

Changes in the step width, step length, and step frequency of the world's top sprinters during a 100 m race

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Purpose

The coaches usually instruct that the narrow step width and the high step frequency are needed to obtain high performance in the sprint start. However, the experimental data regarding the step width during a 100 m race has not been well documented. The purpose of this study was to clarify the changes in the step width, step length, and step frequency of the world's top sprinters during the sprint acceleration phase and for the phase when the full stride length had been achieved. It was thought that this information would be valuable for the coaches and athletes alike, because, the measurements were taken during the men 100 m finals of the IAAF world championships in 2005.

Methods

The subjects were 18 male sprinters who participated in the heats of the 10th World Championships in Athletics held in Helsinki, Finland (2005). They were divided into two groups based on race times: the high performance group (HG; 10.12–10.32 s, 9 sprinters) and the lower performance group (LG; 10.40–10.9 s, 9 sprinters). Two video cameras were set up on the spectator stand. One of them focused was placed so that it recorded the foot contacts with the track surface covering the initial acceleration phase of the 0 to 30m. The second camera was set the cover middle phase of the race so that it gave the measures of the longest stride length achieve the race. It was assumed that 60m center point for the camera with the optical range from 40 to 80m would provide this information. Two-dimensional Direct Linear Transformation method was applied to the x-y coordinates of the runners' toe during each visible foot contact period. Consequently, the analysis provided the accurate measures of the step length, step frequency and step width (Fig.1). These values were then used to compare the two groups of the sprinters.

Results and Discussion

As expected, the step length increased gradually during the early phase of the sprint acceleration (Fig. 2). The patterns of the increase were similar in both groups. However, the better sprinter group (HG) had longer step length during this acceleration phase. The same was true for the full stride length that was, on the average, 0.12 ± 0.03 m, longer ($p < 0.003$) in HG as compared to LG. The step frequency was maintained at almost the same level (4.56 ± 0.16 steps /s; Fig.3) in the starting dash and the full stride phases, and no difference was observed between the groups. While the sprint running velocity increased during the acceleration phase, the distance (60m) when the full stride length had been achieved in both groups demonstrated that the HG group had already reached higher velocity (see Fig. 4). The step width demonstrated no difference between groups, but it decreased in all runners from 0.39 ± 0.07 m in the 1st step after the start to 0.17 ± 0.04 m in the phase of the full stride length ($p < 0.001$; Fig 5).

These results indicate that the wide step width may be suited for developing the driving force during the long foot contact period under the acceleration phase such as the sprint start. On the other hand, the narrow step width may be suited for developing the driving force during the short foot contact period under the fast velocity condition such as the full stride sprinting. However, the full mechanisms of the optimal step changes need further clarification.

Suggestions for coaching

The results obtained could suggest the following advices (Fig. 6). Coaches should advice sprinters 1) to concentrate not only to reach a higher step frequency in the sprint start, but 2) to utilize the longer step already from the beginning of the start; and finally 3) it could be advisable that the step width will be maximized during the first steps and then gradually decreased from the about 0.4 m (1st step) to about 0.17 m (the full stride).

Figure 1 Measurement method of step width

Figure 2 Step length measured for the initial acceleration steps (1 to 2, ..., 7 to 8) and the period of the full stride length.

