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kasuya, Taizo / 中澤, 史 / 粕谷, 泰造 / Nakazawa, Tadashi

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Response of cognitive and physiological performance in soccer players during small-sided games

Taizo KASUYA（Tokyo College of Chiropractic）
Tadashi NAKAZAWA（Hosei University）

Abstract

The aim of this study was to manipulate the effects of condition changes on physical and psychological (cognitive-perceptual) loads for soccer players during 5-a-side soccer small-sided games (SSGs). In this study, twelve soccer players (age: 25.5 ± 2.2years, height: 178.59 ± 6.25cm, body mass: 74.67 ± 6.56kg, playing experience: 10.84 ± 2.62years) participated a total of eight SSGs under four conditions with a combination of physical-intensity {high-intensity (HI) and low-intensity (LI)} and soccer-related decision making task {high-task (HT) and low-task (LT)}. Heart rate (HR), RPE, blood lactate (Bla^-), technical activities and cognitive-perceptual questionnaires (CSAI-2) were analysed. In comparison among conditions, HI/LT condition presented significantly greater response in physical (HR, RPE, Bla^-) and technical performance {passing frequency (PF), numbers of playing option (PO)} during SSGs ($P < 0.05$). HI/HT condition showed higher physical responses, but poor technical activities observed, whereas LI/LT demonstrated lower physical demands but higher numbers of playing activity (PA) demonstrated. Various scores were collected for CSAI-2, specifically HI/LT and LI/LT conditions showed significantly lower anxiety level, however, no significant difference were observed in self-confidence scores during SSGs. This study revealed that 5-a-side SSGs played with such conditions can manipulate an effective development of psycho-physiological behaviours and differentiate technical activities in soccer players. Subsequently, it is importance for coaches to understand the relationship between physiological and psychological demands imposed upon players within SSGs.

Key words : small-sided games (SSGs), psycho-physiology, technical performance, exercise intensity, cognitive task, soccer

1. INTRODUCTION

Soccer has become the most popular sports and performed by various levels of expertise populations (Stolen *et al*., 2005). One of the reasons that it is so widely popular is that players may not need to have extraordinary athletic capacities, but possess a reasonable level within them, especially at professional level. Earlier studies have focused that physical, technical, and tactical developments are fundamental structures in soccer, yet they are not enough to produce greater players. Psychology (cognitive-perception) has been realized as another vital factor. Cognitive-perception is the ability to recognize and read 'play' as well to make quick and accurate soccer-related decisions during match. It is imaginable that a situation in which physical and cognitive tests become tools to further develop new and optimal training regimes in result of creating 'great' players. Moreover, it is necessary to study whether it is possible to enhance cognitive functions through training, such that improvement is expressed on the field.

Soccer is characterized as complex and frequent bouts of high-intensity exercise with various diverse movements requiring high demand of decision making skills (Aguiar *et al*., 2012; Reily, 2005). Especially, modern elite soccer players have been well-developed requiring in explosive power and strength, high agility and quickness abilities, and repeated endurance capacity as well as sufficient levels of tactical, technical, and cognitive-perceptual skills under continuous of high pressure and fatigue. Additionally, within a soccer match, players are required to undertake up to 1,500 activity changes and decisions, which incorporate aerobic actions including, running, sprinting, turning, and jumping, also high-intensity activities that require contributions from anaerobic metabolism (Bangsbo *et al*., 2006; Stolen *et al*., 2005). In such high performance required in soccer, it has been well documented that the maximum benefits are achieved when the training stimuli is similar to competitive demands (Bompa, 1983). Thus, many coaches and sports scientists have recognized a need of findings between ideal physical and manageable cognitive-perceptual prescriptions in soccer trainings in order to allow sufficient adherence for desired performance adaptation during competitive seasons. Laboratory-based researches have demonstrated valid data; however, it has failed to represent physical demands the unorthodox modes of soccer-specific movement associated with match-play (Drust *et al*., 2000; Stolen *et al*., 2005).

Of all, recent researchers have addressed in training sessions by using specific tasks with the aim of reducing any interactions and increasing the ratio of players' participation in physical fitness and decision making, but preserving basic variability properties from games (Aguiar *et al*., 2012). These tasks are known as small-sided games (SSGs) and its study is currently one of the most addressed topics in soccer contemporary research (Hill-Haas *et al*., 2009, 2010). SSGs have been introduced to simulate full soccer matches in terms of physical load and intensity resulting in improvements of fitness, tactical and technical performance. (Durante *et al*., 2009; Hill-Haas *et al*., 2010; Rampinini *et al*., 2007, 2009). Hill-Haas *et al*. (2009) reported that SSGs also increase player's motivation when compared to generic running intervals eliciting the same overall HR response. Moreover, by using SSG, coaches have the opportunity to maximize their contact time with players, increase efficiency of training, and subsequently reduce the total training time because of its multifunctional nature, particularly beneficial for elite players who have limited training time (Owen *et al*., 2012). Although soccer match is played with 10 field players per team, various formats of SSGs (2-a-side to 8-a-side) can provide reliable internal responses (e.g., heart rate, ratings of perceived exertion, and blood lactate concentration) and external load (i.e., total distance covered, technical performance) and thus represents a viable alternative to traditional interval training for maintaining aerobic in soccer players. In this context, SSGs are often being used in belief that they concurrently develop the key qualities of soccer athletes, irrespective of status (amateur, professional) and age (youth, adult) (Dellal *et al*., 2011).

