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Preference and Performance of Deviation during a Short Sprint

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Abstract: ***Our study aims to assess foot preference and performance of deviation during a short sprint task among two groups. Sixty right handed subjects, aged between 18 and 30 years, divided into two groups of thirty (trained group and untrained one) participated in this study. We used a questionnaire to evaluate the degree of foot preference. We have also compared the performance of deviation during a short sprint. Results showed a better performance to deviate to the right than to the left. A significant interaction between trained group vs untrained one, and direction of deviation is also observed (right deviation vs. left deviation). These results were discussed in relation to the debate on the genetic origins and the influence of cultural factors on asymmetries.***

Keywords: Sports practice - Deviation Preference - Deviation Performance.

1. Introduction

Most people have a good understanding of what is meant to be right- handed which is an increase of mobility and strength with the preferred hand. However the notion of foot or leg dominance may not be as obvious and it might require to be viewed in a different perspective considering the roles of the legs in different tasks such as mobility and stability. A leg can be used to manipulate an object such as a soccer ball whereas the other foot has an important role of postural control and stability (Velotta et al., 2011).

The human foot exhibits a wide range of structural variations than many other parts of the body. During growth, the foot changes not only its dimensions but also its shape and using (Kulthanan et al., 2004; English et al., 2006). The human foot, the foundation for bipedal locomotion, is a complex adaptation that evolved through extensive remodeling of the hind appendage of the human arboreal primate forebears (Fessler et al., 2005). The foot is the base of support for the chain of motion and body posture (Mauch et al., 2008).

Motoric dominance, the preferential usage of an upper or lower limb based on its primacy or dominant use in motor functions in a specific situation, is a universal, uniform and unique characteristic of all humans. One of the most obvious manifestations of motoric dominance is footedness, the tendency to prefer the use of a consistent foot in performing voluntary motor acts (Grouios, 2005).

Typically, footedness for a particular task is characterized by its stabilizing and mobilizing (or manipulating) features. That is, one limb is used to manipulate an object or lead out (example, kicking a ball), whereas the other foot has the role of lending postural (stabilizing) support. In such a bilateral context, which provides a relatively clear division of functional limb action, the consensus is that the mobilizing limb is the preferred (dominant) foot, whereas the foot used to support the actions of the preferred foot is defined as the non-preferred limb (Gabbard & Hart, 1998).

The appeal of such handedness accounts is one reason why foot preferences have been neglected by the neuropsychological community. Foot preferences are also right-biased (approximately 80%), but are studied much less frequently than handedness. In fact, foot preference is as good as or may even be a better predictor of cerebral lateralization than hand preference (Vallortigara et al., 2005) and is less subject to cultural biases against left sidedness (Calvert and Bishop, 1998; Nunome et al., 2006; Zverev et al., 2007).

Additionally, foot-related behaviours routinely require coordination of stabilizing and mobilizing movements of both legs (Gabbard and Hart, 1998), while much hand-related behaviour are often performed in relative isolation. And of course, a consequence of bipedalism is that strength differences between the feet/legs are typically minimal, and therefore patterns of foot preference are not as easily ‘‘explained away’’ by differential strength or practice of one leg relative to the other. The non-preferred leg is just as experienced in walking, running, standing and balancing as the preferred leg, and yet behaviours such as kicking a ball are consistently lateralised to the right side in most people. The absence of research on foot performance and preference in sport in particular is even more surprising. First, asymmetrical motor performance in soccer is present even at the highest level (Carey et al., 2001), but the ways in which the preferred and non-preferred feet differ remain unknown. Second, scientists have argued that foot preferences can persist in skilled soccer players, even though a substantial amount of training has a strong emphasis on bilateral skill development (Capranica et al., 1992; Starosta and Bergier, 1992). There is remarkably little data on this issue.

The belief regarding the plasticity of foot bias is mirrored by several models of the genetics of handedness transmission. In these theories environmental, person-specific factors play a role in determining side biases, which is one reason why the genetic theories include non-genetic factors as components of their models (Annett, 2002, 2004, 2008; Klar, 2003). In some of these accounts, the non genetic chance factors are primarily developmental/perinatal (McManus, 2002) or are primarily genetic influences on subsequent development (Yeo & Gangstead, 1993), but others do hypothesize that cultural pressures, learning and practice play roles in the development of both hand choice and hand skill (Ehrman & Perelle, 2004; Medland et al., 2004, 2009; Papadatou-Pastou et al., 2008; Suzuki, & Ando., 2014). In fact, in several of the models, the absence of a particular gene or set of genes specifies chance with respect to direction and/or magnitude of hand preference (Klar, 2005).

