

A HIGHER TREADMILL ACCELERATION LEADS TO A HIGHER WALK-TO-RUN TRANSITION SPEED

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INTRODUCTION

When an acceleration is imposed to walking humans they eventually start running. This actual walk-to-run transition (WRT) has been the focus of many studies elucidating mechanics and control of gait. Using a small range of (low) accelerations (0.04-0.12m/s²) no consensus has been reached whether (treadmill) acceleration magnitude influences this transition and induces changes in WRT-speed [1,2]. When accelerating freely overground subjects use a higher (constant) acceleration (0.5m/s²) in approach to WRT and have a greater WRT-speed as using lower accelerations [3]. The current study discusses the influence of treadmill acceleration on WRT. A higher WRT-speed with a higher treadmill acceleration is expected.

METHODS

13 subjects performed WRT's on a treadmill imposing 3 constant accelerations (0.1, 0.2 and 0.5m.s⁻²). Spatiotemporal data of the subjects were obtained using sagittal high speed video-images (100Hz), afterwards corrected for movement in the lab-reference frame. WRT-speed was defined as the mean speed of the subject in the treadmill reference frame during step0 (transition step, i.e. the first step with a flight phase). Whole body 3D-kinematics (40 markers) were recorded (Qualisys Pro Reflex, 200 Hz) and analyzed (Visual3D™, 11 segments). Statistical analyses consisted of repeated measures (RM) anova (for speed)/ancova (covariate centred speed difference for other data). Standardized β -values of a multiple linear regression ($V = \beta_1 * SL + \beta_2 * SF$) point out the contributions of step length (SL) and step frequency (SF) to speed (V).

RESULTS AND DISCUSSION

A higher treadmill acceleration evoked a higher WRT-speed (Table 1). This higher WRT-speed was a consequence of acceleration effects before and during WRT.

The multiple linear regression revealed that SL contributed more to speed of step0 compared to SF. Theoretically four strategies could be implemented to increase SL of step0 (Figure 1). An increased acceleration only influenced the

distance the belt travelled during flight (3a) by a greater belt speed during flight (V_{flight}) and a prolonged flight phase (FP). To prolong this flight phase and to push off against the backwardly accelerating belt, subjects probably use a more vigorous push-off.

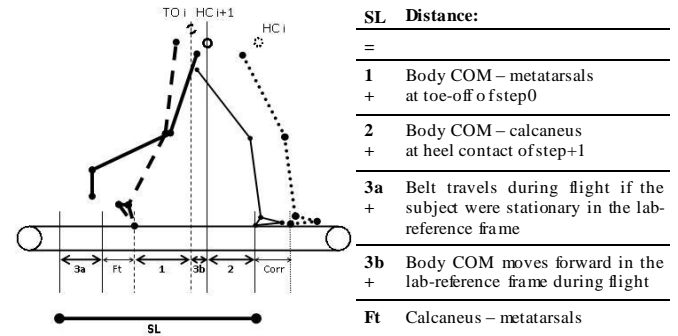


Figure 1: Components contributing to SL of step0.

In step-1 speeds are equal for all accelerations. The speed increase between step-1 and launch of WRT is larger in a higher acceleration, inevitably resulting in a higher speed at initial contact of step0 (V_{wrt ic}). This could be related to triggering mechanisms of transition in the course of step-1.

CONCLUSIONS

A higher treadmill acceleration induces a higher WRT-speed due to a larger step length caused by a prolonged flight phase. Our data suggest a stronger role of the last walking step before transition in triggering mechanisms of WRT than assumed until now. Therefore, mechanisms explaining the increase in transition speed are to be found as well before as during transition.

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REFERENCES

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Table 1: Influence of acceleration on realization of transition: means (M) and coefficients of variation (cv).

**: p<0.05; a: 0.1-0.2m.s⁻², b: 0.1-0.5m.s⁻², c: 0.2-0.5m.s⁻² (p<0.05).

			0.1 m/s ²		0.2 m/s ²		0.5 m/s ²		RM	pairwise
			M	cv	M	cv	M	cv	p	p
Vwrt	Mean speed of step 0	(m/s)	2.11	0.10	2.21	0.13	2.37	0.13	**	a,b,c
β	standardized β -ratio (BSL/BSF)		1.54		2.08		2.29		/	/
SL	Step Length of step 0	(m)	0.96	0.10	0.99	0.11	1.05	0.11	**	b,c
'(1)	See fig.1	(m)	0.43	0.03	0.44	0.04	0.44	0.03		
'(2)	See fig.1	(m)	0.12	0.05	0.14	0.08	0.13	0.07	**	
'(3a)	See fig.1	(m)	0.15	0.09	0.19	0.09	0.23	0.11	**	a,b,c
'(3b)	See fig.1	(m)	0.01	0.14	0.02	0.06	0.02	0.12		
FP	Duration of flight phase of step 0	(s)	0.06	0.45	0.08	0.34	0.09	0.37	**	a,b
Vflight	Mean belt speed of flight phase of step 0	(m/s)	2.28	0.08	2.37	0.10	2.59	0.11	**	a,b,c
V-1	Mean speed of step -1	(m/s)	2.10	0.08	2.09	0.11	2.10	0.12		
Vwrt ic	Belt speed at initial contact of step 0	(m/s)	2.24	0.08	2.29	0.11	2.40	0.13	**	b,c