Available studies have indicated that SSGs protocol can be affected to provide various performance responses by altering factors including players number, field dimension and shape, exercise and resting duration, game rules, encouragement, absence/presence of goalkeepers, limited ball contacts or scoring (Da-silva *et al*., 2011; Della *et al*., 2011; Fachini *et al*., 2011; Gabbet, 2008; Hill-Haas *et al*., 2009; Jones and Drust, 2007; Koklu *et al*., 2011; Little *et al*., 2007; Ngo *et al*., 2012; Rampinini *et al*., 2007). Although most of studies have mainly utilized physical and physiological variables to observe how training intensity effects soccer-specific performance in the field (Di-Salvo *et al*., 2009; Marcora *et al*., 2009), a better understanding of relationship between physiological capability and cognitive-perceptual behaviors in soccer players can contribute coaches in organizing of optimal training process. In this way, previous researches may have overlooked the influence of performing cognitive-perceptual aspects on physical exertion in soccer (Marcora *et al*., 2009; McMorris and Graydon 2010). Limited documents are available that they have attempted to explore the links between them (Beedie *et al*., 2005; Hampson *et al*., 2004; Marcora *et al*., 2009; Micklewright *et al*., 2010; Williams and Reilly, 2000). For instance, mood and emotional status can elicit decision making, cognitive-perceptual capability, running pace and strength performance (Baron *et al*., 2011; Mickewright *et al*., 2010; Perkins *et al*., 2001). Additionally, motivational interventions have shown to improve aerobic performance in distance running and speed (Barwood *et al*., 2008, 2009; Papaioannou *et al*., 2004). In contrast, increased training load has been eluded to negatively affect cognitive and emotional status (Filaire *et al*., 2001). Gabbett and Mulvey (2008) have reported improved performance in SSGs' tactical training in soccer players after cognitive-perceptual exercise. They observed that players with elite level of technical and perceptual skill spent less time in high-intensity activities and more time at jogging, walking and standing. Although perceptual training may has shown to increase decisional and tactical abilities, no study has investigated whether such improved abilities increase physical demands of game-based activities. The specific skill frequency of player may also influence training intensity; previous studies examining SSGs have primarily focused on the distance covered at various running speeds, leaving technical analysis of SSGs limitation (Owen *et al*., 2011). In added research, Drach-Zahavy and Erez (2002) demonstrated that as tasks become more complex the effects of specific athletic performance might be less pronounced or even harmful. One possible explanation was that combination of complex tasks with difficult goals creates stress that may lead to reduced performance. However, Vestberg *et al*. (2012) showed certain executive functions in soccer players finding that elite soccer players performed better in complex tests of executive functions than general populating. Nevertheless, all these studies did not determine the possible link between cognitive behavior, and its effects on physical development. Taken all together, understanding the interaction of soccer specific exercise in relationship between those parameters may provide a new insight into improving performance and ensuring players are ready to compete.

To our knowledge, no attempt has been made to examine between physiological and cognitive-perceptual behaviors during SSGs, revealing how different physical-intensity and decisional tasks a soccer player responses while 'reading' the game. Hereby, this study aimed to provide an example of operative training regimens in relevant physical responses and soccer-specific technical performance frequency not highlighted in previous literature. This may also provide an update on how ranges of physical-intensity and cognitive-perceptional loads affect 'psycho-physiological' behaviors within SSGs. It is thought that, physical and cognitive-perceptual loads can manipulate an ideal frequency of soccer-specific technical performance, moreover, 'psycho-physiological' variables can enlarge further understanding of relationship between physical and psychological attitude in soccer player, which may give us one of the ideal soccer-specific training programs resulting in production of 'greater' players.

2. METHODS

2.1. Experimental design

To test the study aim, participants were evaluated during SSGs play under four different combinations of physical-intensity and soccer-related decision task condition: 1) high-intensity and high-task (HI/HT), 2) high-intensity and low-task (HI/LT), 3) low-intensity and high-task (LI/HT), and 4) low-intensity and low -task (LI/LT) (Table I). In this repeated measures study, participants were taken part in one familiarization and total of eight 5-a-side SSGs' sessions within 4 weeks in separate days. Specifically, participants attended each of four SSGs' conditions twice, and each session consisted 1×5-min of SSG play. At each session, participants performed two different conditions of SSGs under random order, interspersed with 10-min passive recovery. Physical-intensity was set with a same number of players (5 vs.5 including GK) under different pitch size to create a range of participant's physical-intensity responses {low-intensity at 35×50m; high-intensity at 45×60m (width × length)}, and they were similar to those used in previous researches, as the pitch ratio per player in different intensity percentages (Aguiar *et al*., 2012; Clemente *et al*., 2012; Iaia *et al*., 2009). Decisional task was controlled by presence or absence of two neutral players for every attacking play, making 7 vs.5 condition, to generate different frequency of playing options (e.g., passing, dribbling, shooting) and to release high pressure from opponent team. All matches were played during the same hours of day between 16:00 and 17:00, under similar conditions (temperature: 20.75 ± 1.17° C, relative humidity: 48.5 ± 3.43%) with the pitch surface totally dry. The study was completed in an outdoor soccer field equipped with artificial turf at IM Marsh Sports Complex of Liverpool John Moores University. Data on HR and video analysis of each player were recorded during SSGs, whereas RPE and Bla- were collected at immediately after every game, also participants were required to complete CSAI-2 questionnaires every post-game.

