

## SUPPLEMENTARY MATERIAL

### **Title:**

Selection Procedures for the Largest Lyapunov Exponent in Gait Biomechanics

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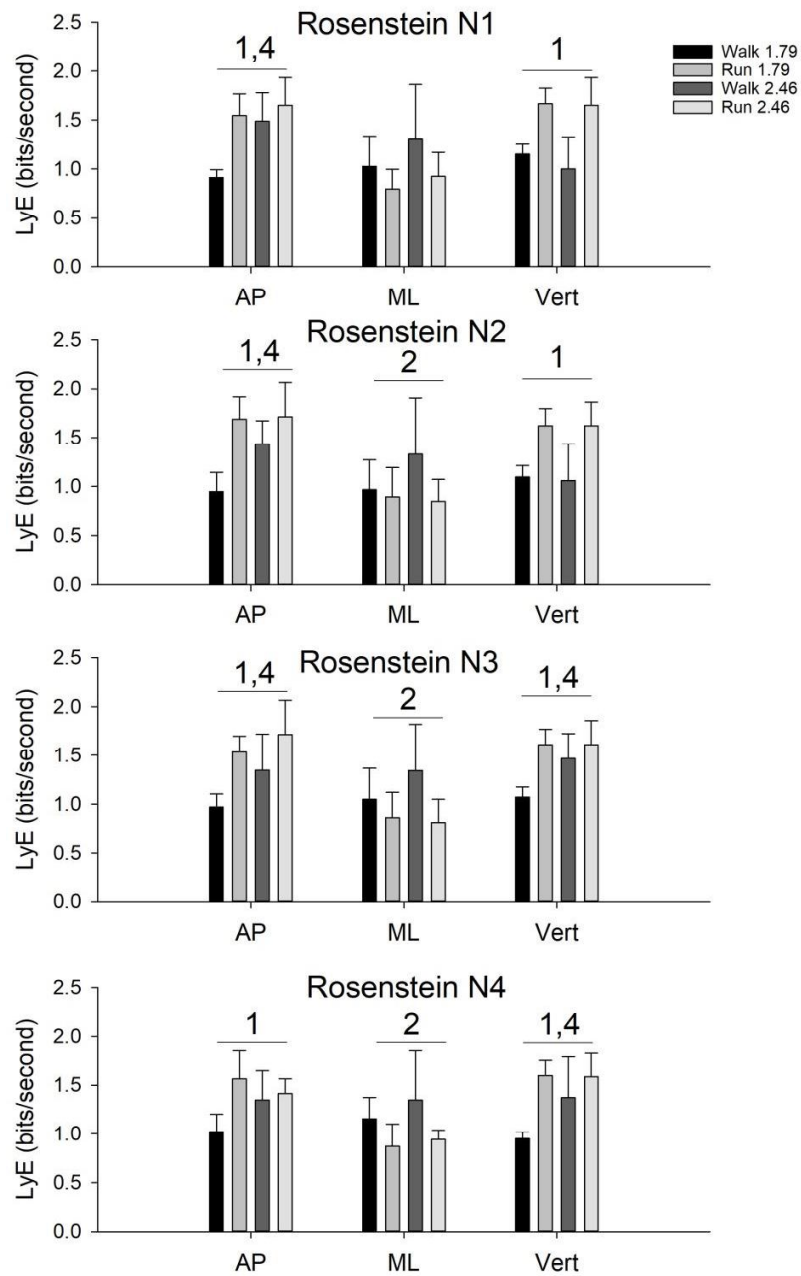
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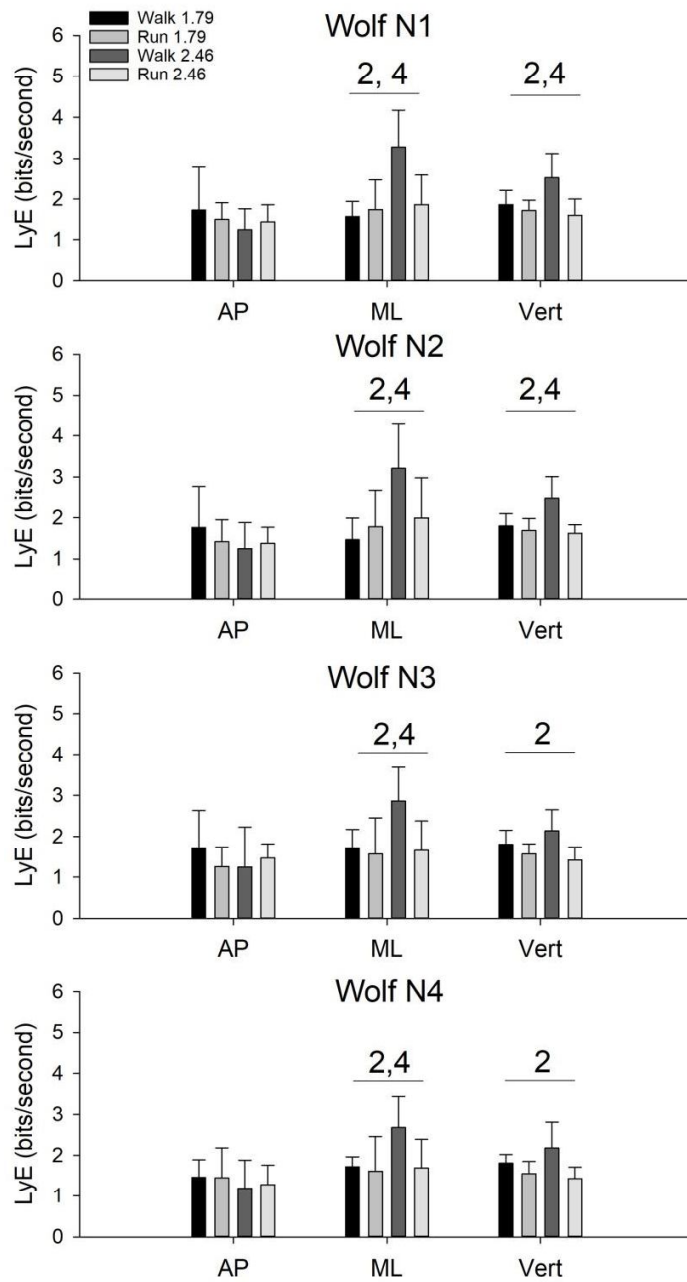
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## State space reconstruction with individual time lag and embedding dimension



