Fundamental motion outcomes - Steps / Strides

We describe the close relationship between stride, cadence and velocity, as fundamental motion outcomes, in particular for the elderly. Stride (Length, Time, CoV) is a meaningful mobility outcome for clinical intervention trials. Stride variability while motor-cognitive dual-tasking is a sensitive mobility outcome for fall risk and cognitive disorders (e.g. Alzheimer's disease) at an early stage. Salsa proved to be a safe and feasible exercise programme for older adults accompanied with a high adherence rate

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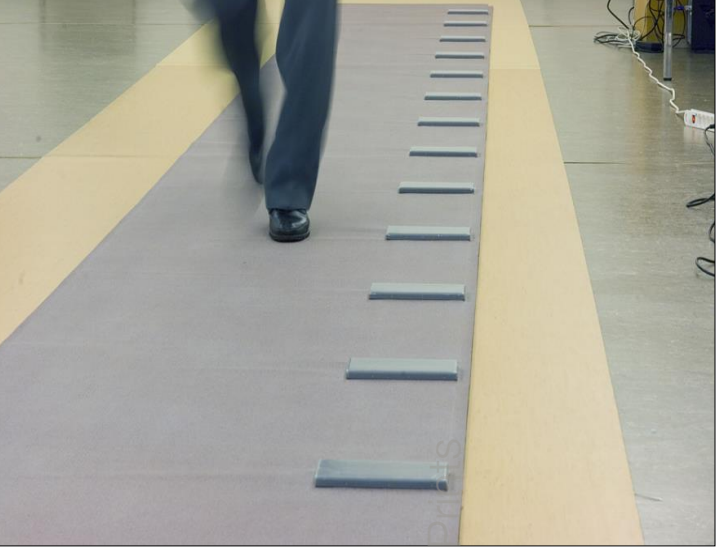

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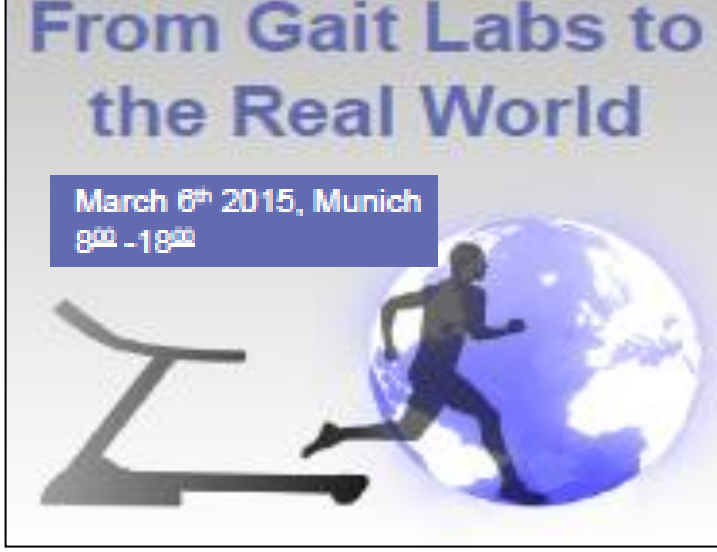

Fundamental Motion Outcomes

Steps/Strides

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Chair of Geriatrics

Department Head

felixplatterhospital

University Center for Medicine of Aging

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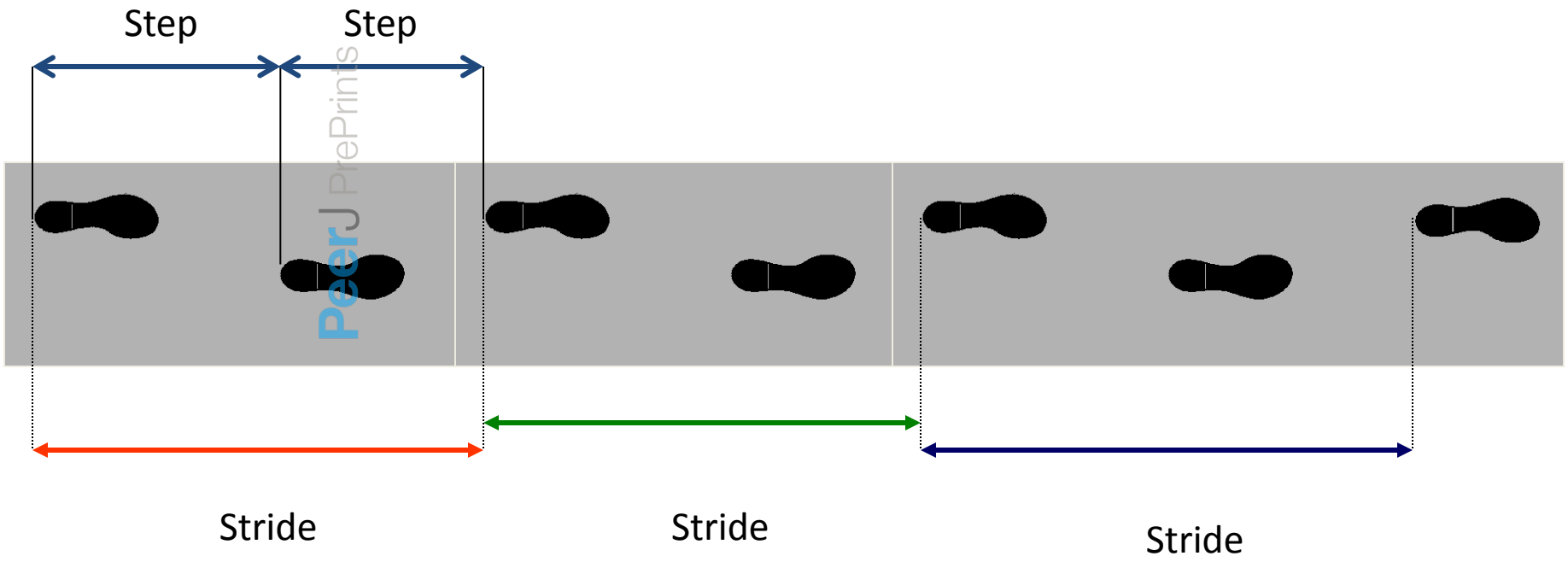
Step / Stride (length/time)

spatial - temporal



Perry J: Gait Analysis: Normal and Pathological Function. Thorofare (NJ): Slack, Inc.; 1992

