivos coletivos. *Jogos desportivos coletivos: ensinar a jogar* Porto: Editora da Universidade do Porto.
14. Teoldo I, Costa M (2011). Proposta de avaliação do comportamento tático de jogadores de Futebol baseada em princípios fundamentais do jogo.
15. Teoldo I, Garganta J, Guilherme J (2015). Para um futebol jogado com ideias: concepção, treinamento e avaliação do desempenho tático de jogadores e equipes. Vila Mariana: Editora Appris.
16. Teoldo I, Garganta J, Mesquita I, Maia J, Greco PJ (2011). System of tactical assessment in Soccer (FUT-SAT): Development and preliminary validation. *Motricidade* 7, 1: 69-84.
17. Vaeyens R, Lenoir M, Williams AM, Philippaerts RM (2007). Mechanisms underpinning successful decision making in skilled youth soccer players: An analysis of visual search behaviors. *Journal of motor behavior* 39, 5: 395-408.
18. van Maarseveen MJ, Oudejans RR, Mann DL, Savelsbergh GJ (2016). Perceptual-cognitive skill and the in situ performance of soccer players. *The Quarterly Journal of Experimental Psychology*. 1-17.
19. van Maarseveen MJ, Oudejans RR, Savelsbergh GJ (2015). Pattern recall skills of talented soccer players: Two new methods applied. *Human movement science* 41: 59-75. Epub 2015/03/10.
20. Williams A, Davids K (1998). Visual search strategy, selective attention, and expertise in soccer. *Research quarterly for exercise and sport* 69, 2: 111-128.