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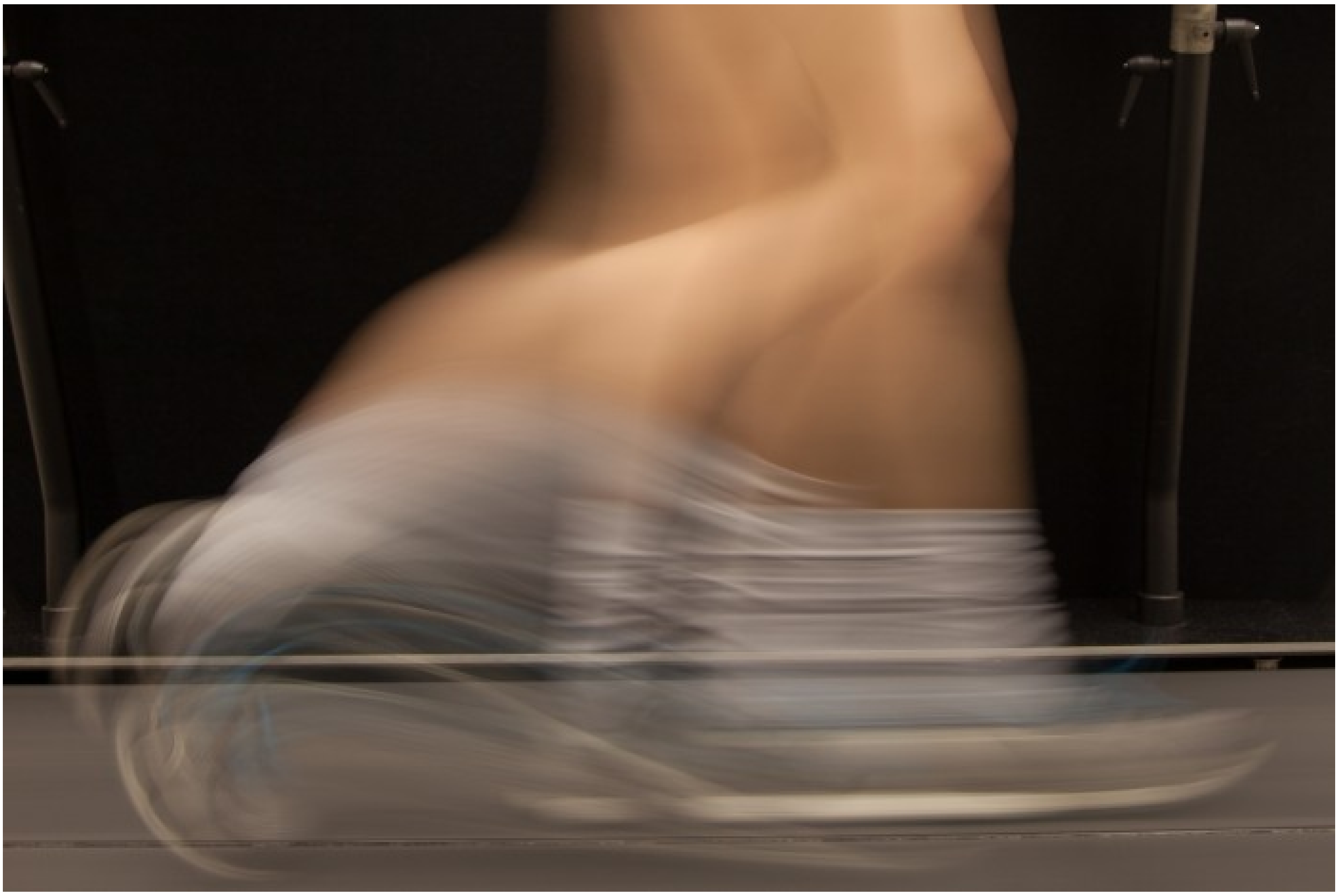


Aging & Chronic Diseases

Adaptive control of dynamic balance during human gait

...what happens when you assist a person’s balance during gait rehabilitation?

