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Influence of non-preferred foot technical training in reducing lower limbs functional asymmetry among young football players

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Abstract
The functional asymmetry of the lower limbs has been regarded as a relevant factor of the performance of football players. We purposed to ascertain whether a specific technical training programme for the non-preferred foot has implications in the increasing utilisation rate of the respective member during the game. Young football players (n = 71) were randomly divided into experimental group (N = 35; 14.37 ± 1.94 years) and control group (N = 36; 14.50 ± 1.81 years). The study was developed into three stages: first, assessment of the index utilisation of both limbs during the game; second, application of a technical training programme that includes the drilling of specific motor skills exclusively directed to the non-preferred foot; and third, assessment of the new rate of both limbs' utilisation after the predefined six months. The main findings were: (1) the use of the non-preferred foot increased significantly with the technical training programme in the experimental group and remained constant in the control group; (2) the use of the preferred foot decreased significantly in the experimental group and remained similar in control group. We concluded that a systematic and specific technical training for the non-preferred foot increases its use and reduces functional asymmetry in game situation, consequently improving the player's performance.

Keywords: *football, functional asymmetry, preferred foot, non-preferred foot, skill acquisition*

Introduction

The quality of a football player emerges from the interaction of complex issues, linked with cognitive, motor and perceptive skills (Bate, 1996; Reilly, Williams, Nevill, & Franks, 2000; Williams, 2000). The cognitive skill is related to the competence that the players show to understand and realise what is happening in the game context (Williams, 2000; Williams, Davids, & Williams, 1999). The perceptive skill refers to the ability that player demonstrates to anticipate game events, and, consequently, to know what and how to perform, taking into account the information that protrudes from the context (Tavares, Greco, & Garganta, 2006; Williams, 2000; Williams et al., 1999). The motor skill refers to the execution of specific technical and tactical abilities, which are in turn sustained by physiological abilities (Reilly et al., 2000).

During a match, the performance of a specific technical skill elapses from a decision that arises from cognitive, perceptive and motor skills (Garganta, 2006; Williams, 2000; Williams et al., 1999; Williams & Hodges, 2005). Consequently, the technical quality of a player should not be analysed separately from the game, because this is the context that holds the constraints of adversity, randomness, variability in space and time to decide and execute (Ali, 2011; French, Werner, Rink, Taylor, & Hussey, 1996; Garganta, 2006; Knapp, 1972). In the technical range, there are several studies concerning skill performance in football that highlight the relevance of the use of both preferred and non-preferred foot in the proficiency of players (Barfield, 1995; Capranica, Cama, Fanton, Tessitore, & Figura, 1992; Carey et al., 2001; Grouios, Kollias, Koidou, & Poderi, 2002; Oliveira, Beltrão, & Silva, 2003; Starosta, 1988, 1990; Starosta & Bergier, 1993). This leads to the importance of analysing the functional asymmetry of the lower limbs in football players.

Functional asymmetry can be defined as the difference in the performance of a human characteristic called body laterality, which is expressed as the use of the preferred symmetric parts of the body: foot, hand, ear or eye (Fonseca, 1988). The functional asymmetries have been increasingly considered

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dynamic processes, since they arise from a multitude of factors, such as genetic, neurological, sociocultural and life experiences, which correlate and influence each other. With regard to sport more broadly, persistent training must also be considered as a relevant factor underpinning fluctuations in functional asymmetry (Teixeira & Paroli, 2000; Vasconcelos, 2004).

However, asymmetries can be included in two categories: those of preference and those of proficiency. The first are related to the preferred limb used to perform a unilateral task or, in the event of being a bilateral task, the limb that assumes the main role. The latter relate to the most skilful limb to complete the task (Leconte & Fagard, 2006; Teixeira, 2006; Teixeira & Paroli, 2000). Thus, to determine foot preference and foot proficiency, it is required to distinguish the task that will be observed, since a limb may be preferred for a certain task, for example handling of the ball, while its contralateral limb is assumed as non-preferred. Nevertheless, the latter is preferred for stabilising the body while the first for this task becomes non-preferred (Leconte & Fagard, 2006; Teixeira, 2006; Teixeira & Paroli, 2000).

