Dual-Tasking: early recognition of motor and cognitive decline

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Risk factors for falls identified in 16 studies: Summary of univariate analysis

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Mean RR</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle weakness</td>
<td>4.4</td>
<td>1.5 – 10.3</td>
</tr>
<tr>
<td>History of falls</td>
<td>3.0</td>
<td>1.7 – 7.0</td>
</tr>
<tr>
<td>Gait deficit</td>
<td>2.9</td>
<td>1.3 – 5.6</td>
</tr>
<tr>
<td>Balance deficit</td>
<td>2.9</td>
<td>1.6 – 5.4</td>
</tr>
<tr>
<td>Use assistive device</td>
<td>2.6</td>
<td>1.2 – 4.6</td>
</tr>
<tr>
<td>Visual deficit</td>
<td>2.5</td>
<td>1.6 – 3.5</td>
</tr>
<tr>
<td>Arthritis</td>
<td>2.4</td>
<td>1.9 – 2.9</td>
</tr>
<tr>
<td>Impaired ADL</td>
<td>2.3</td>
<td>1.5 – 3.1</td>
</tr>
<tr>
<td>Depression</td>
<td>2.2</td>
<td>1.7 – 2.5</td>
</tr>
<tr>
<td>Cognitive Impairment</td>
<td>1.8</td>
<td>1.0 – 2.3</td>
</tr>
<tr>
<td>Age &gt; 80 years</td>
<td>1.7</td>
<td>1.1 – 2.5</td>
</tr>
</tbody>
</table>

Involved systems for postural control

Motor Control (Brain)

Vestibular system, Cerebellum

Vision & Hearing

Neuro muscular control
Reaction time

Peripheral Sensibility

Muscle strength and power

Motor Learning and Motor Memory

EXPLORATION

ADAPTATION

AUTOMATISATION

Attentional resources

Attention needed for walking…
Walk and Talk Test

High fall risk if person is stopping when answering a question

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

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Gait Variability: Stride-to-Stride Variability

Example: Left Stride Length

Coefficient of Variation (%), CoVar = (SD/M) x 100
### Stride Length Variability and Falls Among Older Community-Dwelling Older Adults

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

Gait Variability and Falls in Patients with Alzheimer’s Disease

### Table 2. Quantitative gait parameters at baseline by final cognitive status. Values are means with standard deviations.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>No dementia (n = 366)</th>
<th>Developed dementia (n = 33)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity, cm/sec</td>
<td>94.1 ± 23.6</td>
<td>79.5 ± 23.0</td>
<td>0.002</td>
</tr>
<tr>
<td>Cadence, steps/min</td>
<td>101.5 ± 12.1</td>
<td>95.3 ± 11.8</td>
<td>0.007</td>
</tr>
<tr>
<td>Stride length, cm</td>
<td>110.6 ± 21.1</td>
<td>99.3 ± 23.1</td>
<td>0.004</td>
</tr>
<tr>
<td>Stride length variability, SD</td>
<td>4.55 ± 2.82</td>
<td>5.56 ± 2.42</td>
<td>0.01</td>
</tr>
<tr>
<td>Swing time, sec</td>
<td>0.43 ± 0.04</td>
<td>0.45 ± 0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Swing time variability, SD</td>
<td>0.03 ± 0.02</td>
<td>0.04 ± 0.02</td>
<td>0.001</td>
</tr>
<tr>
<td>Stance time, sec</td>
<td>0.77 ± 0.13</td>
<td>0.84 ± 0.18</td>
<td>0.01</td>
</tr>
<tr>
<td>Double support time, sec</td>
<td>0.34 ± 0.11</td>
<td>0.37 ± 0.11</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Brain function, cognition, and motor control…

« Multi-tasking »

Model for stress resistance testing
Normal Walking

M.B., 72 years
Multiple falls

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

M.B., 72 years
Multiple falls

MCI
Mild Cognitive Impairment

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

Backward counting out loud

Executive Function: crucial for Dual-Tasking

Frontal Brain

Executive Function

« those cognitive processes that plan, coordinate and orchestrate targeted complex activities and decide about contribution of attention »

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.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Walking alone</th>
<th>Walking backwards counting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR (95% CI)</td>
<td>p-value</td>
</tr>
<tr>
<td>Coefficient of variation of stride time (coded as a binary variable)*</td>
<td>7.4 (0.9-59.0)</td>
<td>0.060</td>
</tr>
</tbody>
</table>

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).
Music, Rhythm and Brain Activation


Jaques-Dalcroze Eurhythmics

Jaques-Dalcroze Institute, Geneva, Switzerland

## Jaques-Dalcroze Eurhythmics and stride time variability

**Table 1.** Mean values and coefficients of variation of stride time under single and dual-task among the Dalcroze group (n = 10; mean age = 79.6±4.9) and a control group of healthy older adults (n = 11; mean age = 77.7±4.1) with no practice of regular exercise

<table>
<thead>
<tr>
<th></th>
<th>Walking alone</th>
<th>Walking while backward counting</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dalcroze group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean value (ms)</td>
<td>1050.1 ± 48.5</td>
<td>1070.5 ± 86.2</td>
<td>.445</td>
</tr>
<tr>
<td>coefficient of variation</td>
<td>2.1 ± 1.4</td>
<td>2.7 ± 1.9</td>
<td>.139</td>
</tr>
<tr>
<td><strong>Control group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean value (ms)</td>
<td>1146.1 ± 15.1</td>
<td>1235.8 ± 19.9</td>
<td>.010</td>
</tr>
<tr>
<td>coefficient of variation</td>
<td>3.9 ± 0.9</td>
<td>11.9 ± 9.9</td>
<td>.016</td>
</tr>
</tbody>
</table>

ms : millisecond  
± : standard deviation  
* : based on Wilcoxon rank-sum test

Pilot study
23 community-dwelling older adults without previous JD Eurhythmics experience (9-months intervention, 1x/week)

Attendance rate: 84%
Jaques Dalcroze Eurhythmics – Children & Seniors

Attendance rate

Seniors: 92.1 %
Children: 92.6 %

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

Variability Changes under Dual-Task

Step length CV (Dual-task)

**Fall reduction: 54%**

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

Summary

• Close link between gait and cognition
• Increased gait variability as risk marker for falls and dementia
• Simultaneous motor and cognitive dual-tasking as stress resistance model for early detection of fall risk and executive disorders
• Important role of quantified gait assessment in the evaluation of potential dementia patients