**Figure S1:** LyE calculated with an individual time lag and embedding dimension from the anterior-posterior (AP), mediolateral (ML) and vertical (Vert) displacement of the sacrum marker during the four conditions using the Rosenstein et al. algorithm and the four different normalization procedures. 1 above the bars indicates significantly higher LyE for the sacrum displacements during running at the low speed compared to walking at the low speed, 4 above the bars indicates significantly higher LyE for the sacrum displacements during walking at the high speed compared to walking at the low speed.



**Figure S2:** LyE calculated with an individual time lag and embedding dimension from the anterior-posterior (AP), mediolateral (ML) and vertical (Vert) displacement of the sacrum marker during the four conditions using the Wolf et al. algorithm and the four different normalization procedures. 2 above the bars indicates significantly higher LyE for the sacrum displacements during walking at the high speed compared to running at the high speed, 4 above the bars indicates significantly higher LyE for the sacrum displacements during walking at the high speed compared to walking at the low speed.

**Table S1:** Confirmed criteria and sensitivity for the LyE calculated with an individual time lag and embedding dimension and using the Rosenstein et al. algorithm for the anterior-posterior, mediolateral and vertical displacement of the sacrum marker.

	Confirmed criteria	Sensitivity (%)
Rosenstein et al. normalization 1		
Anterior-posterior	1, 4	58.8
Mediolateral	-	38.2
Vertical	1	41.2
Mean across direction	NA	46.1 ± 11.1
Rosenstein et al. normalization 2		
Anterior-posterior	1,4	58.8
Mediolateral	2	47.1
Vertical	1	41.2
Mean across direction	NA	49.0 ± 9.0
Rosenstein et al. normalization 3		
Anterior-posterior	1, 4	52.9
Mediolateral	2	50.0
Vertical	1, 4	52.9
Mean across direction	NA	52.0 ± 1.7
Rosenstein et al. normalization 4		
Anterior-posterior	1	52.9
Mediolateral	2	44.1
Vertical	1, 4	67.6
Mean across direction	NA	54.9 ± 11.9

**Table S2:** Confirmed criteria and sensitivity for the LyE calculated with an individual time lag and embedding dimension and using the Wolf et al. algorithm for the anterior-posterior, mediolateral and vertical displacement of the sacrum marker.