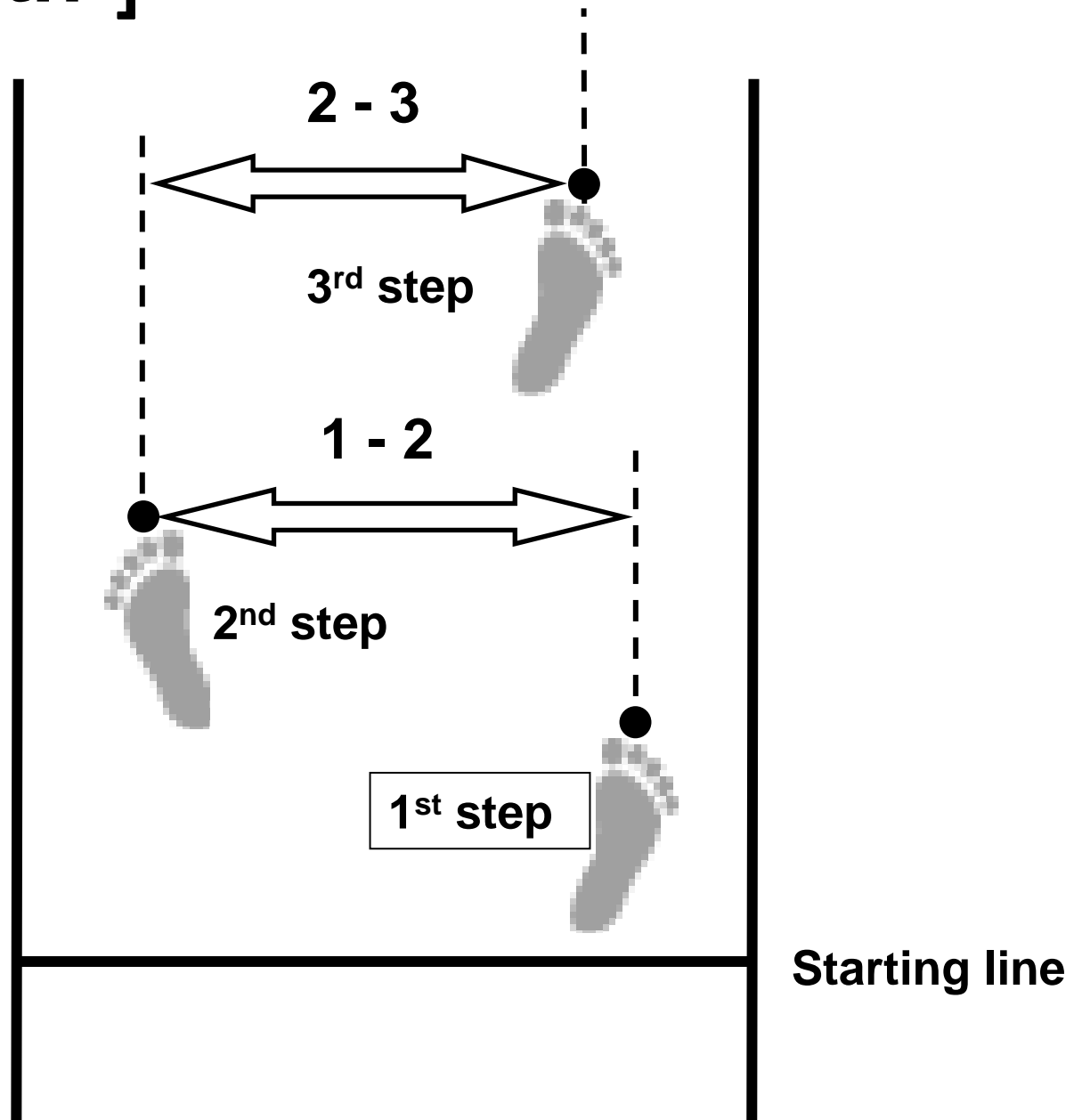
Figure 3 Step frequency for the period identified already in Fig 2.

Figure 4 Running velocity for the period identified already in Fig 2.

Figure 5 Step widths for the period identified already in Fig 2.

Figure 6 Coaching Tips

[Step width]



[Step length]