In the present study, as we focus on the specific technical analysis of football players, the preferred and most proficient limb coincide. Taking into account the assumptions made about the use of one limb over another during the football game, and as such use is related to conscious and unconscious processes, resulting from life experiences (Beilock, Wierenga, & Carr, 2003; Damásio, 2000, 2010; Gasaniga, 2000; Godinho, Mendes, Melo, & Barreiros, 2002; Greenfield, 2000; McCrone, 2002; Tenenbaum, 2003), it seems relevant to study the influence of technical training in reducing functional asymmetry of the lower limbs of football players during the game situation. Several studies (Cobalchini & Silva, 2008; Haaland & Hoff, 2003; Teixeira, 2001; Teixeira, Silva, & Carvalho, 2003) point out the influence of technical training on reducing limbs asymmetry. However, the control analysis of these asymmetries relate to the quality of execution of technical skills outside the context of the game, making it impossible to confirm the increase in the use of the non-preferred foot in a game situation.

Thus, the main purposes of the present study are: (1) to determine whether a specific technical football training focussed on the non-preferred foot induces a decrease of the functional asymmetry; and (2) ascertain whether there are differences in the utilisation index of the non-preferred foot during a game situation in the different age groups.

Methods

The study was approved by the ethical committee of the Faculty of Sport of the University of Porto and by clubs authorities. All the coaches were informed about the entire study protocol and showed receptivity in its application. In addition, they clarified the different players, getting their consent and interest in participating. Study participation was voluntary; soccer players were free to withdraw at any time.

Sample

The sample consisted of 71 male football players aged between 11 and 16 who were divided randomly into two groups: experimental group, with 35 players, and control group with 36. The participants were placed in teams of different age groups: 24 players were in the under-13 team (experimental group: 12; control group: 12); 23 belonged to the under-15 team, (experimental group: 11; control group: 12), and 24 belonged to the under-17 team (experimental group: 12; control group: 12). The number of years of competitive practice of the different participants ranged between 1 and 7. Table I shows the characteristics of the sample in detail.

Regarding the number of training sessions per week, under-13 and under-15 teams performed three sessions, while under-17 group held four sessions, each one lasting 90 min.

The initial number of participants in the study was 92. Nevertheless, due to different reasons: dropouts, injuries and illnesses, 21 players were no longer part of the study. Figure 1 is intended to clarify how the participants were initially distributed and how it was after several exclusions.

Considering foot preference, 60 players preferred the right foot, which represents 84.5% of the sample, in contrast to 11 which elected the left foot, corresponding to 15.5% of the participants.

Table I. Characteristics of the sample concerning the number of players in each team and the respective average and standard deviation of age and years of competitive practice.

	Total sample			Experimental group			Control group		
Characteristics	No.	Age	Years of practice	No.	Age	Years of practice	No.	Age	Years of practice
Total	71	14.44 ± 1.86	3.61 ± 1.60	35	14.37 ± 1.94	3.51 ± 1.52	36	14.50 ± 1.81	3.69 ± 1.69
Under 13	24	12.29 ± 0.69	2.13 ± 0.74	12	12.17 ± 0.72	2.17 ± 0.83	12	12.42 ± 0.67	2.08 ± 0.67
Under 15	23	14.43 ± 0.51	3.52 ± 1.08	11	14.36 ± 0.50	3.45 ± 1.21	12	14.50 ± 0.52	3.58 ± 1.00
Under 17	24	16.58 ± 0.50	5.17 ± 1.13	12	16.58 ± 0.51	4.92 ± 1.00	12	16.58 ± 0.51	5.42 ± 1.24