2.2. Small-sided games (SSGs)

Game duration was set based on previous researches and coaching experience, taking into account that 5-min do not correspond to effective playing time due to the stoppages (e.g., fouls, goals, throw-ins, goal kicks) that normally occur in soccer matches (Casamichana and Castellano, 2010; Dellal *et al*., 2011). A standard warm-up procedure consisting 10-min of jogging, striding, stretching were explained previously to first session and completed by all participants at pre-game. During SSGs, all participants were encouraged to play fairly with own and opponent teammates and to perform in order to win. All the official rules were implemented using FIFA rules

Table I. Characteristics of four different SSGs' *[1]conditions.

	HI/HT*[3]	HI/LT*[4]	LI/HT*[5]	LI/LT*[6]
Numbers of player	5 vs. 5	5 vs. 7	5 vs. 5	5 vs. 7
Neutral player*[2]	No	Yes	No	Yes
Goalkeepers	Yes	Yes	Yes	Yes
Duration	1 × 5 min	1 × 5 min	1 × 5 min	1 × 5 min
Pitch size	60 × 50 m	60 × 50 m	50 × 40 m	50 × 40 m
Playing area	3000 m^2	3000 m^2	2000 m^2	2000 m^2
Ratio per player	300 m^2	250 m^2	200 m^2	167 m^2
FIFA rules (no offside)	Yes	Yes	Yes	Yes

*[1] *SSGs = small-sided games.*
*[2]*Neutral players = two additional participants to join at every attacking team.*
*[3-6] *HI = high intensity; LI = low intensity; HT = high task; LT = low task.*

Table II. Participant's physical and physiological features.*1

Variables	
Age (years)	25.5 ± 2.2
Height (cm)	178.59 ± 6.25
Body mass (kg)	74.67 ± 6.56
BMI (%)	23.42 ± 1.88
Playing experience (years)	10.84 ± 2.62
Maximum heart rate (b/min^{-1})*2	194.50 ± 2.19

*1 *Values are given as mean ± SD (n = 8).*
*2 *Maximum heart rate (HR_{max}) was based using standard age calculation (220 – age = HR_{max}).*

apart from the offside, and rules were controlled by researchers but no referees or sidelines were present. No further instruction or feedback about SSGs was conceded throughout the study.

2.3. Participants

Twelve male soccer players (age: 25.5 ± 2.2yearss, height: 178.59 ± 6.25cm, body mass: 74.67 ± 6.56kg, BMI: 23.42 ± 1.88%, HR_{max}: 194.5 ± 2.19bpm, playing experience: 10.84 ± 2.62years) were volunteered to participate from friends and acquaintance of the researchers in this experiment (Table II). All participants received a participant information sheet and provided written informed consent after verbal explanation of the study, and they were aware that they could withdraw at any time. This study was approved by Research Institute of Sport and Exercise Science (RISES). To minimize the effect of experimental variables, all participants were required to wear similar sporting clothes and proper soccer boots, whereas colored bibs (orange and yellow) were provided in order to differentiate teams. For a period of 24 hours before each session, participants were refrained from strenuous exercise and alcohol and they were also refrained consuming of any food or caffeine 2 hours prior to testing.

2.4. Video analysis (technical performance)

Technical performance was measured to estimate numbers of soccer-specific 'observable' frequency option and activities each participant have during various SSGs' conditions. From video analysis, we assessed the possible passing frequency at every ball possession individual player received and summarized for average of passing frequency (PF), total number of passing option (PO), and total number of playing activity (PA). All matches were filmed using a standard camera recording device with consent of participants to examine the performance indicators during SSGs. The cameras were fixed on a tripod at 5-meters behind each goal with an elevation of 3-meters. Images were transferred to a computer via USB and viewed in Windows Media Player (Microsoft® Corporation, U.S.A). Afterward, data were recorded and calculated on a Microsoft Office Power Point 2007 (Microsoft® Corporation, U.S.A) and exported to SPSS Statistics, version 17.0 (SPSS® Inc., U.S.A).

2.5. Physiological variables

Heart rate (HR), ratings of perceived exertion (RPE), Blood lactate (Bla^-) were measured as an indication of physical workload imposed on participants during SSGs.