In spite of these differences, the extension of both of these models to other side biases such as eye and foot preference (Annett, 2000) posit the same sort of mix of genetic bias and chance environmental factors which determines side bias for hand or foot. Given practice effects (Carey et al. 2009; Greenwood et al., 2007; Hebbal et al., 2006), soccer seems ideally suited to examine plasticity of foot use and skill.

Although writing hand has historically been subject to environmental pressures (Porac and Friesen, 2000; Siebner et al., 2002), it is the exception to the rule; the emphasis on practice and foot preference plasticity in soccer is in stark contrast with virtually all other asymmetrically-performed manual tasks, even sports relevant skills such as throwing. Therefore, performance asymmetries in kicking skill and choice seem a natural place to examine the effects of non-genetic factors on this well described but poorly understood right-sided bias. Additionally, asymmetries that remain after bilateral training in such people could provide essential insights into the innate nature of behavioural and ultimately, cerebral asymmetries.

The environment characteristics may influence running asymmetries, which are more frequent in angular parameters. Environment characteristics are related to ground irregularities requiring compensatory movements changing the mechanical workload on joints and bones, which may influence asymmetries in biomechanical parameters between lower limbs. Symmetry can be improved with increasing running speed (Carpes et al., 2010).

However, asymmetries were suggested to be related to lower levels of performance (Nunome et al., 2006). During pedaling, previous studies reported asymmetries in favor of the preferred leg for force (Sanderson et al.,2000 ; Rahnama et al., 2005), crank torque (Carpes et al., 2007) or power output (Valdez et al., 2004) and kinematics (Williams et al., 2001).

Also, there is no evidence of preference-advantages in terms of muscle recruitment for the lower extremity. For example, it has been documented that during a situation eliciting fatigue, there is an increase of common bilateral input (Nagano et al., 2011) that could facilitated excitability and neural coupling by inter-hemispheric cortical communication which is among the factors minimizing the lateral differences (Anguera et al., 2007; Bernard et al., 2012; Langan et al., 2011).

Most clinical studies compare the non-surgery leg to the surgery leg without taking in consideration limb dominance. Determining leg dominance is not as simple and creates an inconvenience of when analyzing differences between limbs and it is often determined in different ways: by right- and left-hand preference (Velotta et al., 2011), which leg the subjects prefer to kick a ball with (Chow et al., 2005), by jump preference (Nyland et al., 1994; English et al., 2006), or by stance preference when kicking a ball (Dorge et al., 2002; Nunome et al., 2006).

Several studies support the notion that humans are generally right-footed for mobilization tasks but left-footed for tasks requiring postural stabilization (Gentry & Gabbard, 1995; Spry et al., 1993). Velotta et al., (2011) tested leg preference of subjects on different types of tasks, than when it were manipulative in nature such as kicking a ball, most subjects used the right leg (most people are right-side preference) but when the task involved stabilization such as standing on one leg, more that 50% of the subjects used the left leg to perform the task. Spry et al., (1993), also found similar results with respect to the tasks and found no relationship between lower extremity dominance and isokinetic measures at knee and hip. More recently, studies have found significant leg difference between dominant and non-dominant leg strength measured by the hamstring quadriceps (H: Q) ratio and recommended the adjustment of clinical tests based on leg dominance (Lanshammar & Ribom, 2011; Kong & Burns, 2010).

2. Materials and Method

2.1 Subjects

Sixty subjects aged between 18 and 30 years participated in this study. The participants were all adult boys right handed writing belonged to two different groups:

- The first group consists of 30 trained boys.
- The second group consists of 30 untrained boys.

2.2 Experimental Procedure

We used three tests:

- The first is to assess the podal preference through a questionnaire with 10 items of foot preference: (hopping feet, shooting a ball, grasping an object between the toes, writing on the sand, crushing a cigarette, put his shoe, remove and stir the sand, tap the rhythm of a well known nursery rhyme, range five pebbles on the ground, walk-up a step).
- We used the classification of Dellatolas et al, (1988) to identify the frequencies of right-footed, mixed right-footed, left-footed and mixed left-footed.
- If the score of use of the foot is 0: the boy is a strong right-footed.
- If the score of use of the foot is between 1 and 6: he is a mixed right-footed.
- If the score of use of the foot is between 7 and 16: he is a mixed left-footed.

- If the score of use of the foot is greater than or equal to 17: he is a strong left-footed.
- The second test is a test of podal preference. It is a speed running in a straight line along 8 meters, then turn on to the right of the picket or to its left depending on the choice of the subject at a distance of 4 meters, which is limited by a picket and we recorded the chosen direction to achieve this turn.
- The third test is a performance test. This is the same procedure as above, but we must call from the outset about the direction of deviation by measuring the elapsed time with a stop-watch.

3. Results

3.1 Podal Preference

For all items, the frequency of homogeneous footed is 8.3%, of right-footed, 70 % of mixed right footed, 21, 67 % of mixed left footed and no left-footed were observed (Table 1).