(m)
3.0

2.5
2.0
1.5
1.0
0.5
0.0

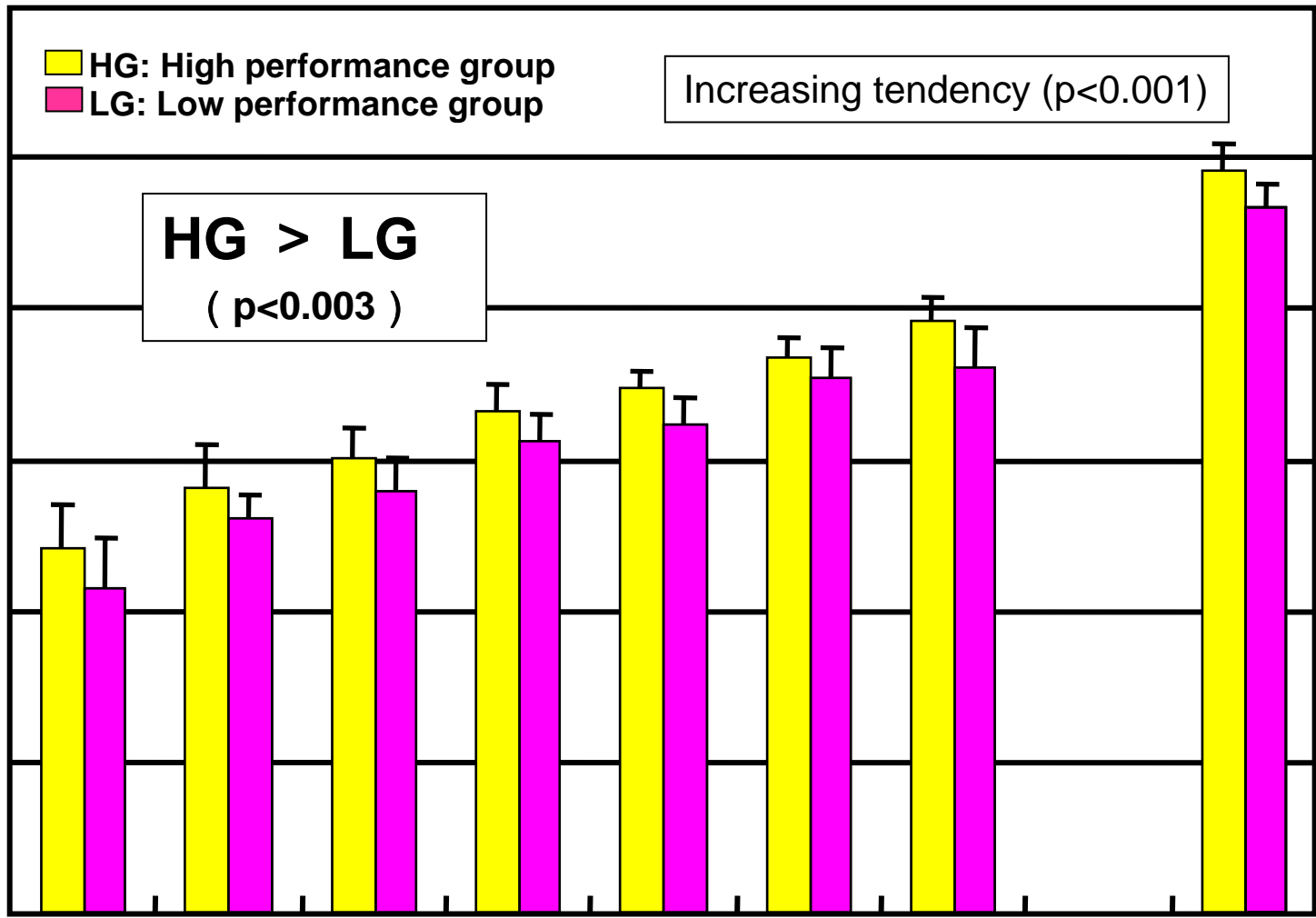
■ HG: High performance group
■ LG: Low performance group

Increasing tendency (p<0.001)

HG > LG
(p<0.003)