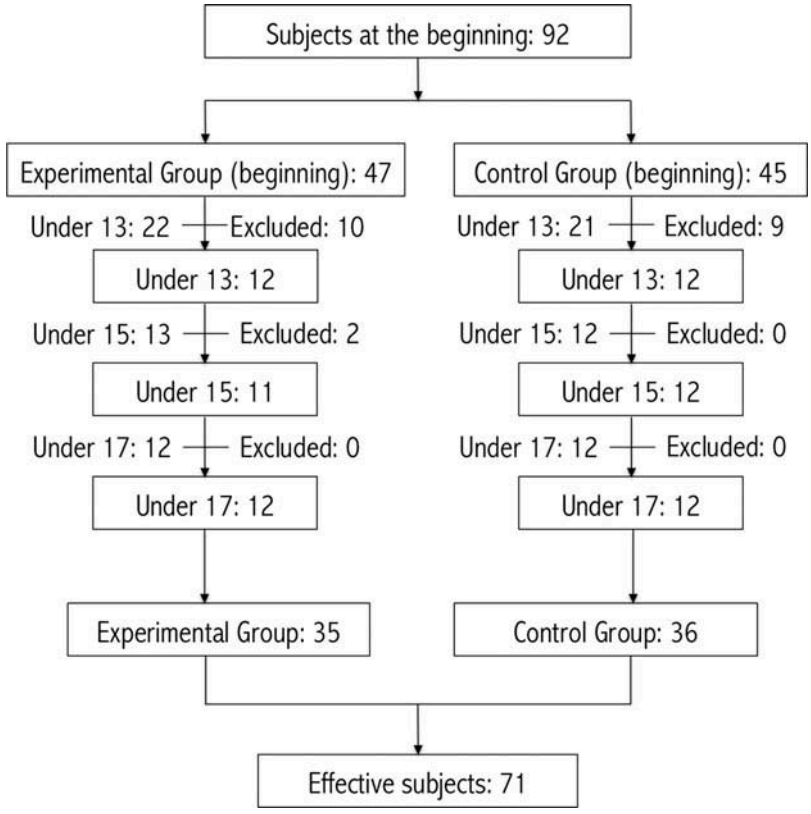

Figure 1. Initial and final distributions of the participants of the different groups and teams involved in the study and the respective exclusions.

Instruments

In order to measure foot preference and the respective functional asymmetry index, the instrument "System of assessment of functional asymmetry of the lower limbs in Football" (SAFALL-FOOT) (Guilherme, Graça, Seabra, & Garganta, 2012) was used. SAFALL-FOOT consists of 6 categories and 32 subcategories, with a valuation associate, which allow the analysis of the frequency and effectiveness of all technical actions performed with the ball, using the lower limbs during a five-a-side football game, which is filmed for further observation, lasting 20 min (Table II). This analysis provides an utilisation index of the preferred and non-preferred foot in the game, and consequently reflects the respective functional asymmetry index.

The equations used to calculate the utilisation ratio of both members were:

"Preferred foot":

Score of the positive subcategories of the "preferred foot" + score of the negative subcategories of the "preferred foot"/Σ of the actions performed (subcategories: "preferred foot" and "non-preferred foot")

"Non-preferred foot":

Score of the positive subcategories of the "non-preferred foot" + score of the negative subcategories of the "non-preferred foot"/Σ of the actions performed (subcategories: "preferred foot" and "non-preferred foot")

The values found range between 0 and 10. The use of the preferred foot and non-preferred foot is lower the more the values approach 0 and higher the more they approach 10. The difference between the values of the right foot and the left foot represents the functional asymmetry revealed by the performer. For more details, please consult SAFALL-FOOT guidelines (Guilherme et al., 2012).

Experimental design

The study was carried out for a period of six months. The players who took part in the study were randomly distributed into two groups: experimental group and control group.

At the baseline, an evaluation of the functional asymmetry of the lower limbs was held through

Table II. Presentation and appreciation of the categories and subcategories.