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Nomalized plot summarizing stride, cadence and walking speed

Stature: dividing by body height

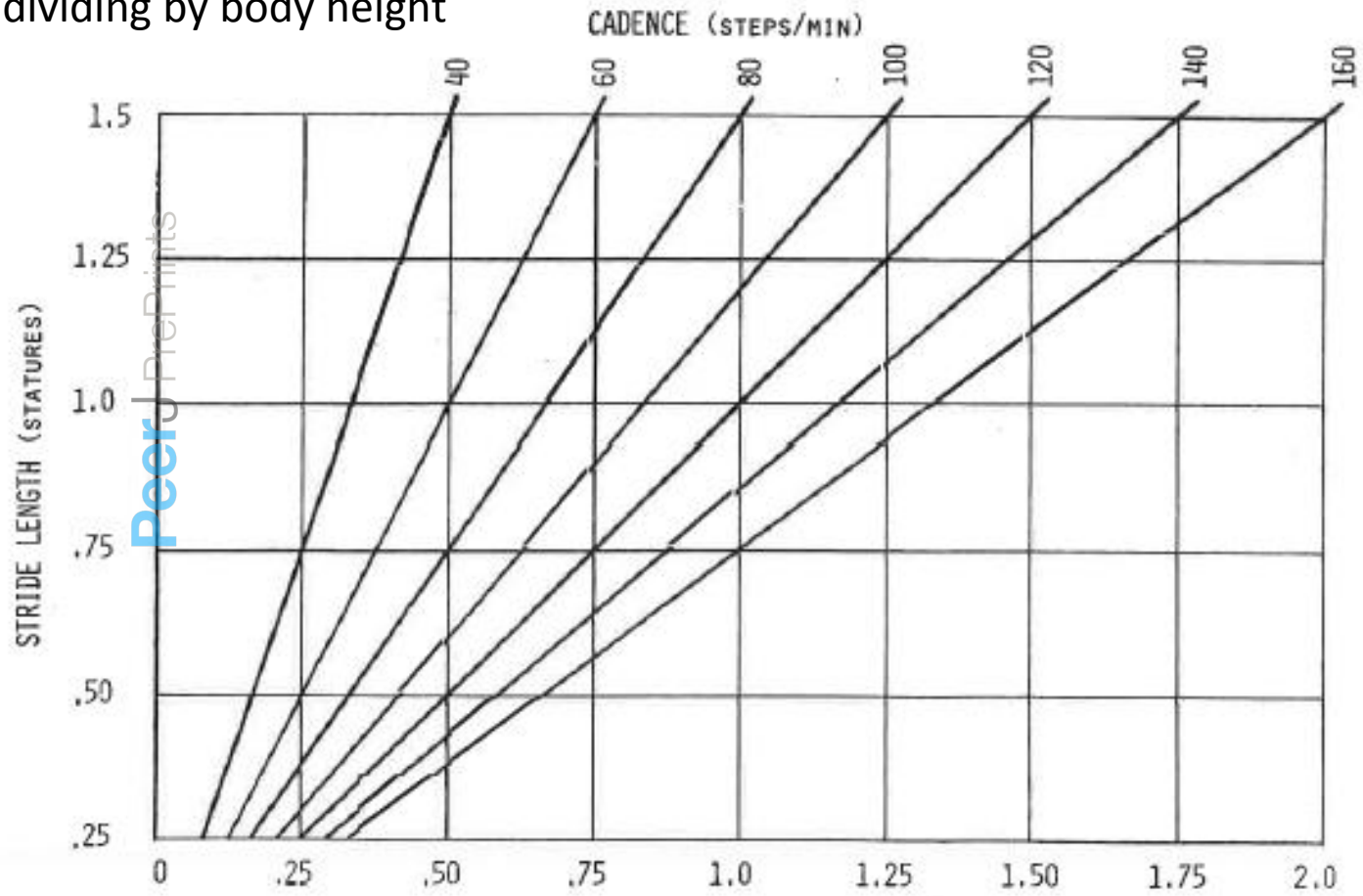

Figure 2.30(b)

(Nomogram by Grieve 1968)

Winter DA. The Biomechanics and motor control of human gait. University of Waterloo Press 1987

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Comparison of Young and Elderly Subjects: Stride Length (m)

	Young	Elderly	Signif.
Stride Length (m)	1.56 ± 0.1	1.38 ± 0.12	$p < .01$
Stride Length (Stat.)	0.890 ± 0.46	0.809 ± 0.81	$p < .01$
Cadence (steps/min.)	110.5 ± 8.3	111.8 ± 8.7	

Winter DA. The Biomechanics and motor control of human gait: Normal, Elderly and Pathological. Second Edition. University of Waterloo Press 1990