2.5.1. Heart rate (HR)

HR was monitored telemetrically using 5-sec intervals Polar Heart Rate Monitors RS400 (Polar Electro Oy, Finland) during SSGs. The monitors were attached to participants using an adjustable elastic chest strap where transmitted signals to a receiver on the wrist. Participants were instructed to regulatory check that monitors were functioning correctly, and researchers were on hand to deal with any problems that arose. Immediately after each SSG session, the data were stored in the watch and then downloaded on a computer using Polar precision 3.0 software (Polar Advantage™, Polar Electro, Kempele, Finland) and subsequently exported and analyzed using Excel micro software program (Microsoft Corporation, USA). Mean HR ($b \cdot m^{-1}$), percentage of maximal HR (%HR_{max}), peak HR ($b \cdot m^{-1}$), and percentage of peak HR (%HR_{peak}) during working periods were calculated for each participant during SSG. Resting periods were excluded from the analysis. Maximum HR for each player were established using an incremental maximum HR correlate with an age (220 - age = maximum HR) (Fox and Haskell, 1970; Tanaka *et al.*, 2001).

	Not at all	Somewhat	Moderately so	Very much so
1. I am concerned about this competition.	1	2	3	4
2. I feel nervous.	1	2	3	4
3. I feel at ease.	1	2	3	4
4. I have self-doubts.	1	2	3	4
5. I feel jittery.	1	2	3	4
6. I feel comfortable.	1	2	3	4
7. I am concerned I may not do as well in this competition as I could.	1	2	3	4
8. My body feels tense.	1	2	3	4
9. I feel self-confident.	1	2	3	4
10. I am concerned about losing.	1	2	3	4
11. I feel tense in my stomach.	1	2	3	4
12. I feel secure.	1	2	3	4
13. I am concerned about losing.	1	2	3	4
14. My body feels relaxed.	1	2	3	4
15. I'm confident I can meet the challenge.	1	2	3	4
16. I'm concerned about performing poorly.	1	2	3	4
17. My heart is racing.	1	2	3	4
18. I'm confident about performing well.	1	2	3	4
19. I'm worried about reaching my goal.	1	2	3	4
20. I feel my stomach sinking.	1	2	3	4
21. I feel mentally relaxed.	1	2	3	4
22. I'm concerned that others will be disappointed with my performance.	1	2	3	4
23. My hands are clammy.	1	2	3	4
24. I'm confident because I mentally picture myself reaching my goal.	1	2	3	4
25. I'm concerned I won't be able to concentrate.	1	2	3	4
26. My body feels tight.	1	2	3	4
27. I'm confident of coming through under pressure.	1	2	3	4

Instructions: Complete the following scale on two separate occasions: at pre-trial when you are fairly relaxed, and at post-trial when a competitive situation that you feel highly stressful.
The following are several statements that participant use to describe their feelings before and after competition. Read each statement and circle the appropriate number to indicate how you feel right now, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement.

This scale is called the Competitive State Anxiety Inventory-2 (CSAI-2), a sport-specific state anxiety scale developed by Martens, Vealey, and Burton (1990). The scale divides anxiety into three components: cognitive anxiety, somatic anxiety, and a related component-self-confidence. Self-confidence tends to be the opposite of cognitive anxiety and is another important factor in managing stress.

Table III. Physiological variables: HR (HR_{mean}, $\%HR_{max}$, HR_{peak}, $\%HR_{peak}$), RPE and Bla^- between four different SSGs' conditions.*[1]

	HI/HI	HI/LT	LI/HT	LI/LT
Heart rate ($b{\cdot}min^{-1}$)				
Mean HR ($b{\cdot}min^{-1}$)	174.0 ± 2.36	167.1 ± 3.23	165.5 ± 1.67	154.4 ± 2.54
Mean HR ($\%HR_{max}$)	89.7 ± 1.97	86.1 ± 2.62	85.3 ± 2.65	82.2 ± 1.39
Peak HR ($b{\cdot}min^{-1}$)	188.0 ± 2.19	182.2 ± 2.98	180.9 ± 2.37	173.6 ± 5.73
Peak HR ($\%HR_{peak}$)	96.86 ± 2.18	93.85 ± 2.76	93.22 ± 2.56	89.47 ± 5.04
RPE (6 – 20)				
Post-	15.56 ± 0.42	14.38 ± 0.52	14.56 ± 0.62	13.19 ± 0.92
Bla^- ($mmol.L^{-1}$)				
Post-	8.58 ± 3.83	7.09 ± 3.03	7.19 ± 3.31	6.34 ± 4.73

[1] Values are given as mean ± SD. (n = 8).
**Significant difference from the 5-a-side SSGs in four different conditions, $p < 0.05$.*
**Mean = average of heart rate during 5-min SSG; $\%HR_{max}$ = percentage of maximum heart rate, Peak = peak of heart rate during 5-min SSG.*
**RPE = ratings of perceived exertion; Bla^- = blood lactate concentration.*
**HI/HT = high intensity/high task, HI/LT = high intensity/low task, LI/HT = low intensity/high task, and LI/LT = low intensity/low task.*