Categories	Subcategories	Appreciation
Interception/disarm	Interception/disarm – right foot – positive	10.0
	Interception/disarm – right foot – negative	2.50
	Interception/disarm – left foot – positive	10.0
	Interception/disarm – left foot – negative	2.50
Reception	Reception – right foot – positive	10.0
	Reception – right foot – negative	2.50
	Reception – left foot – positive	10.0
	Reception – left foot – negative	2.50
Passing	Passing – right foot – positive	10.0
	Passing – right foot – negative	2.50
	Passing – left foot – positive	10.0
	Passing – left foot – negative	2.50
Driving/protection	Driving/protection – right foot – positive	10.0
	Driving/protection – right foot – negative	2.50
	Driving/protection – left foot – positive	10.0
	Driving/protection – left foot – negative	2.50
	Driving/protection – dominance of right foot – positive	10.0
	Right foot	5.00
	Left foot	2.50
	Driving/protection – dominance of right foot – negative	1.25
	Right foot	
	Left foot	
	Driving/protection – dominance of left foot – positive	5.00
	Right foot	10.00
	Left foot	1.25
	Driving/protection – dominance of left foot – negative	2.50
	Right foot	
	Left foot	
Feint/dribble	Feint/dribble – right foot – positive	10.00
	Feint/dribble – right foot – negative	2.50
	Feint/dribble – left foot – positive	10.00
	Feint/dribble – left foot – negative	2.50
	Feint/dribble – dominance of right foot – positive	10.00
	Right foot	5.00
	Left foot	2.50
	Feint/dribble – dominance of right foot – negative	1.25
	Right foot	
	Left foot	
	Feint/dribble – dominance of left foot – positive	5.00
	Right foot	10.00
	Left foot	1.25
	Feint/dribble – dominance of left foot – negative	2.50
	Right foot	
	Left foot	
Shooting	Shooting – right foot – positive	10.00
	Shooting – right foot – negative	2.50
	Shooting – left foot – positive	10.0
	Shooting – left foot – negative	2.50

SAFALL-FOOT. After this stage, and for a period of six months, both the experimental group and control group followed a technical training programme. Thus, the experimental group performed a technical training programme consisting of the performance of specific motor skills categorised exclusively for the non-preferred foot three times a week during the first 20 min of the training session; while the control group, in the same period of training, performed exercises without any guidance or emphasis of the use of the lower limbs. Therefore, specialised motor skill training was provided for 60 min each week. In the other training periods and in the fourth training session of the week, in under-17 team, players from both groups performed the same exercises without any restriction or constraint on the use of the lower limbs. At the end of the six months, both groups were again evaluated, with the use of the same protocol and instrument, namely SAFALL-FOOT.

The training protocol consisted of the drilling of technical exercises, but not in a game context so as to be able to control the use of the non-preferred foot. The exercises included the different specific motor skills of soccer (receiving, passing, driving, dribbling, shooting, disarm/interception), in isolation and in interaction. During the protocol, in all sessions, the different skills were constantly practised.

Statistical procedures

Descriptive statistics (means and standard deviations) were calculated for the two groups at the baseline and after six months. None of the characteristics analysed showed significant deviations from a normal distribution (Shapiro–Wilk test). Baseline differences in mean characteristics between experimental group and control group were tested with unpaired sample *t*-tests. For each characteristic, percentage of relative change (%Δ) was calculated as the difference between baseline and six months, and the difference was then divided by the baseline value. Effect size was calculated using partial eta-squared (η^2) and interpreted as small (≥0.01), medium (≥0.06), or large (≥0.14) (Cohen, 1988). Intervention effects were examined by repeated measures analysis of variance (ANOVA). Significance level in all analyses was set at 0.05. Statistical analyses were conducted using SPSS version 21.0.

Results

Table III shows the results of the repeated measures ANOVA models for preferred leg and non-preferred leg according to groups (experimental group and control group), competition level (under-13, under-15 and under-17) and time (baseline and six months). For the preferred leg, a significant main effect for time ($F = 91.66$, $P < 0.001$) and a significant group by time interaction ($F = 92.36$, $P < 0.001$) were found. This significant interaction suggests that the time effects in the preferred leg differed between experimental group and control group (Figure 2). Among experimental groups, mean values of the preferred legs tended to decrease with the follow-up; among control group players, mean values remained rather constant at follow-up.

Identical results were revealed for the non-preferred leg, i.e., a significant time main effect and a significant group by time interaction (Figure 3). The significant interaction indicated that non-preferred leg significantly improved in experimental group with the technical training (%Δ = + 117.4, $P < 0.001$), whereas in control group it remained rather constant at follow-up (%Δ = + 5.97, $P > 0.05$) (Figure 3).