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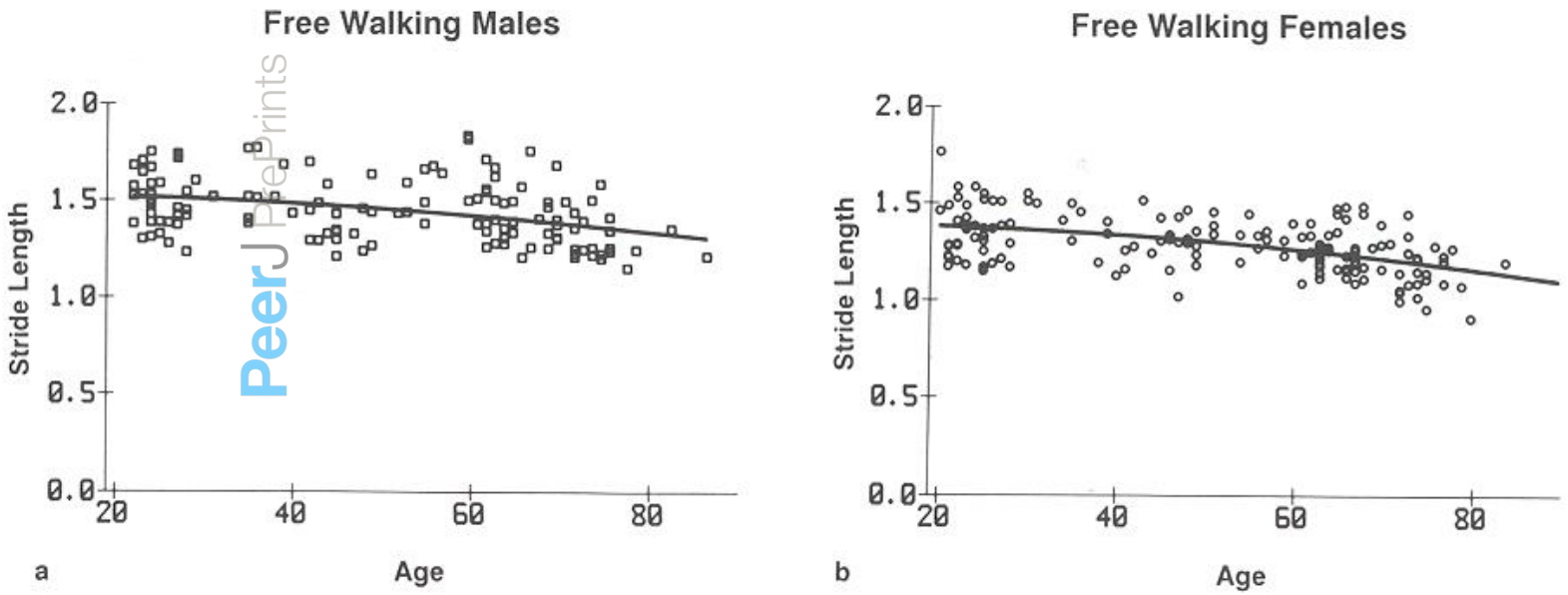
Age-associated gait changes: stride length



Normal stride length during free pace walking. (a) Males (n=135); (b) Females (n=158). Vertical scale = meters; Horizontal scale = age (20 to 85 yrs).

Perry J: Gait Analysis: Normal and Pathological Function. Thorofare (NJ): Slack, Inc.; 1992

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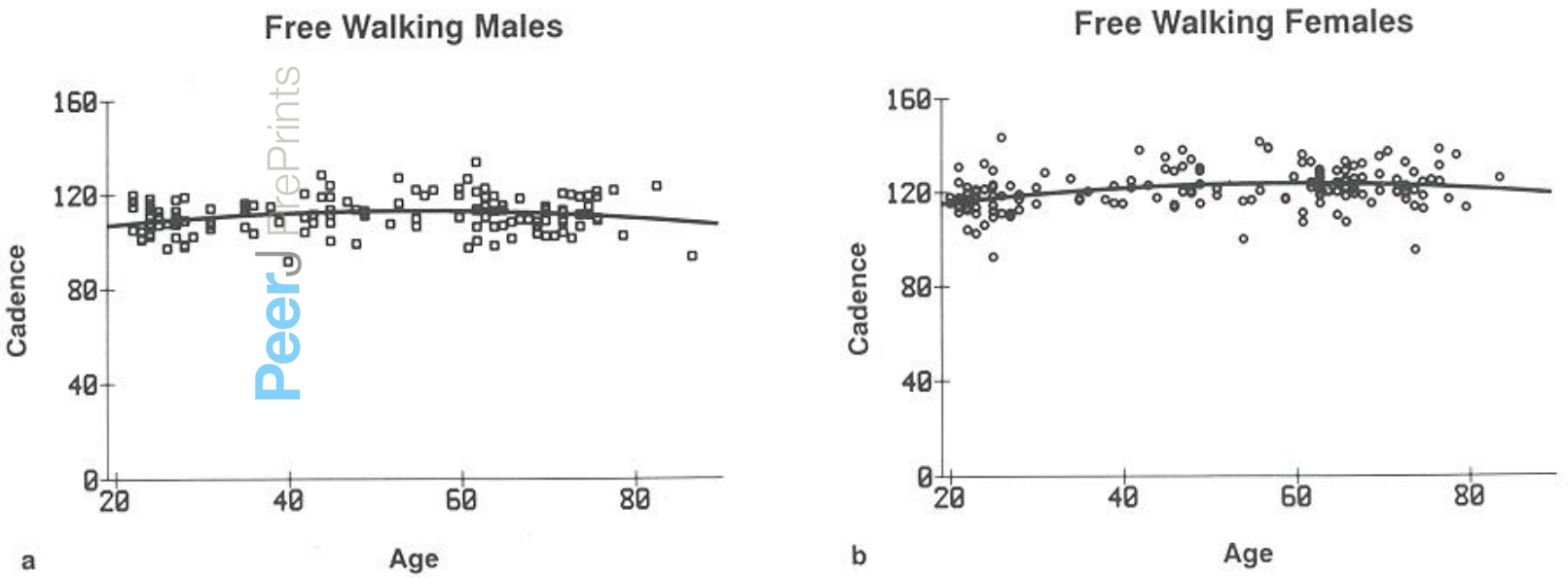
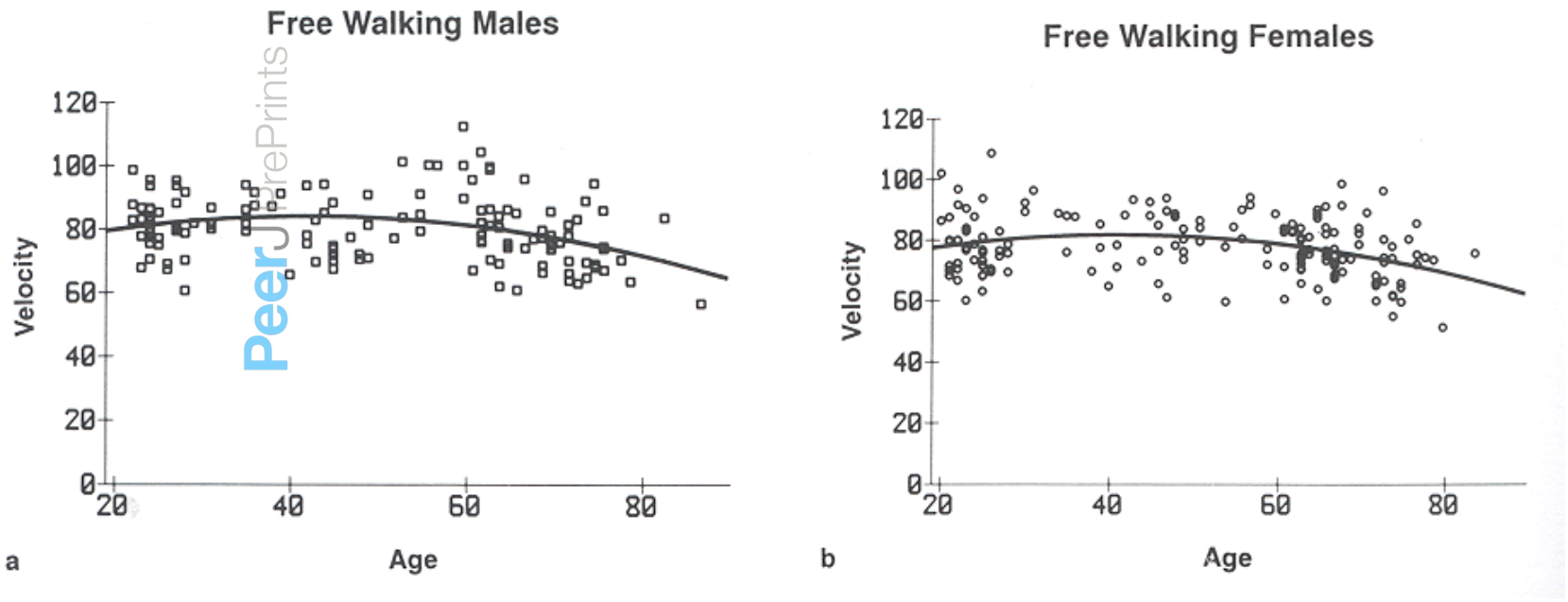
Age-related gait changes: cadence