1-2 2-3 3-4 4-5 5-6 6-7 7-8 Full stride

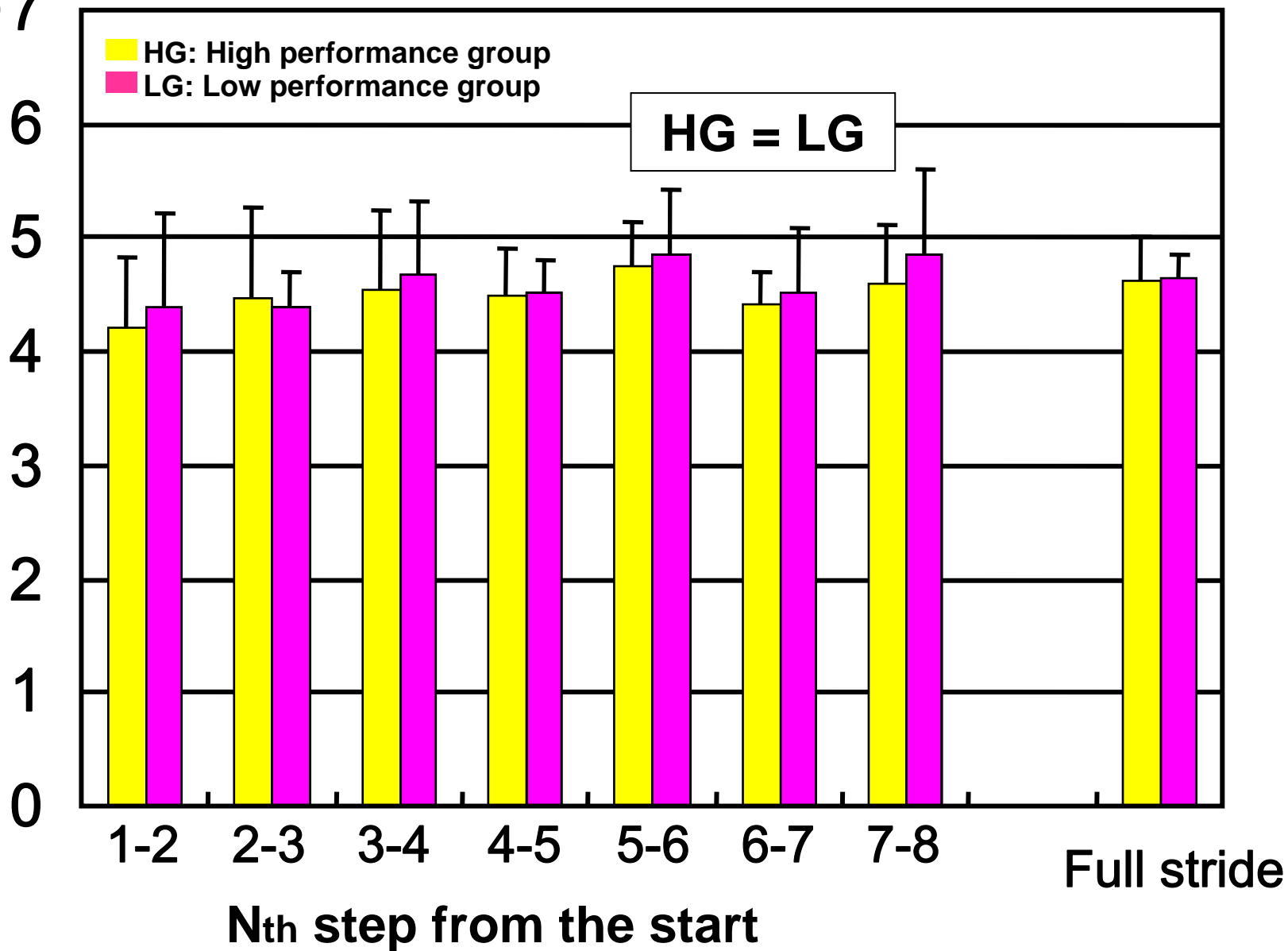
Nth step from the start



[Step frequency]