	Confirmed criteria	Sensitivity (%)
Wolf et al. normalization 1		
Anterior-posterior	-	26.5
Mediolateral	2, 4	47.1
Vertical	2, 4	58.8
Mean across direction	NA	44.1 ± 16.4
Wolf et al. normalization 2		
Anterior-posterior	-	23.5
Mediolateral	2, 4	44.1
Vertical	2, 4	61.8
Mean across direction	NA	43.1 ± 19.1
Wolf et al. normalization 3		
Anterior-posterior	-	11.8
Mediolateral	2, 4	44.1
Vertical	2	50.0
Mean across direction	NA	35.3 ± 20.6
Wolf et al. normalization 4		
Anterior-posterior	-	23.8
Mediolateral	2, 4	44.1
Vertical	2	50.0
Mean across direction	NA	39.2 ± 13.9

**Table S3:** Statistical outcome from One-way ANOVA for repeated measure and post hoc test, with Rosenstein et al. algorithm and first normalization procedure.

Rosenstein et al. algorithm	Normalization 1 Anterior-posterior direction – overall effect of locomotion mode: NS			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NA	NA	NA
Run 1.79	NA		NA	NA
Walk 2.46	NA	NA		NA
Run 2.46	NA	NA	NA	

Rosenstein et al. algorithm	Normalization 1 Mediolateral direction – overall effect of locomotion mode: p < 0.001			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		p = 0.01	p < 0.001	p = 0.012
Run 1.79	p = 0.01		p = 0.027	NS
Walk 2.46	p < 0.001	p = 0.027		p = 0.027
Run 2.46	p = 0.012	NS	p = 0.027	

Rosenstein et al. algorithm	Normalization 1 Vertical direction – overall effect of locomotion mode: p < 0.001			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		p < 0.001	NS	p < 0.001
Run 1.79	p < 0.001		p < 0.001	NS
Walk 2.46	NS	< 0.001		p < 0.001
Run 2.46	p < 0.001	NS	p < 0.001	

**Table S4:** Statistical outcome from One-way ANOVA for repeated measure and post hoc test, with Rosenstein et al. algorithm and second normalization procedure.

Rosenstein et al. algorithm	Normalization 2 Anterior-posterior – overall effect of locomotion mode: NS			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NA	NA	NA
Run 1.79	NA		NA	NA
Walk 2.46	NA	NA		NA
Run 2.46	NA	NA	NA	

Rosenstein et al. algorithm	Normalization 2 Mediolateral – overall effect of locomotion mode: p < 0.001			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		p = 0.002	p < 0.001	p = 0.002
Run 1.79	p = 0.002		NS	NS
Walk 2.46	p < 0.001	NS		NS
Run 2.46	p = 0.002	NS	NS	

Rosenstein et al. algorithm	Normalization 2 Vertical – overall effect of locomotion mode: p < 0.001			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		p < 0.001	NS	p < 0.001
Run 1.79	p < 0.001		p < 0.001	NS
Walk 2.46	NS	p < 0.001		p < 0.001
Run 2.46	p < 0.001	NS	p < 0.001	

**Table S5:** Statistical outcome from One-way ANOVA for repeated measure and post hoc test, with Rosenstein et al. algorithm and third normalization procedure.

Rosenstein et al. algorithm	Normalization 3 Anterior-posterior – overall effect of locomotion mode: $p = 0.004$			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		$p = 0.007$	$p = 0.038$	$p = 0.011$
Run 1.79	$p = 0.007$		NS	NS
Walk 2.46	$p = 0.038$	NS		NS
Run 2.46	$p = 0.011$	NS	NS	

Rosenstein et al. algorithm	Normalization 3 Mediolateral – overall effect of locomotion mode: $p < 0.001$			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		$p = 0.014$	$p < 0.001$	$p = 0.022$
Run 1.79	$p = 0.014$		$p = 0.024$	NS
Walk 2.46	$p < 0.001$	$p = 0.024$		$p = 0.019$
Run 2.46	$p = 0.022$	NS	$p = 0.019$	

Rosenstein et al. algorithm	Normalization 3 Vertical – overall effect of locomotion mode: $p < 0.001$			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		$p < 0.001$	$p = 0.001$	$p < 0.001$
Run 1.79	$p < 0.001$		NS	NS
Walk 2.46	$p = 0.001$	NS		NS
Run 2.46	$p < 0.001$	NS	NS	

**Table S6:** Statistical outcome from One-way ANOVA for repeated measure and post hoc test, with Rosenstein et al. algorithm and fourth normalization procedure.