Normal cadence during free pace walking. (a) Males (n=135); (b) Females (n=158). Vertical scale = steps/minute; Horizontal scale = age (20 to 85 yrs).

Perry J: Gait Analysis: Normal and Pathological Function. Thorofare (NJ): Slack, Inc.; 1992

Age-related gait changes: walking speed



Normal velocity during free pace walking. (a) Males (n=135); (b) Females (n=158). Vertical scale = meters/minute Horizontal scale = age (20 to 85 yrs).

Perry J: Gait Analysis: Normal and Pathological Function. Thorofare (NJ): Slack, Inc.; 1992

Gerontology

Clinical Section / Original Paper

Gerontology
DOI: 10.1159/000334814

Effects of a Salsa Dance Training on Balance and Strength Performance in Older Adults

Urs Granacher[a] Thomas Muehlbauer[a] Stephanie A. Bridenbaugh[b]
Madeleine Wolf[c] Ralf Roth[c] Yves Gschwind[b] Irene Wolf[b] Rui Mata[d]
Reto W. Kressig[b]

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Granacher U et al. Gerontology 2012; 58(4):305-12.

Salsa-related physical performance changes in older adults

Measure	INT (n = 14)		CON (n = 14)		p value
	before	after	before	after	time
Standing					
CoPtot, mm	1,984.4 ± 584.8	1,744.6 ± 670.7	2,192.3 ± 437.1	2,140.9 ± 457.7	0.076
CoPml, mm	1,210.5 ± 342.7	1,078.5 ± 441.0	1,448.8 ± 358.9	1,310.4 ± 297.4	0.046
CoPap, mm	1,315.0 ± 437.5	1,145.5 ± 459.9	1,335.1 ± 332.8	1,401.3 ± 403.4	0.440
CoPspeed, mm/s	67.1 ± 19.5	59.3 ± 23.0	74.3 ± 14.7	72.9 ± 15.6	0.093
CoParea, mm^2	15.6 ± 9.2	13.8 ± 7.4	16.4 ± 8.4	14.7 ± 9.6	0.461
Walking					
Stride velocity, cm/s	133.8 ± 20.2	148.9 ± 25.8	141.8 ± 14.4	142.2 ± 14.2	0.001
Stride time, s	1.02 ± 0.07	0.98 ± 0.07	1.04 ± 0.06	1.05 ± 0.07	0.018
Stride length, cm	136.8 ± 22.0	145.5 ± 26.8	147.6 ± 15.0	148.4 ± 13.3	0.001
Stride velocity CV, %	2.7 ± 1.5	2.4 ± 1.1	2.3 ± 1.0	2.4 ± 0.7	0.637
Stride time CV, %	1.7 ± 1.0	1.9 ± 0.6	1.4 ± 0.7	1.6 ± 0.4	0.332
Stride length CV, %	1.9 ± 0.8	1.9 ± 1.1	1.9 ± 0.8	1.7 ± 0.6	0.612
Power					
CMJ power, W/kg	14.0 ± 2.8	15.7 ± 3.5	16.2 ± 2.2	19.2 ± 2.9	0.000

Granacher U et al. Gerontology 2012; 58(4):305-12.