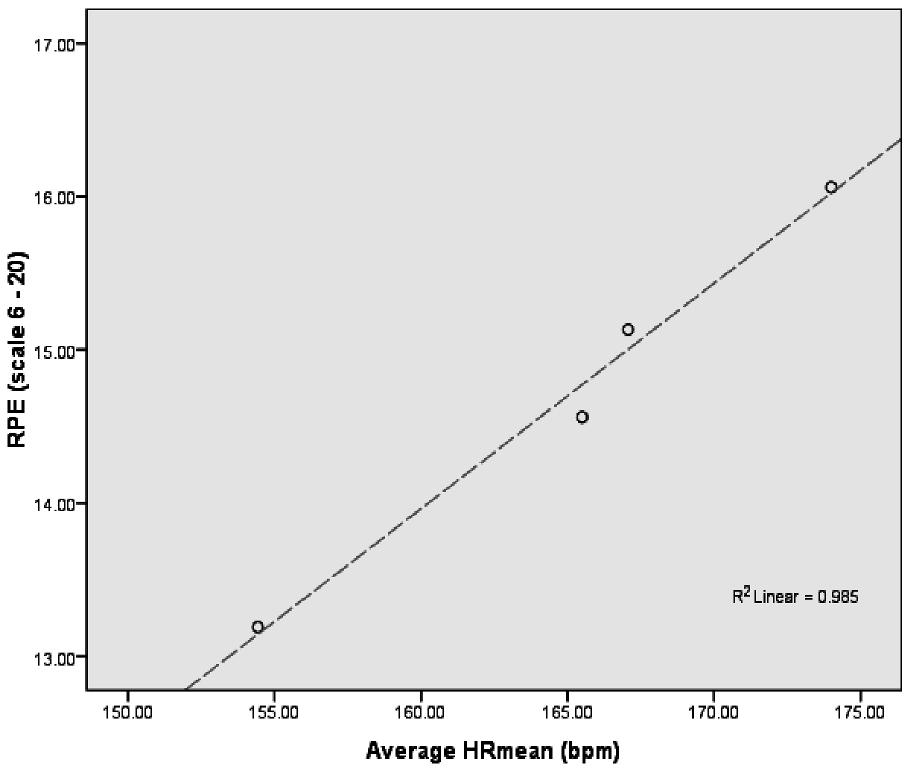

Figure. 1.
Relationship between mean heart rate (HR_{mean}) and mean ratings of perceived extension (RPE) using 4 mean values from all 8 participants. $r = 0.98$, $P = 0.01$.

2.5.2. *Ratings of perceived exertion (RPE)*

Participants were asked to state their mean perceived exertion and physical effort, relative to a bout of SSG just completed, using a printed Borg's 15-point scale modified by Foster *et al.* (2001). For a period prior to testing, all participants were educated and familiarized with the use of RPE scale.

2.5.3. *Blood lactate concentration (Bla^-)*

Bla^- was analysed as to contribute anaerobic glycolysis during SSGs. One blood sample was collected immediately after completion of SSG using capillary blood sample by pricking from participant's tip of finger, and instantly analysed using portable amperometric micro-volume lactate analysers (LactatePro, Arkray, Japan). Participants were asked to temporarily leave the pitch within 30-sec and sit on a side-line for collection. We carefully cleaned, disinfected and dried participant' tip of finger before collection, in order to avoid any possible interference due to sweat and dirt. Before each session, the analysers were calibrated following manufactures recommendations. To limit the influence of diet on Bla^-, all participants were asked to follow a generic weekly nutritional plan to ensure an adequate carbohydrate intake, however, a food diary was no recorded by participants.

2.6. *Cognitive-perceptual variable*

Competitive state anxiety inventory-2 (CSAI-2) (Martens *et al.*, 1990) was used to determine psychological 'subjective' variable as an indication of cognitive load imposed on participants during SSGs. The CSAI-2 consists of 27 questions, 9 for each subscale (cognitive, somatic, and self-confidence). Each item was rated on a 4-point Likert-type scale, producing a score ranging from a low 9 to a high 36 for each subscale. All items were positively stated except the item 14 which was stated as negatively and was, thus, scored reversely in the analyses. Higher scores on cognitive and somatic anxiety indicate higher levels of anxiety, whereas higher scores on self-confidence subscale correspond to higher levels of self-confidence.

3. STATISTICAL ANALYSIS

All data are presented as me*f*an ± *SD*. Differences between four conditions of each dependent variable, including game activities (PF, PO, and PA), physiological variables (HR, RPE, Bla^-), and cognitive-perceptual scores (CSAI-2), were determined using a repeated two-way ANOVA with the factor intensity of 2 levels (high-intensity and low-intensity), and factor task with 2 levels (high-task and low-task). Significant main effects were subsequently analyzed using Bonferroni's test to locate differences. Correlation coefficients were tested for significance using Pearson's regression test and determined both of physiological variables (HR_{mean} and RPE) and cognitive-perceptual scores with game activities in each SSG. The magnitudes for correlation coefficients were considered in accordance with Hopkin's definition (Hopkins, 2002). All statistical analysis was carried out using the statistical package for social science (SPSS) for MS window release 17. In all case, the acceptance level significant was set at $P < 0.05$ and all results were presented as mean values ± standard deviation (*SD*).