Rosenstein et al. algorithm	Normalization 4 Anterior-posterior direction – overall effect of locomotion mode: $p = 0.014$			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		$p = 0.021$	NS	$p = 0.035$
Run 1.79	$p = 0.021$		NS	NS
Walk 2.46	NS	NS		NS
Run 2.46	$p = 0.035$	NS	NS	

Rosenstein et al. algorithm	Normalization 4 Mediolateral direction – overall effect of locomotion mode: $p = 0.003$			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NS	$p = 0.001$	NS
Run 1.79	NS		NS	NS
Walk 2.46	$p = 0.001$	NS		NS
Run 2.46	NS	NS	NS	

Rosenstein et al. algorithm	Normalization 4 Vertical direction – overall effect of locomotion mode: $p < 0.001$			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		$p < 0.001$	$p < 0.001$	$p < 0.001$
Run 1.79	$p < 0.001$		NS	NS
Walk 2.46	$p < 0.001$	NS		NS
Run 2.46	$p < 0.001$	NS	NS	

**Table S7:** Statistical outcome from One-way ANOVA for repeated measure and post hoc test, with Wolf et al. algorithm and first normalization procedure.

Wolf et al. algorithm	Normalization 1 Anterior-posterior – overall effect of locomotion mode: NS			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NA	NA	NA
Run 1.79	NA		NA	NA
Walk 2.46	NA	NA		NA
Run 2.46	NA	NA	NA	

Wolf et al. algorithm	Normalization 1 Mediolateral – overall effect of locomotion mode: p = 0.017			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NS	p = 0.012	NS
Run 1.79	NS		NS	NS
Walk 2.46	p = 0.012	NS		NS
Run 2.46	NS	NS	NS	

Wolf et al. algorithm	Normalization 1 Vertical – overall effect of locomotion mode: p < 0.001			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NS	p < 0.001	NS
Run 1.79	NS		p < 0.001	NS
Walk 2.46	p < 0.001	p < 0.001		p < 0.001
Run 2.46	NS	NS	p < 0.001	

**Table S8:** Statistical outcome from One-way ANOVA for repeated measure and post hoc test, with Wolf et al. algorithm and second normalization procedure.

Wolf et al. algorithm	Normalization 2 Anterior-posterior – overall effect of locomotion mode: p = 0.035			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NS	NS	p = 0.040
Run 1.79	NS		NS	NS
Walk 2.46	NS	NS		NS
Run 2.46	p = 0.040	NS	NS	

Wolf et al. algorithm	Normalization 2 Mediolateral – overall effect of locomotion mode: p = 0.017			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NS	p = 0.011	NS
Run 1.79	NS		NS	NS
Walk 2.46	p = 0.011	NS		NS
Run 2.46	NS	NS	NS	

Wolf et al. algorithm	Normalization 2 Vertical – overall effect of locomotion mode: p < 0.001			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NS	p < 0.001	NS
Run 1.79	NS		p < 0.001	p < 0.001
Walk 2.46	p < 0.001	p < 0.001		NS
Run 2.46	NS	p < 0.001	NS	



**Table S9:** Statistical outcome from One-way ANOVA for repeated measure and post hoc test, with Wolf et al. algorithm and third normalization procedure.

Wolf et al. algorithm	Normalization 3 Anterior-posterior – overall effect of locomotion mode: NS			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NA	NA	NA
Run 1.79	NA		NA	NA
Walk 2.46	NA	NA		NA
Run 2.46	NA	NA	NA	

Wolf et al. algorithm	Normalization 3 Mediolateral – overall effect of locomotion mode: NS			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NA	NA	NA
Run 1.79	NA		NA	NA
Walk 2.46	NA	NA		NA
Run 2.46	NA	NA	NA	

Wolf et al. algorithm	Normalization 3 Vertical – overall effect of locomotion mode: p < 0.001			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		p = 0.030	p < 0.001	p = 0.025
Run 1.79	p = 0.030		p < 0.001	NS
Walk 2.46	p < 0.001	p < 0.001		p < 0.001
Run 2.46	p = 0.025	NS	p < 0.001	

**Table S10:** Statistical outcome from One-way ANOVA for repeated measure and post hoc test, with Wolf et al. algorithm and fourth normalization procedure.

Wolf et al. algorithm	Normalization 4 Anterior-posterior – overall effect of locomotion mode: NS			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NA	NA	NA
Run 1.79	NA		NA	NA
Walk 2.46	NA	NA		NA
Run 2.46	NA	NA	NA	

Wolf et al. algorithm	Normalization 4 Mediolateral – overall effect of locomotion mode: p = 0.043			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NS	NS	NS
Run 1.79	NS		NS	NS
Walk 2.46	NS	NS		NS
Run 2.46	NS	NS	NS	

Wolf et al. algorithm	Normalization 4 Vertical – overall effect of locomotion mode: p < 0.001			
	Walk 1.79	Run 1.79	Walk 2.46	Run 2.46
Walk 1.79		NS	p < 0.001	NS
Run 1.79	NS		p < 0.001	NS
Walk 2.46	p < 0.001	p < 0.001		p < 0.001
Run 2.46	NS	NS	p < 0.001	