Discussion

The present study intended to analyse how a specific technical training programme for the non-preferred foot influences the utilisation rate of the same limb during the game. Results showed that the intervention protocol to which the experimental group was subjected had an effective impact in increasing the use of the non-preferred foot during the game, once the values of experimental group utilisation index were significantly higher when compared to those

Table III. Mean values (standard deviations), percentage of change (%Δ), *F*-test (*P*-values) and partial eta-squared (η^2) for repeated measures analysis of variance (ANOVA) for the preferred and non-preferred foot.

	Preferred foot			Non-preferred foot		
	Baseline	Six months	%Δ	Baseline	Six months	%Δ
Competitive level						
Under 13	7.81 (0.66)	7.51 (0.51)	−3.6	0.96 (0.50)	1.41 (0.53)	+71.8
Under 15	7.45 (0.55)	7.21 (0.54)	−3.2	0.88 (0.46)	1.25 (0.57)	+56.6
Under 17	7.66 (0.65)	7.34 (0.62)	−4.0	0.83 (0.55)	1.16 (0.67)	+54.2
Groups						
Experimental	7.72 (0.62)	7.13 (0.52)	−7.5	0.88 (0.49)	1.61 (0.42)	+117.4
Control	7.57 (0.64)	7.57 (0.64)	+0.2	0.90 (0.51)	0.94 (0.55)	+5.97
Results of ANOVA repeated measures						
Sources of variation	*F* (*P*)		η^2	*F* (*P*)		η^2
Time (*T*)	91.66 (<0.001)		0.58	184.27 (<0.001)		0.74
Group (*G*)	1.22 (0.273)		0.02	7.82 (0.007)		0.11
Competitive level (*CL*)	2.07 (0.134)		0.06	0.89 (0.414)		0.03
T × *G*	92.36 (<0.001)		0.57	145.66 (<0.001)		0.69
T × *CL*	0.28 (0.757)		0.01	1.58 (0.214)		0.05
G × *CL*	0.67 (0.517)		0.02	0.92 (0.402)		0.03
T × *G* × *CL*	0.34 (0.716)		0.01	0.41 (0.664)		0.01

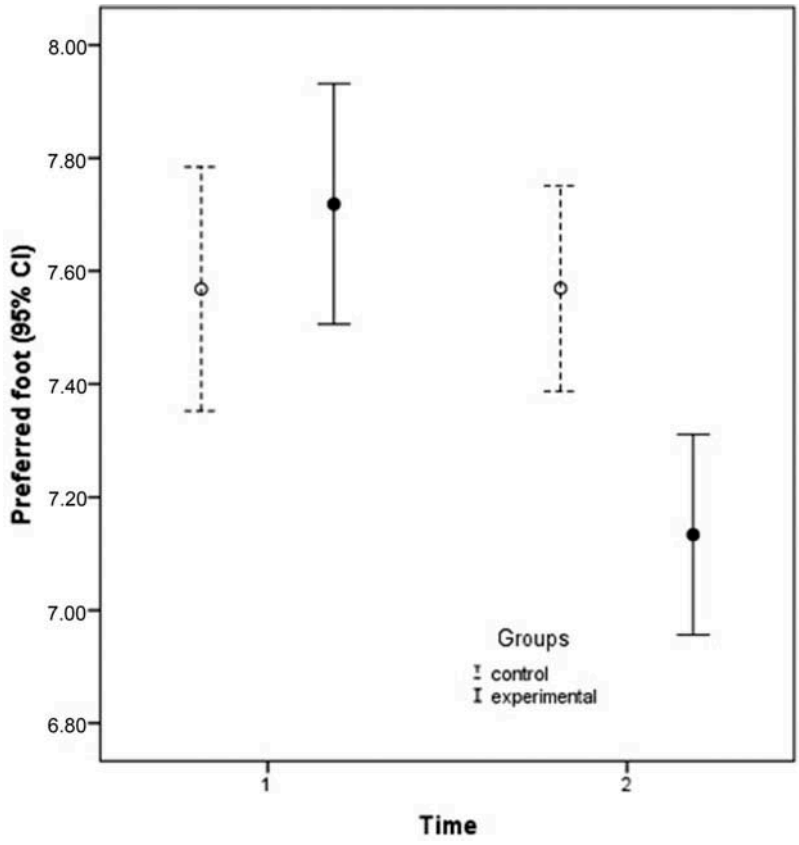

Figure 2. Mean values and respective 95% confidence intervals for the use of the preferred foot in the different groups of participants throughout the study.