4. RESULTS

4.1. *Physiological variables*

HR responses showed varied results according to four different SSGs' conditions. HR at HI/HT condition as $\%HR_{max}$ and $\%HR_{peak}$ was greater during SSGs comparison to those found in other conditions ($P < 0.01$). In contrast LI/LT condition presented the lowest HR response, whereas, HI/LT and LI/HT showed similar responses during SSGs (Table III). RPE results presented also significant differences among all condition. HI/HT condition (16.1 ± 0.5) presented significantly higher response of RPE during SSGs ($P < 0.001$), whereas LI/LT (13.19 ± 0.92) presented as the lowest value compared to other conditions (Table III). The correlation between HR_{mean} and RPE was $r = 0.98$ ($P < 0.01$) and this non-statistically significant relationship is shown in Figure 1. There is a high positive correlation between variables with HR_{mean} accounting for 98% of variation in RPE during SSGs. Although more high-intensity running activities were performed during HI/HT condition, Bla^- recorded similar values across all condition (Table III). Only HI/HT condition remained significantly higher value in comparison to other conditions ($P < 0.01$). In general, there were higher increased HR, RPE and Bla^- in response to conditions using large field (HI) without presence of neutral players (HT) during SSGs.

4.2. *Technical performance analysis*

There were significantly varied differences in effective performance frequency according to different SSGs' formats (Table IV). Specifically, a greater number of PF and PO were found during HI/LT condition (PF: 4.32 ± 0.01; PO: 25.8 ± 8.87) in comparison to other conditions, whereas a higher number of PA activities during SSG was found in LI/LT condition (9.35 ± 3.54). In contrast, HI/HT condition significantly showed the poorest performance frequency in all variables (Table IV). The correlation of technical analysis with HR_{mean} and RPE during SSGs are presented in Table V. There were high negative correlation between number of PA

Table IV. Technical analysis comparison between four different SSGs' conditions.*[1]

	HI/HI	HI/LT	LI/HT	LI/LT
Passing frequency (PF)	2.61 ± 0.09	4.32 ± 0.01	2.35 ± 0.06	3.70 ± 0.02
Total play activity (PA)	6.95 ± 0.71	7.90 ± 2.83	8.80± 2.83	9.35 ± 3.54
Total passing options (PO)	17.6 ± 5.08	25.8 ± 8.87	20.4 ± 5.38	24.4 ± 7.85

**[1] Values are given as mean ± SD. (n = 8).*
**Significant difference from the 5-a-side SSGs in four different conditions, p < 0.05.*

Table V. Relationship between technical analysis with HR_{mean} and RPE using 4 mean values (*n* = 8).

	Passing frequency	Total play activity	Total passing options per play
HR_{mean}	0.15	0.86*	0.65
RPE	- 0.08	-0.93*	-0.58

**Significant correlations.*

and HR_{mean} (r = -0.86, P < 0.01), whereas significant negative correlation with RPE was also found (r = -0.93, P < 0.01). However there were no other significant correlations between SSGs' conditions and technical performance.

4.3. Cognitive-perceptual variables

CSAI-2 scores for entire samples are shown in Table VI. The results presented that significant higher cognitive and somatic anxiety scores were found (P < 0.05) in HI/HT and LI/HT conditions, whereas HI/LT condition showed lower scores during SSGs. However, there were no significant differences in self-confidence scores between all conditions (P < 0.05). Of all, HI/LT condition reports as being the most facilitating and less debilitating to performance (Cognitive: 30.94 ± 1.53, Somatic: 25.56 ± 2.31) in comparison to other conditions. Coefficient of variation between physiological variables and CSAI-2 scores are presented in Table VII. In general, there were no significant correlations among conditions.

5. DISCUSSION

The present SSGs' protocol was 5-a-side 2×5-min with a 10-min resting period, whereas other studies investigated various different bouts, duration and player numbers (Brito *et al*., 2012; Castagna *et al*., 2009; Drust *et al*., 2007; Duarte *et al*., 2009; Gabbett, 2009; Kelly and Drust, 2009; Rampinini *et al*., 2007, 2009). Therefore, comparison between studies should be done with caution, since several factors such as duration, field dimension, exercise type, and player numbers may affect psycho-physiological behaviors to SSGs (Rampinini *et al*., 2007). Given that understand role of internal performance load in inducing training adaptation for soccer players, researchers and coaches have gained further interest in cognitive-perceptual influences.