Table 1: Frequency of right-footed, mixed and left foot footed depending on the items.

	Right footed	*Mixed right footed*	*Mixed left footed*	*Left footed*
Number	5	42	13	0
%	8.33	70	21.67	0

3.2 Preference of Deviation

The majority of subjects prefer turning to the right. The frequencies of deviation to right and to the left are 70% and 30% respectively (Table 2).

Table 2: Frequency of preference deviation to the right and to the left.

	Right deviation	Left deviation
Number	42	18
%	70	30

Our results showed an effect of degree of the foot preference on direction of deviation ($\chi 2$ (2) = 5.95, p<.05). This effect indicates that right footed subjects have the higher frequency to deviate to the right (Fig 1).

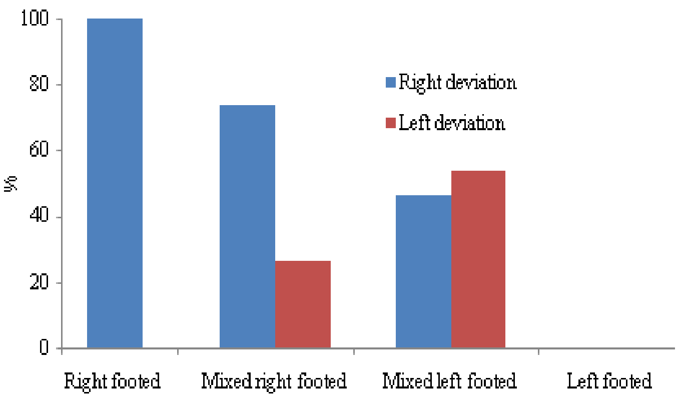

Figure 1: Frequency of right-footed, mixed right-footed, mixed left footed and left footed as a function of direction of deviation.

We didn't found an effect of group (trained vs untrained) on the preference of deviation. The frequencies to deviate to the right are similar for the two groups (67.9 % for trained group and 71.9 % for untrained group).

3.3 Performance of Deviation

A MANOVA for group as independent variable and for direction of deviation as repeated factors showed a significant group effect, F(1,58) = 141.26, p < .0001, and a significant direction effect F(1,58) = 5, p< .05 and a significant group × direction interaction, F(1,58) = 9.85, p < .01.

The group effect indicates a better performance for trained group (3, 24 sec) compared to the untrained group (5 sec), shown in Fig 2.

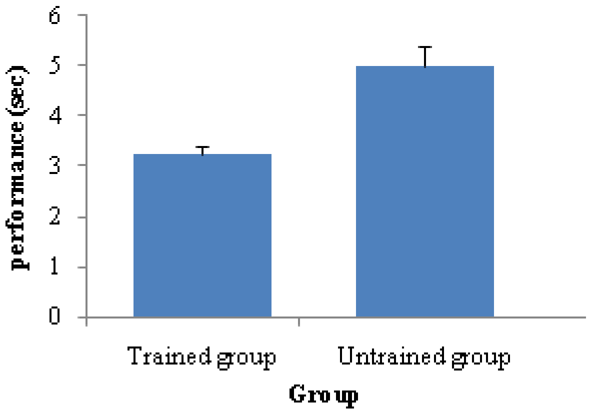

Figure 2: Performance of deviation as a function of group.

The direction effect indicates a better performance when deviating to the right (4.07 sec) than when deviating to the left (4.18 sec), shown in Fig 3.

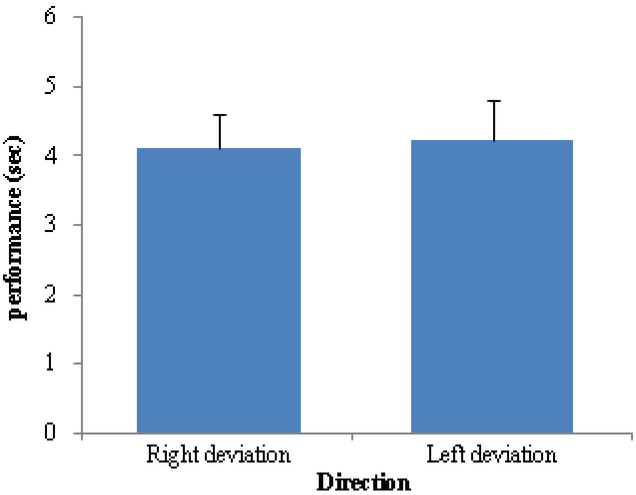

Figure 3: Performance of deviation as a function of direction.

The interaction group × direction shows a large difference between performances of right deviation and left deviation among the untrained group but not among the trained group (Fig 4).