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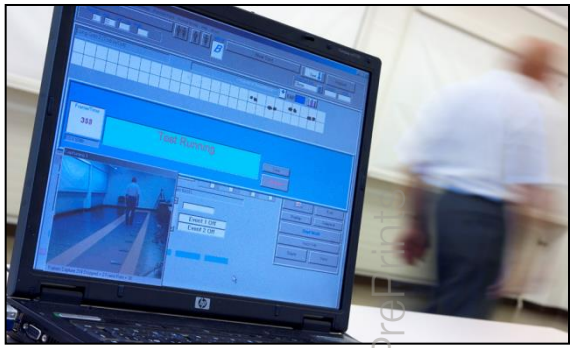
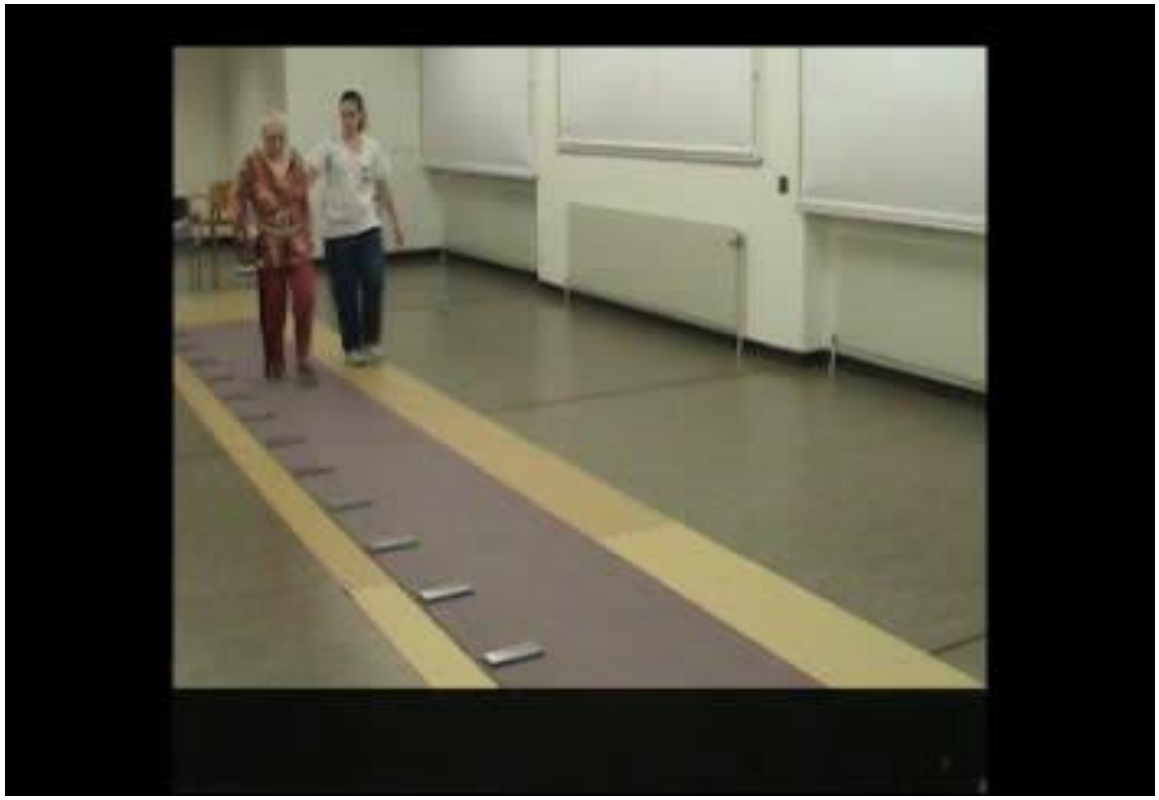
Basel Mobility Center

felixplatterhospital
University Center for Medicine of Aging





Kressig RW, Beauchet O.

Guidelines for clinical applications of spatio-temporal gait analysis in older adults. Aging Clin Exp Res 2006;18:174-6.

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Bridging the Gap between Clinical and Behavioural Gerontology
Part I: Promoting Late-Life Mobility and Independence

Gerontology

Gerontology
DOI: 10.1159/000322194

Published online: October 27, 2010

Gerontology 2011;57:256-64.

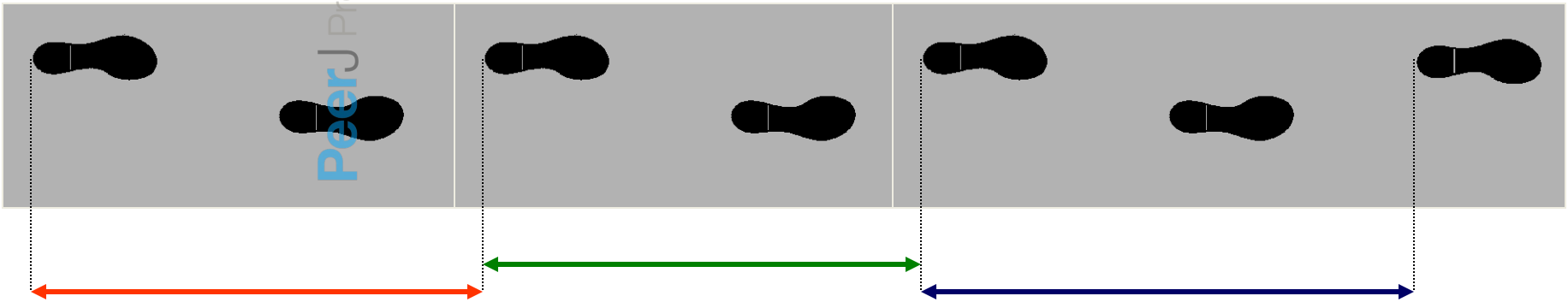
Laboratory Review: The Role of Gait Analysis in Seniors' Mobility and Fall Prevention

