Mediolateral gait stability maintained: By limiting the ankle strategy, can foot placement be trained?

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Abstract

Humans use different gait strategies to ensure mediolateral stability during walking, of which accurate coordination of foot placement relative to the trunk or whole-body center of mass kinematic state seems to be the most important [1]. Ageing negatively affects the ability to use those strategies and specifically foot placement becomes less accurately coordinated [2]. Foot placement becomes more accurate immediately after a session in which it is mechanically perturbed [3]. In previous (unpublished) work, we found that constraining humans to use the ankle strategy using special shoes (LesSchuh, Figure 1a) causes decreased instead of increased foot placement accuracy. This decrease in foot placement accuracy when walking on LesSchuh may be caused by an inability to use the stance leg ankle strategy to control the swing leg, as needed for accurate foot placement. As such, walking on these shoes could also be seen as walking with perturbed foot placement. If subjects learn to improve their foot placement with this decreased ankle strategy, this could lead to increased foot placement accuracy after walking with the shoes. This could make LesSchuh a training device in those with impaired foot placement. To test this idea, participants (n=19) walked during one session in three conditions; normal (baseline, 10 minutes), using special shoes which did not allow to use the lateral ankle strategy (training, 15 minutes), and normal again (aftereffects, 10 minutes). Data of all conditions were cut into epochs of 30 strides, and for each epoch, foot placement accuracy was calculated as the % of variance in foot placement that could be explained from trunk kinematic state [4]. Results (Figure 1b) showed that during the baseline condition, foot placement accuracy increased over epochs. Walking with the LesSchuh decreased foot placement accuracy initially, but this gradually improved over time. Clear aftereffects were present with the foot placement accuracy being higher than during the baseline, illustrating the potential of the LesSchuh. In conclusion, limiting the use of the ankle strategy does not directly lead to improved accuracy of foot placement, but rather deteriorates it (potentially through adverse effects on the controllability of foot placement). However, prolonged exposure to walking with a constrained ankle strategy may improve foot placement accuracy in normal walking. These findings have direct implications for our understanding of the complementary nature of stabilizing mechanisms in human gait, and may lead to novel training approaches.

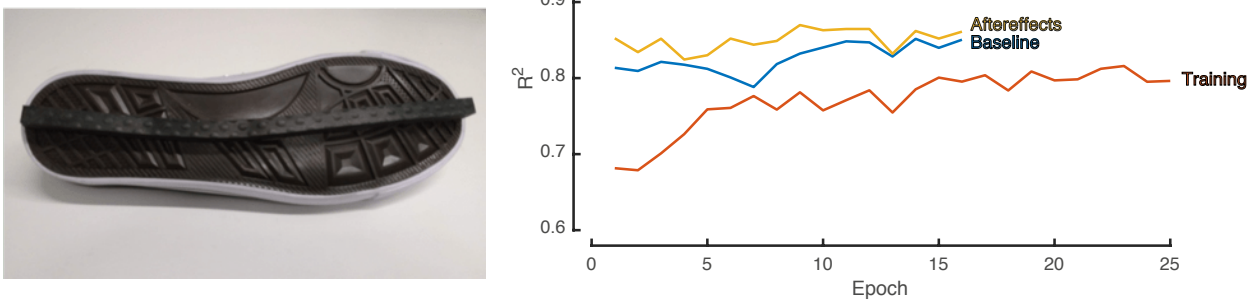

Figure 1. a) LesSchuh, a shoe on which using the mediolateral ankle strategy is impossible. This is achieved by a flexible ridge along the sole, which makes the shoe resemble a skate. The flexible ridge allows for normal push off. **b)** During baseline walking, R^2 gradually increased over time. During walking on the LesSchuh, R^2 was decreased compared to normal walking, and increased over time, while during the aftereffects period, R^2 was higher than during the baseline condition, although not significantly.

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