The aim of this study was to examine whether physical response and technical performance in soccer players can be manipulated using four SSGs' conditions, and to determine how these conditions can interact cognitive-perceptual behaviors, which may play a key role to alter the individual playing on physical responses in soccer training. From previous researches involving the analysis of technical and physical behaviors during SSGs (Clemente *et al*., 2012; Iaia *et al*., 2009; Rampinini *et al*., 2007), we predicted that there would be systematics, skill-based differences in cognitive-perceptual processes as a function of task constraints. We further expected that such skills would reveal an interaction each other during performance. The findings from present study showed that 5-a-side SSGs under four conditions induce significant differences for most of the variables including a high variation of intensity level, aerobic system response and

Table VI. Scores of cognitive and somatic anxiety state, and self-confidence between four different SSGs' conditions.*[1]

	HI/HI	HI/LT	LI/HT	LI/LT
CSAI-2				
Cognitive Anxiety	34.81 ± 1.83	30.94 ± 1.53	35.19 ± 0.95	31.34 ± 1.44
Somatic Anxiety	31.44 ± 2.22	25.56 ± 2.31	31.50 ± 1.90	28.81 ± 2.54
Self-confidence	18.94 ± 3.38	18.31 ± 2.36	17.86 ± 3.98	17.88 ± 3.18

**[1] Values are given as mean ± SD. (n = 8)*

Table VII. Correlation between HR and CSAI-2.*[1]

	Cognitive-anxiety				Somatic-anxiety				Self-confidence			
	HI/HI	HI/LT	LI/HT	LI/LT	HI/HI	HI/LT	LI/HT	LI/LT	HI/HI	HI/LT	LI/HT	LI/LT
Correlation	- 0.36	0.06	0.63*	- 0.14	- 0.32	- 0.20	0.14	- 0.06	- 0.08	- 0.21	0.02	- 0.24
Mean value	34.81 ± 1.83	30.94 ± 1.53	35.19 ± 0.95	31.34 ± 1.44	31.44 ± 2.22	25.56 ± 2.31	31.50 ± 1.90	28.81 ± 2.54	18.94 ± 3.38	18.31 ± 2.36	17.86 ± 3.98	17.88 ± 3.18

**[1] Values are given as mean ± SD. (n = 8).*
**Significant correlations*

performance frequency. The major interesting was found that technical analysis has shown there was a large practical difference, especially high-intensity and low-task (HI/LT) condition demonstrated a higher number of performance load (HR, RPE, and Bla^-) and affected greater technical frequency actions (PF and PO) compared to other conditions. Moreover, SSG played in condition at HI/HT induced higher physical-intensity performance but poor in technical activities, whereas condition at LI/LT showed less intensity but higher in numbers of PA during SSGs. Furthermore, physical workload and RPE were all significantly different, whereas certain cognitive-perceptual anxieties were observed high rate at HI/HT and low with HI/LT. These findings could be linked to necessity for further understanding the relationship between cognitive-perceptual behavior and physiological load in soccer training thereby importance not only increasing intensity, but also careful organization of practice with psychological load (Casamichana and Castellano, 2010; Hill-Haas *et al*., 2010; Owen *et al*., 2012).

Although SSGs have been commonly described as training to maintain and improve physical, technical, and tactical capacity (Couts *et al*., 2009; Dellal *et al*., 2012; Katis and Kellis, 2009; Kelly and Drust, 2009; Impellizzeri *et al*., 2007), the majority of earlier studies have not yet addressed and differentiated physical activities and physiological responses during four combination of SSGs' conditions. HR monitoring has been traditionally used during SSGs in order to examine physiological requirements. Our results showed that average figures for $\%HR_{max}$ in all conditions were ranging from 82% to 90%, with $\%HR_{peak}$ close to maximum ranging from 89% to 97% (Table III), which are in agreement to what previous studies have observed for individuals during 5-a-side SSGs on the grass pitch (Brito *et al*., 2012), during match-play for experienced players (Little and Williams, 2006, 2007; Rampinini *et al*., 2007), and futsal (Castagna *et al*., 2007). Moreover, individual $\%HR_{max}$ values were significantly higher at HI/HT compared to other conditions ($\%HR_{max}$, 89.7 ± 1.97% and peak $\%HR_{max}$, 96.86 ± 2.18%), which are similar to, or even higher than what has been observed previously. Little *et al.* (2007) measured intensity in different soccer training drills (from 2 vs.2 to 8 vs.8) and results demonstrated when number of players decreased, a higher $\%HR_{max}$ was attained, although 2 vs.2 SSGs induced significantly lower responses than 3 vs.3 and 4 vs.4. In contrast, some authors reported a different conclusion (Aroso *et al*., 2004; Dellal *et al*., 2012; Hill-Haas *et al*., 2008, Hoff and Helgeryd, 2004; Kelly and Drust, 2007; Sampaio *et al*., 2007). These different results could be explained with a lack of consistency in standardization of SSGs' design, variable external load and environmental effect; it is still difficult to make accurate conclusions on the influence of these factors separately.

Using HR to monitor exercise responses has not been considered as only the indicator to examine physiological requirements during SSGs. RPE can be an alternative measure of soccer-training load (Rampinini *et al*., 2007, 2009) that allows for analysis global internal load (Alexiou and Coutts, 2008; Coutts *et al*., 2009; Jones and Drust, 2007). In present study, RPE appeared to be a good indicator of overall intensity activity, especially it showed a significant positive correlation with HR_{mean} (r = 0.98, P < 0.01). Our results showed that RPE were significantly difference among conditions expect conditions between HI/LT and LI/HT. Participants perceived easier at LI/LT condition than other conditions, whereas they experienced more difficult at larger field, particularly without neutral players. It would be expected from this data that presence of neutral player could induce lower intensity within SSGs, whereas larger pitch dimension increase both perceptual and physical load. However, Hill-Haas *et al*. (2010) reported no significant changes in RPE between SSGs using 4 different rule modifications in 3 vs.4 and 3 vs.3 + floater games. The authors concluded that in SSGs there are changes in physiological and time-motion responses but not in perceptual responses when rules changes were employed. In this way, further investigation need to be elucidated in in order to facilitate standardized responses.