Stephanie A. Bridenbaugh Reto W. Kressig

Department of Acute Geriatrics, University Hospital of Basel, Basel, Switzerland

Stride-to-Stride Variability: meaningful outcome for gait stability and cognition

Example : Left Stride Length



Coefficient of Variation (%), CoVar = (SD/M) x 100

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Stride Length Variability and Falls Among Older Community-Dwelling Older Adults

Gait Measure	Change	Odds Ratio for Falling (95% Confidence Interval)
Stride-to-Stride-Standard Deviation		
Stride Length	+1.7 cm	1.95(1.08-3.52)
Double-Support	+0.72%	2.05(1.11-3.77)
Stride Velocity	+0.016m/s	2.30(1.17-4.51)

Maki BE. Gait changes in older adults: Predictors of falling or indicators of fear? J Am Geriatr Soc 1997;45:313-320

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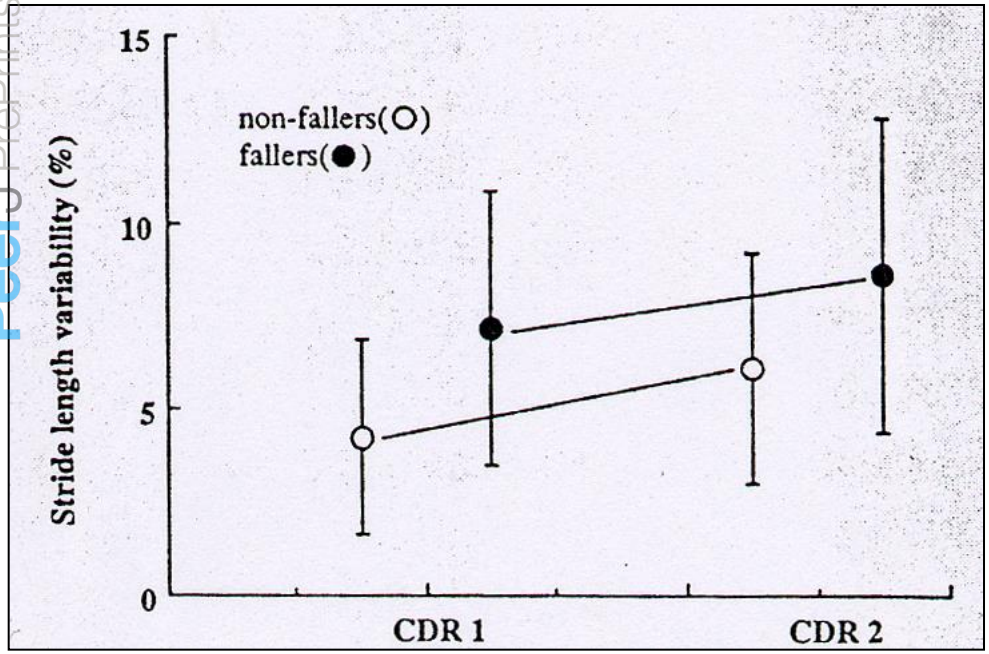
Gait Variability and Falls in Patients with Alzheimer's Disease



Nakamura T, Meguro K, Sasaki H. Relationship between falls and stride length variability in senile dementia of the Alzheimer Type. Gerontology 1996;42:108-113.

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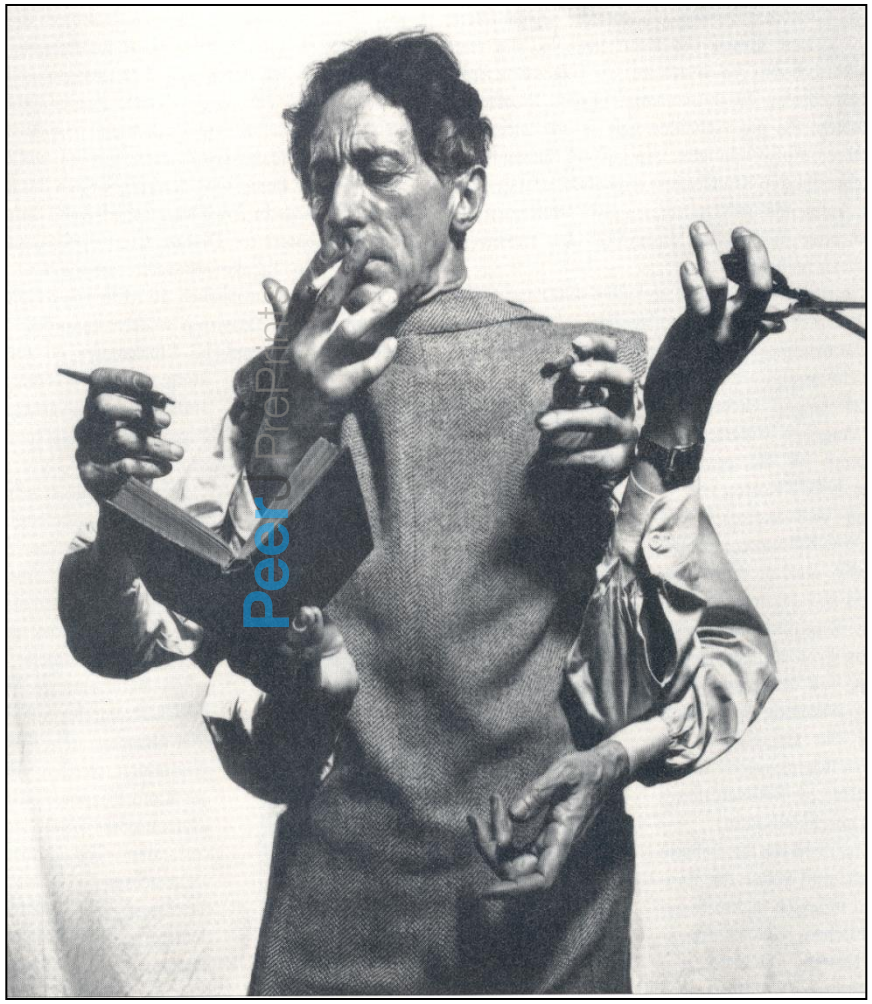

Brain function, cognition, and motor control…

« Multi-tasking »

Model for stress resistance testing
Quantification of functional reserve

Theill N, Martin M, Schumacher V, Bridenbaugh SA, Kressig RW. Simultaneously Measuring Gait and Cognitive Performance in Cognitively Healthy and Cognitively Impaired Older Adults: The Basel Motor-Cognition Dual-Task Paradigm. J Am Geriatr Soc 2011 59:1012-8.