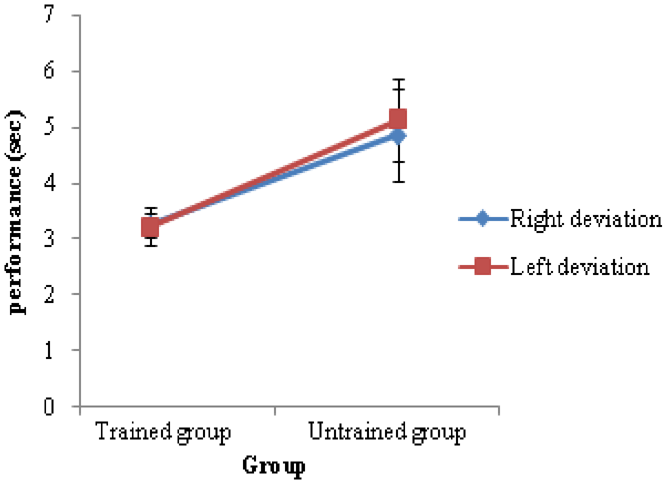

Figure 4: Performance of deviation as a function of direction and group

Our results don't show an effect of the degree of foot preference on the performance of deviation.

4. Discussion

The human foot exhibits a wide range of structural variations than many other parts of the body. The normal distribution of limb dominance among humans is approximately 80-90% are right-handed, 60-80% are right footed, and 80% of participants have a dominant hand and foot on the same side (Barut et al., 2007). However the notion of foot or leg dominance may not be as obvious and it might require to be viewed in a different perspective considering the roles of the legs in different tasks such as mobility and stability. A leg can be used to manipulate an object such as a soccer ball whereas the other foot has an important role of postural control and stability (Velotta et al., 2011). Our study takes place in this scientific junction by trying to assess foot preference and performance of deviation during a short sprint task among two groups (trained group and untrained one).

Our statistical data showed that the majority of subjects were mixed right-footed with 70 % vs mixed left footed ones (21, 67 %) and only 8, 3 % who were homogeneous right-footed. But it doesn't show any left footed subjects. This right podal preference is also reinforced by a preference of deviation with a majority of subjects prefer to deviate to the right (70 % vs 30 % to the left). Much more, our results showed an effect of degree of foot preference on the direction of deviation which indicates that right footed subjects have the higher frequencies to deviate to the right (counter clockwise). This found is consistent with some authors who have observed an influence of cultural factors on the asymmetries of directional trend (Fagard & Dahmen, 2003, 2004; Nunome et al., 2006; Zverev et al., 2007). Although, several authors showed a preference to deviate in the opposite direction of the needle clockwise (Toussaint & Fagard, 2008; Mohr, 2003).

Despite we didn't found an effect of group (trained vs untrained) on the preference of deviation. The frequencies to deviate to the right are similar for the two groups (67.9 % for trained group and 71.9 % for untrained group). Our result are conform to the studies of Kooij et al. (2007) and Carey et al. (2009) among professional soccer, that skill cannot explain asymmetry of choice. This similarity about the preference of deviation between trained and untrained groups is also shown between amateurs compared to the general population (Carey, et al. 2009). Although, some other authors suggested that training and practice play roles in the development of both hand choice and hand skill (Teixiera, 2003; Ehrman & Perelle, 2004; Papadatou-Pastou et al., 2008; Medland et al., 2009; Suzuki, & Ando., 2014).

Concerning the performance of deviation, our results showed a better scores for trained group (3, 24 sec) compared to the untrained group (5 sec) which conform to results found by several studies which noted that training develop the performance of deviation (Carey et al. 2009; Greenwood et al., 2007; Hebbal et al., 2006). Furthermore, the direction effect indicates better performances when deviating to the right (4.07 sec) than when deviating to the left (4.18 sec). The interaction group × direction shows a large difference between performances of right deviation and left deviation among the untrained group but not among the trained group. The absence of difference between performances in the two directions (right vs left), is may be due to the effect of sport practice.

But our results don't show an effect of the degree of foot preference on the performance of deviation which is consistent with the study of Carpes et al. (2010) who noted that symmetry can be improved with increasing running speed. However, asymmetries were suggested to be related to lower levels of performance (Nunome et al., 2006; Sanderson et al.,2000 ; Rahnama et al., 2005; Carpes et al., 2007; Valdez et al., 2004; Williams et al., 2001).

5. Conclusion

Our results on the preference of deviation indicate a preference to deviate to the right in both groups (trained and untrained). This found reflect the importance of biological factors to explain asymmetries. However we highlighted the influence of sport on the performance of deviation. The positive effect of sport on the performance of deviation can affect the non-preferred side. These results partly reinforce the role of environmental factors. It will be particularly interesting to study the preference and performance of deviation among left- footed population.

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