Interestingly, in spite of different intensity load observed during SSGs, blood analysis showed slightly differences between conditions. The average Bla^- of 6.3-8.6 $mmolL^{-1}$ observed from present study are similar to, or slightly higher to those reported for experienced players during SSGs (Rampinini *et al*., 2007), 11-a-side soccer games (Krustrup *et al*., 2010), and futsal games (Castagna *et al*., 2007), averaging of 3.4, 7.9, and 5.3 $mmolL^{-1}$. Due to higher intensity runs being performance during SSGs, anaerobic energy turnovers would be expected to contribute more to muscle metabolism as comparing between conditions. This finding that higher Bla^- at condition of HI/HT(8.58 ± 3.83 $mmolL^{-1}$) may well be explained by the fact that high-intensity running level were longer and more demand causing a higher reliance on anaerobic glycolysis rather than ATP and CP breakdown. However, due to a lack of technical collection timing, the data accuracy could be implied.

Nevertheless, it is difficult to control performance frequency due to a tactical component, fitness level, and more coefficients of variations (Dellal *et al*., 2012). The precise determination of four different SSGs' conditions could support additional understanding of technical activities and physical demand for soccer players. As regards of present study, video analysis indicated that average PF increased when SSG is played at high-intensity and low-task (PF: 4.32 ± 0.01, PO: 25.8 ± 8.87) however, smaller dimension with a presence of neutral players had higher repetition of PA (9.35 ± 3.54) compared to other conditions. From these reports, players probably performed quicker movements and more of short running to receive the ball at low-intensity condition, resulting in higher repetition of playing action between players; however, such condition did not show a correlate with a high frequency of PO. We assumed that large dimension where players are situated; they were able to find more spaces and to possess high frequency of technical activities between play, and particularly presenting of neutral players support to increased option numbers. This result has been consistent related with previous findings (Casamichana and Castellano, 2010; Kelly and Drust, 2007; Owen *et al*., 2011; Tessitore *et al*., 2006), however, previous studies reported a significant difference in decision making behaviors, whereas we estimated in available option frequency per given play. Although no previous studies have stated that presenting of neutral players would impose greater load for soccer players as it may increase motivation and reduce decisional stress with aim to gain possessions. The reasons might be that players find higher numbers of playing option with extra players which advantage to maintain players at better ball possessions. In present study, players might have encountered a greater number of changes in different conditions requiring additional efforts throughout SSGs, such to adapt a different game tempo, repeated directional changes, accelerations and decelerations (Dellal *et al*., 2011) although technical elements of player were not measured here. It would appear; therefore, that size of pitch and presenting of neutral players can give an insight of player' s behaviors in SSGs.

In further understanding of players' behavior, we used CSAI-2 questionnaires that could offer a potential explanation of differences in physiological and cognitive stress during SSGs (Martens *et al*., 1990; Lundqvist *et al*., 2011; Rose and Parfitt, 2008). One interesting aspect from present study was that when HR intensities inclined, participants reported more focused and confidence than at lower intensities. Moreover, the findings described that all scores were negatively related with conditions using high-intensity and cognitive-task. This would explain that as a group of players may experience higher psycho-physiological load, less anxieties they 'felt' during SSGs. In this respect, sessions being conducted during SSGs equivalent intensities may not just incline physical load but also cognitive-perceptual scale. Researchers investigating the effects of an increased cognitive load have reported that a rise in an individual's cognitive behavior attenuates feelings of confidence. However, there were number of issues highlighted in the implementation of data collection techniques. Several of participants had not recognized exact term of the words. This resulted in the use of explanatory sheets providing definitions of key words. Furthermore, the questionnaires were used total of eight times throughout the study, which may have led to "learning effect" in participants and they may completed using previous experience instead of immediate feeling after each completion of SSGs.

6. CONCLUSION

Findings from present study underline that the SSGs on all investigated different combination of physical-intensity (field dimension) and cognitive-task (present or absent of neutral players) conditions can be manipulated as an effective stimulus for development of psycho-physiological systems and various performance behaviors. This may have implications in how soccer coaches structure and periodize training ensures stronger relationship between those behaviors across the seasons. Thus, coaches should pay special attention to such roles when designing the training program. In this interest of providing the participants with the most favorable playing stimulation, but to emphasize a further effect, future investigations are required to better understand the difference in moving patterns, physiological and cognitive-perceptual behaviors during daily training and real match with manageable scale. Furthermore, the use of standardized conditions in SSG studies will probably allow a better understanding of role in individual factors and may help researchers and coaches to find more valid and reliable conclusion.

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