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Dual Task-Related Gait Variability and Fall Risk in In-Patients

Table 2B - *Risk estimates of the time to a first fall event occurring during hospital stay based on univariate Cox regression models.*

Variable	Walking alone		Walking backwards counting	
	HR (95% CI)	*p*-value	HR (95% CI)	*p*-value
Coefficient of variation of stride time (coded as a binary variable)*	7.4 (0.9-59.0)	0.060	9.1 (1.9-43.8)	0.006

CI: confidence interval; HR: hazard ratio. *Binary threshold determined by sensitivity analysis (coefficient of variation >4% while walking alone, coefficient of variation >10% while walking backwards counting).

Kressig RW, Herrmann FR, Grandjean R, Michel JP, Beauchet O. Gait variability while dual-tasking : Predictor of falls in older inpatients ? Aging Exp Clin Res 2008;20:123-30.

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The New York Times

Footprints to Cognitive Decline and Alzheimer's Are Seen in Gait

By PAM BELLUCK
Published: July 16, 2012

The way people walk appears to speak volumes about the way they think, so much so that changes in an older person's gait appear to be an early indicator of cognitive impairment, including Alzheimer's disease.

One study involved more than 1,100 elderly people in Basel, Switzerland. About a quarter of them were cognitively healthy, while the others had mild cognitive impairment, considered a precursor to dementia, or were in various stages of Alzheimer's.

Bridenbaugh SA, Monsch AU, Kressig RW. How does gait change as cognitive decline progresses in the elderly? Alzheimer's Association International Conference, Vancouver (Can), July 14 – 19, 2012

Normal Walking

M.B., 72 years
Multiple falls

Velocity: 123 cm/sec
Cycle time CV: 1%

Kressig RW, Beauchet O. Guidelines for clinical applications of spatio-temporal gait analysis in older adults. Aging Clin Exp Res 2006;18:174-6.

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Working Memory Task

M.B., 72 years
Multiple falls

Backward counting out loud

MCI
Mild Cognitive Impairment

Velocity: 24 cm/sec
Cycle time CV: 74%

Kressig RW, Beauchet O. Guidelines for clinical applications of spatio-temporal gait analysis in older adults. Aging Clin Exp Res 2006;18:174-6.

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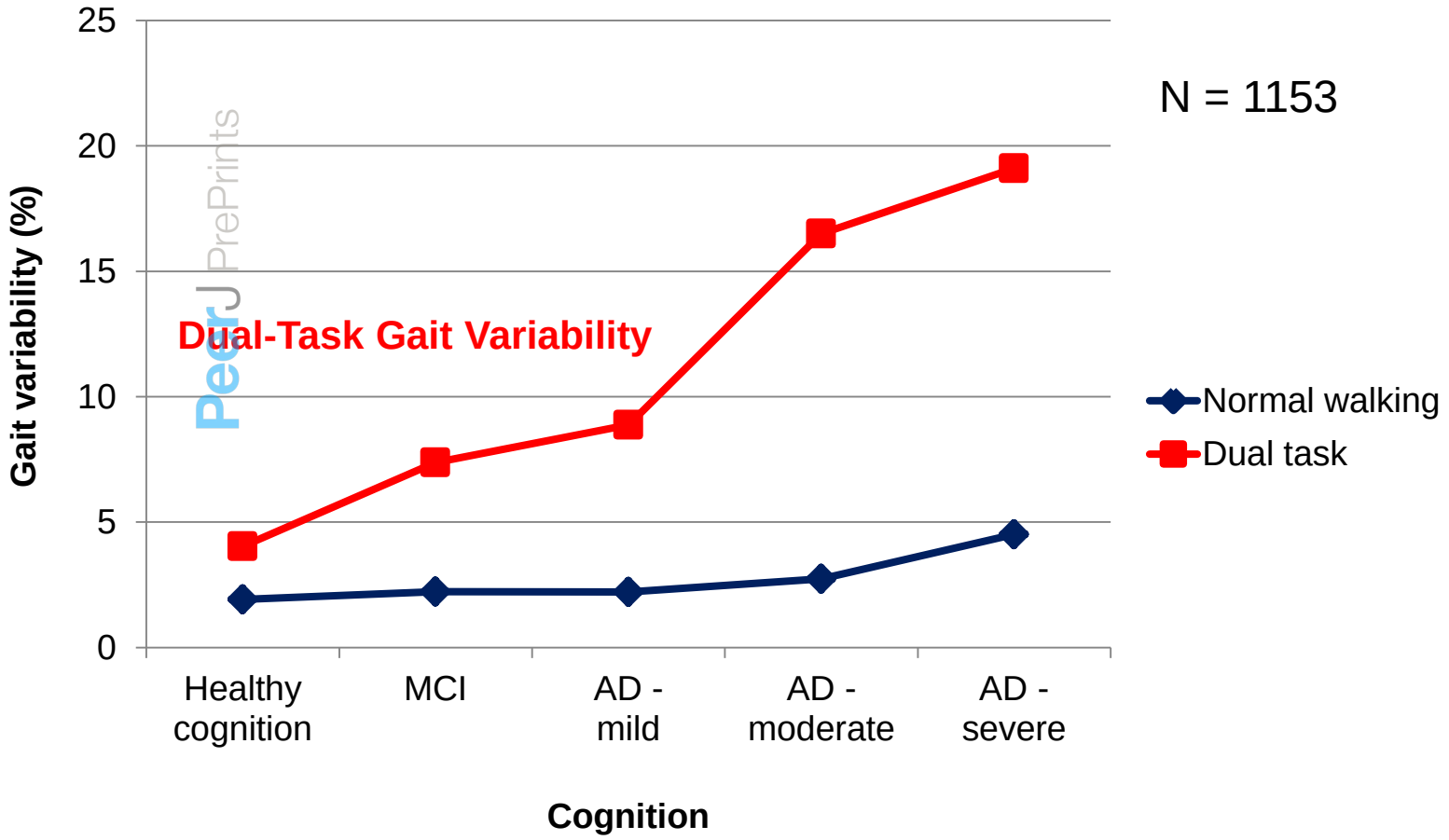
Dual task-related gait variability increases as cognition worsens