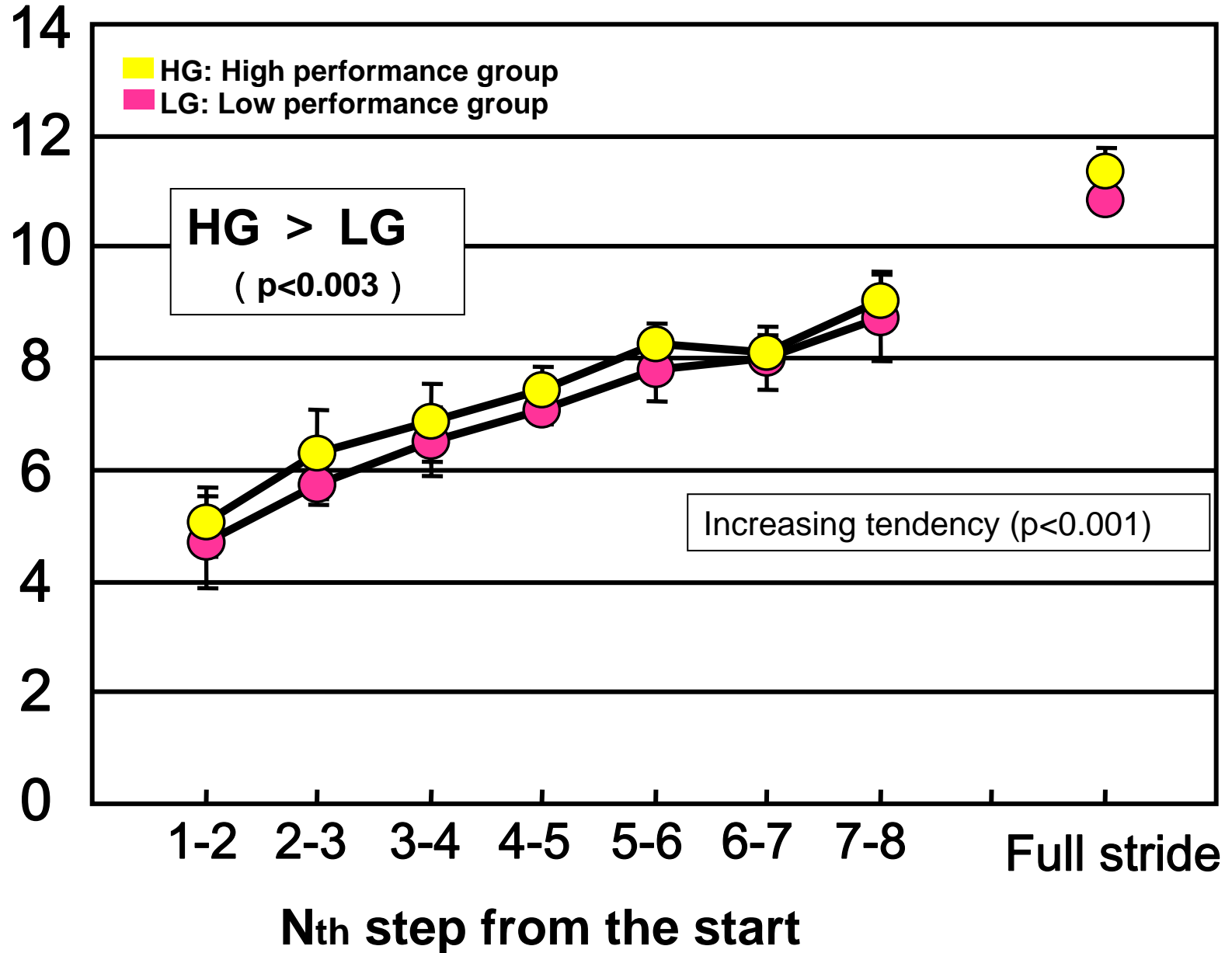
(steps/s

) 7



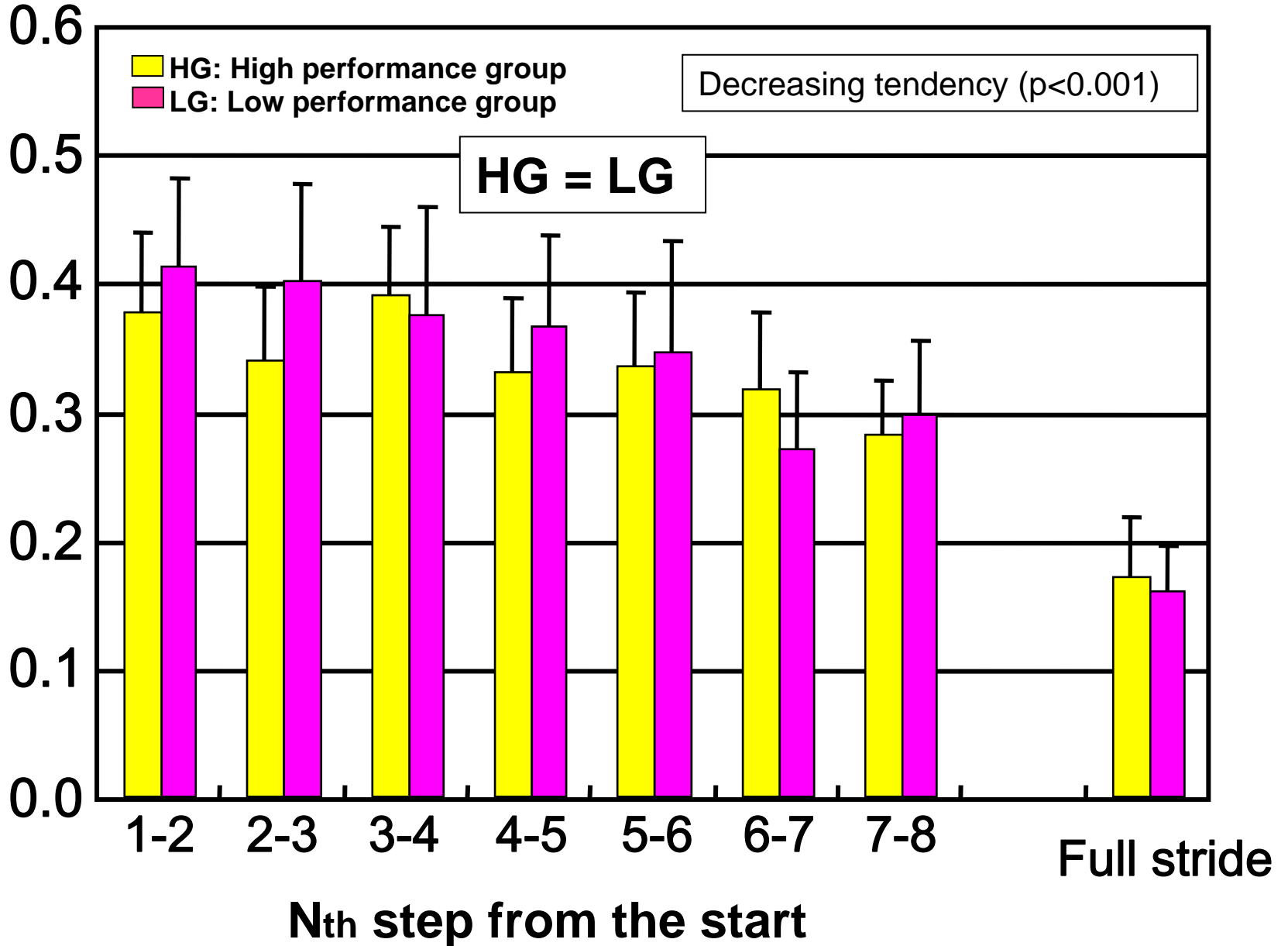
[Velocity]

(m/s)



[Step width]

(m)



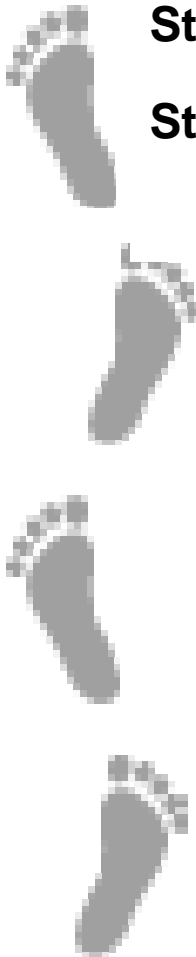
[Coaching Tips]

In the past

Step width: Narrow

Step frequency: High

Step length:



Advice for future

Step width: Wide

Step frequency:

**High but emphasize
long step length**



Starting line