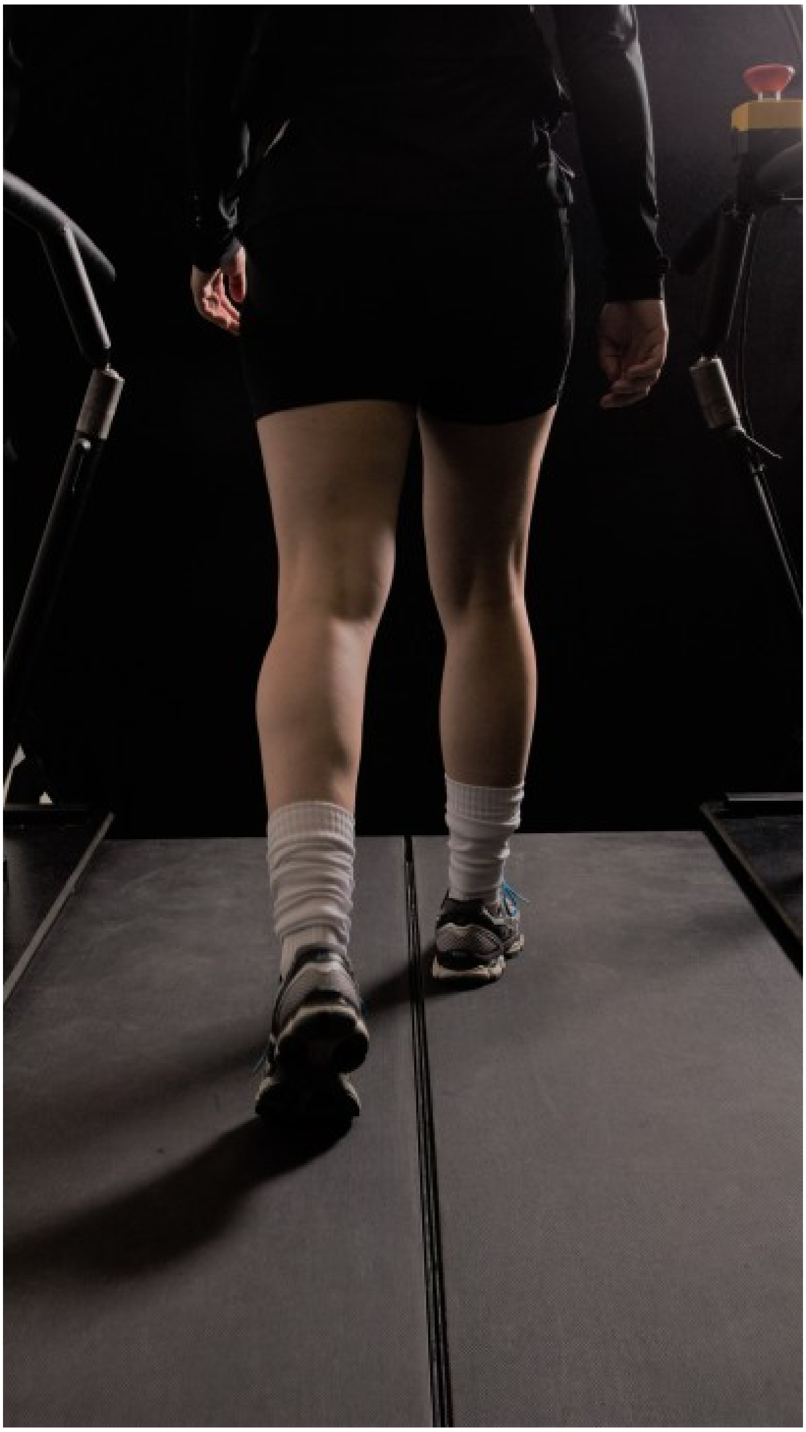
Author : Tom Buurke, PhD

Humans need adaptive control of dynamic balance to remain upright during walking in reaction to constant in- and external perturbations of gait.

Adaptive control of dynamic balance decreases after natural aging or disease, with reduced mobility and increased fall risk as a result.

To better understand these processes, adaptive control of dynamic balance was studied in healthy humans and people post-stroke.

Adaptive control of dynamic balance played a key role in successful locomotion and in locomotor (re-)learning, which indicates that learning to walk is learning to adaptively control dynamic balance.



Adaptation of mediolateral dynamic balance was studied in reaction to walking on a split-belt treadmill. In split-belt walking, healthy participants adapted their stepping and dynamic balance to walking with asymmetric left and right belt speeds. Mediolateral dynamic balance was adapted through a complementary mechanism of foot placement relative to the extrapolated center of mass (i.e. the margin of stability; a measure of dynamic balance) and mediolateral foot roll-off during the stance phase of gait. The adaptation of the margins of stability was found to be directly related to the regulation of bilateral stance times, which may allow for simple and effective adaptive control of dynamic balance.

Next, the tables were turned to assess what happens when balance control is no longer a problem during locomotor learning, by offering external support to participants. Healthy young adults who were externally supported by handrails during split-belt walking were perturbed less and performed better than participants who walked without holding handrails. However, the participants who held on to handrails showed smaller after-effects after split-belt walking compared to the non-supported group, which suggests that external support through handrail holding reduces locomotor learning. This indicates that maintaining dynamic balance is a crucial task goal in human walking, which shapes locomotor learning. Therefore, clinicians should take into account that balance assistance may reduce long-term learning. Furthermore, if patients can safely walk without assistance or support, it may be beneficial for them to do so during gait training.

Finally, reactive control of dynamic balance was studied in people post-stroke in response to a slip-like forward perturbation of gait. People post-stroke were able to recover dynamic balance after this perturbation with both the paretic and non-paretic leg. However, in a forward recovery step with the paretic leg, people post-stroke simultaneously decreased their mediolateral margin of stability. This could mean that when people post-stroke increase forward balance, they may lose sideward balance in paretic reactive stepping. Future research is necessary to find whether this maladaptive paretic coupling increases fall-risk post-stroke and whether it can be decoupled through e.g. perturbation training.

Adaptive control of dynamic balance plays a key role in locomotor control and learning. The latter was stressed by showing that handrail holding dramatically reduces long-term locomotor learning, which should be taken into account in daily clinical practice.

Furthermore, this work showed a maladaptive coupling between the sagittal and frontal plane paretic reactive stepping post-stroke. Further research should indicate whether this maladaptive coupling increases fall-risk and whether it can be decoupled through gait training.

Want to read deeper into this topic? Have a look at these studies by the same author:

- Buurke TJW, Lamoth CJC, van der Woude LHV, Hof AL, den Otter R. Bilateral temporal control determines mediolateral margins of stability in symmetric and asymmetric human walking. Sci Rep 2019;9:12494
- Buurke TJW, Lamoth CJC, Vervoort D, van der Woude LHV, den Otter R. Adaptive control of dynamic balance in human gait on a split-belt treadmill. J Exp Biol 2018;221(13)

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