MCI = Mild Cognitive Impairment; AD = Alzheimer's Dementia

Bridenbaugh SA, Monsch AU, Kressig RW. How does gait change as cognitive decline progresses in the elderly? Alzheimer's Association International Conference, Vancouver (Can), July 14 – 19, 2012

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Galantamine improves dual-task-related gait performance in patients with Alzheimer's disease

	Sitting	Walking		P-Value*
		Usual	Backward counting	
Control subjects (n=18)				
Stride time (ms)		1063.2 (66.6)	1075.4 (209.3)	0.744
Enumerated figures	9.5 (2.0)	-	10 (3.0)	0.501
AD subjects (n=9)				
Before treatment				
Stride time (ms)		1122.6 (84.6)	1499.1(250.9)	0.011
Enumerated figures	9.0 (4.0)	-	10 (2.5)	0.618
After treatment				
Stride time (ms)		1166.1 (175.0)	1278.5 (226.6)	0.092
Enumerated figures	9.0 (4.5)	-	10 (2.5)	1.00

*: Based on Wilcoxon matched-pairs signed-ranks test

ms: millisecond

Assal F, Allali G, Kressig RW et al. Galantamine improves gait performance in patients with Alzheimer's disease. J Am Geriatr Soc 2008;56:946-7.

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UNIVERSITÉ DE GENÈVE

Attendance rate : 84%

Geneva Dalcroze Dual-Task Trial

134 community-dwelling older adults without previous JD Eurhythmics experience (6-months intervention, 1x/week)

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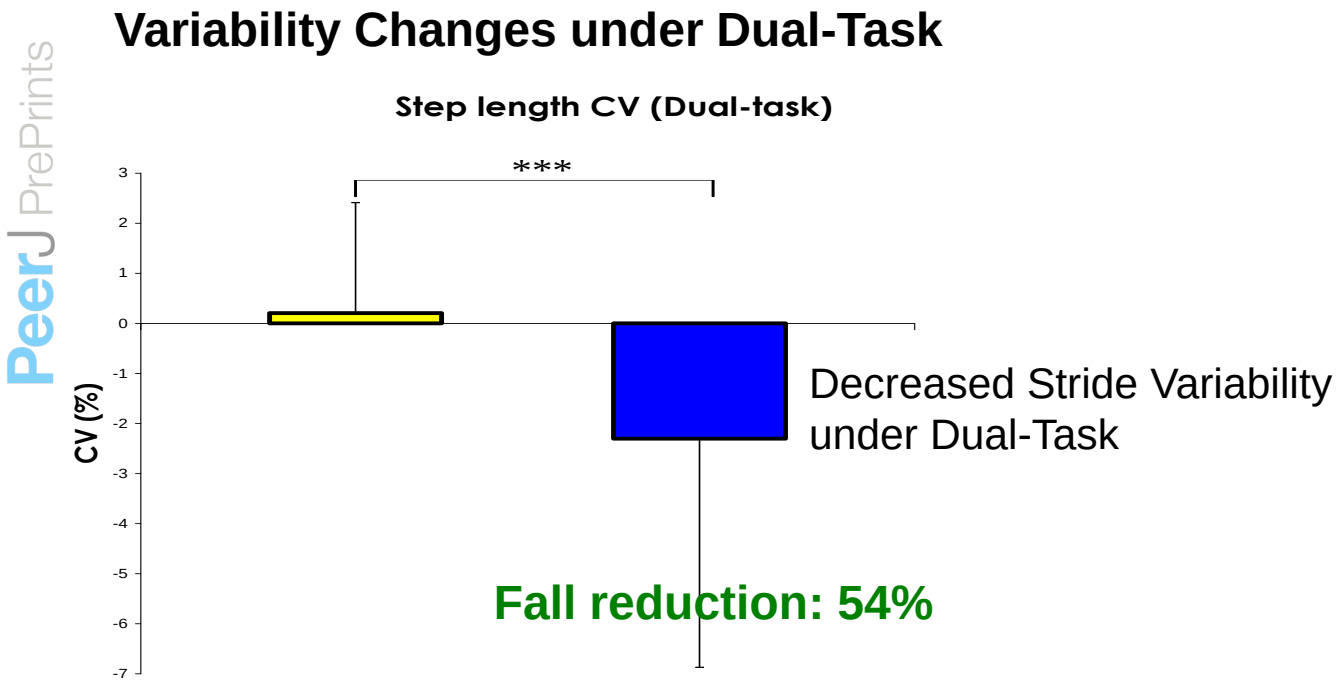
Geneva Dalcroze Dual-Task Trial
n = 134, intervention duration: 6 months



ANCOVAs with the baseline value of the outcome measure as covariate
**p<.05 ***p<.001*

Control

Dalcroze eurhythmics

Trombetti et al. Arch Intern Med 2011; 171(6):525-33.

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Stride: Take home messages

- Close relationship between stride, cadence and velocity
- Stride (Length, Time, CoV): meaningful mobility outcome for clinical intervention trials
- Stride variability while motor-cognitive dual-tasking as sensitive mobility outcome for fall risk and cognitive disorders at an early stage

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