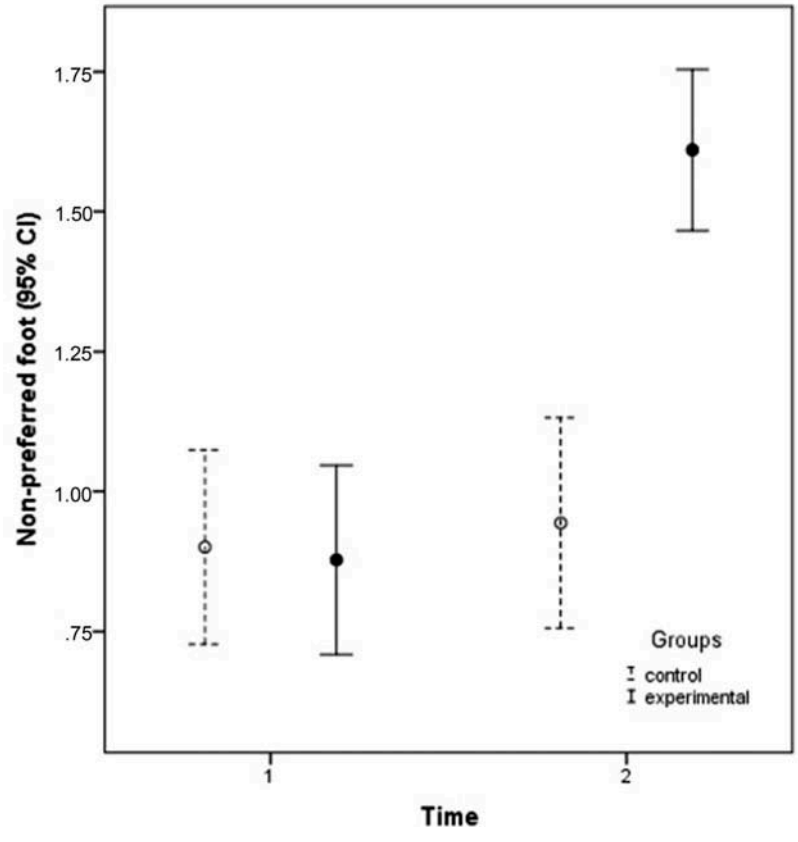

Figure 3. Mean values and respective 95% confidence intervals for the use of the non-preferred foot in the different groups of participants throughout the study.

of control group. From such evidence, different issues may be considered. A first remark is the acknowledgement that the training programme, to which the experimental group was submitted, reflects the requirements that the game sets to the player.

Another issue that may be withdrawn from this study regards the confirmation of the dynamic feature that characterises laterality (Teixeira & Paroli, 2000; Vasconcelos, 2004). The compulsory use of the non-preferred foot to perform actions that usually are not part of their actions leads the body to create new standards of action. This feature meets the views of various authors that highlight the multidimensional and dynamic characteristic of motor behaviour (Martin & Porac, 2007; Teixeira & Okazaki, 2007; Zverev, 2006). The presented results, in line with the studies of several authors (Andrade, 2012; Cobalchini & Silva, 2008; Haaland & Hoff, 2003; Teixeira, 2001; Teixeira et al., 2003), supports the conclusion that the functional asymmetry of the lower limbs tends to reduce when there is an increase of systematic training on the non-preferred limb. However, it would be interesting to find possible explanations for the specific contexts in question, since in all the referred studies, the improvements of the non-preferred lower limb were notorious in a relatively short timeline compared to the requests to which the preferred limb was subjected for years. We believe that one possible explanation may be found in the ecological perspective presented by Gibson (1966). Its principles focus on the information originating from the properties of the contexts that are perceptually accessible and relevant to the individual in order to perform the task. As the non-preferred limb was less stimulated for many years, it is not perceptibly accessible. Therefore, it is not a relevant option to make part of the decisions and performed actions. From the moment it begins to be stimulated, even as an obligation, the body discovers a new perceptual receiver for the context, thus making an active part of the possible action perception coupling (Gibson, 1979). This way, the non-preferred limb also becomes gradually part of the triad perception, decision and action. This explanation finds support in studies of behavioural and neurological areas. The studies of Peters and Ivanoff (1999) and Teixeira (1999) show that the systematic practice of a non-preferred limb yields a performance profile identical to the preferred one. With regard to the neurological evidence, the studies of Elbert, Pantev, Wienbruch, Rockstroh, and Taub (1995) demonstrated, through topographical analysis, that the cortical representation of the non-preferred limbs, which are subject to systematic training, is comparatively more complex than the representation of the untrained limbs. These findings highlight that the systematic training on a particular limb has both behavioural and neurological effects, showing the adaptive and mouldable nature of the human body. However, we think that it is appropriate to perceive whether the gains will be effective or if they will lose consistency if the use of the non-preferred limb is not persistent. This information is particularly important for the football training process.

From the results one can also mention that despite the impressive gains in the use of the non-preferred foot, the preferred foot also has a much higher utilisation rate. These results are considered normal since they are the consequence of years of practice of persistent asymmetry (Barbieri & Gobbi, 2009). In order to solve this problem, taking the dynamic nature of laterality into account, several authors suggest similar training practice for both sides in continuity (Barbieri & Gobbi, 2009; Haaland & Hoff, 2003; Starosta & Bergier, 1993; Teixeira, 2006).

The results also suggest that the technical training targeted to a certain goal enables positive implications in this area. This finding is interesting for the training process and meets the outcomes of several studies that focused on improving the training of certain specific skills and managed to improve their respective performances (Cobalchini & Silva, 2008; Haaland & Hoff, 2003; Teixeira, 2001; Teixeira et al., 2003). Another aspect that can be noted is related to the lack of significant differences between the different competitive levels, that is, the results show the importance of the technical training for the non-preferred foot in increasing its use in the game, regardless of age. This information highlights the importance of exercising the non-preferred foot at any competitive level. Notwithstanding this, on closer analysis, it can be seen that the lower age group, under-13, shows an increase of the use of the non-preferred foot superior to the other levels, however, with no significant differences. In future studies, it will be relevant to check, by increasing the sample, if major differences may be found among different age groups.

In some contexts, there is the idea that the systematic training of the non-preferred foot with the intention of reducing the pedal asymmetry causes a decrease in the variability, the creativity and, consequently, the quality of the preferred foot. Our opinion goes in the opposite direction. We are convinced that the proficiency and functional symmetry of both lower limbs leads the football player to a new path of superior multiplicity of actions, resulting in larger variability, creativity and, of course, greater proficiency. This assumption is confirmed by the studies of several authors who point out that the low level of capacity of the non-preferred limb restricts the ability of the preferred one (Barbieri &

Gobbi, 2009; Haaland & Hoff, 2003; Teixeira et al., 2003). The design of this study presented some initial constraints regarding to its practicability. The need to interfere as less as possible in the dynamic preparation of the respective teams was a requirement. Thus, the amount of training of the experimental group restricted to the use of the non-preferred foot has a much lower percentage of time compared to the training directed to the preferred foot, which can limit the reduction of the asymmetry. However, this apparent disadvantage became an advantage, since the study design met the ecological requirements because there was a low contextual interference and even so it was possible to demonstrate that a percentage of reduced drilling time, 20 for every 90 min of training three times per week, enables significant increased utilisation of the non-preferred foot during the game.

In summary, the present findings suggest that a systematic and specific technical football training for non-preferred foot promotes the reduction of functional asymmetry between the lower limbs in football game settings. The increased use of the non-preferred foot is transversal to all competitive levels with no significant differences between them. Moreover, it still confirms the dynamic characteristic of laterality when there are systematic stimuli focused on the non-preferred limb.

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