Cognition and gait: influence and dual task training

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http://research.ncl.ac.uk/hmst/

Attention please! Dual-tasking in progress

The cognitive contribution to gait

Clinical evaluation

Therapeutic remediation

- Independence and falls risk

The New Scientist (2007)
Neural correlates of gait

Mobility Challenges in PD

"Walking becomes a task which cannot be performed without considerable attention. The legs are not raised to the height, or with that promptitude which the will directs, so that the utmost care is necessary to prevent frequent falls."

James Parkinson, 1817

Walking and talking
- Leg starting to drag (H&Y 1.5)
- Talking getting faster (H&Y 3)
- Possible outside not inside (H&Y 3)
- Cup down before answering (2.5)
- Stopped doing 2 things at once (H&Y 4)
- Possible link to falls (H&Y 4)
- Multi-tasking
- Linked to freezing (H&Y 3)

Spouses' insights
- Possible link to falls (H&Y 4)

Manifestation of cognition in gait

Disturbance
- Continuous gait disturbance (single and dual-task)
- Episodic – FOG

Methods
- Association
- Dual-task protocols
Continuous gait disturbance: relationship between cognition and gait

Purpose
- Relationship between range of gait and cognitive outcomes (OA, MCI, PD)
- Gait speed most commonly studied
  - Executive function and attention
  - Memory
  - Visuospatial function
- Selective association of discrete gait and cognitive characteristics

Amboni et al., 2013

Continuous gait disturbance: relationship between cognition and gait

- Executive function and attention are associated with gait speed and variability
- Relationship on and off levodopa
- More advanced PD
- Uncertain of relationship in early PD

Lord et al., in review

<table>
<thead>
<tr>
<th>Gait domain</th>
<th>Cognitive domain</th>
<th>P</th>
<th>R²</th>
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<tr>
<td><strong>Control</strong></td>
<td>Pace Attention</td>
<td>&lt;0.001</td>
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<td>Visual memory</td>
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<td>Postural control</td>
<td>Attention</td>
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<td>Rhythm</td>
<td>Executive function</td>
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Cognitive-Motor Interference

- Dual-tasks are a cognitive function
- Working memory

ATTENTION

Single Dual Multi

VELOCITY

Cognitive-motor interference
(dual-task)

Purpose of dual-task studies
- Demonstrate in real-time
  - Attention/working memory as a compensatory feature
  - Ability to prioritise task (EF)
  - Limits of compensation (cog imp)
- ↑ with age and pathology
- Sensitive to task demand
- Dual-task interference
  - ↓ Speed (step length) ↑ Variability

Recent reviews

Dual tasking, gait rhythmicity, and Parkinson’s disease: Which aspects of gait are attention demanding?

- In moderate PD increasing evidence for specific effect on discrete gait characteristics
  - co-ordination deficit/postural control
- May be especially important for FOG
Cognition and FOG

- Dual-task interference > Fr v N-Fr
- EF (Conflict resolution)
- Attention
- Visuospatial

- Role of cognition

Dual tasks predict falls

Beauchet et al (2009)
Cognition and falls in PD

Summary

• Robust relationship between gait and cognition that demonstrates the contribution to
  – Continuous (single and dual-task)
  – Episodic – FOG
• Present early and evolves with progression
• Relationship with falls unclear (multiple strategies), however may predispose to increased risk
• May differ with respect to sub-type of PD
• Related to capacity (WM) and attentional control
• Assessment advised
Testing in the clinic

<table>
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<tr>
<th>TUG 10m test</th>
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<td>+</td>
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</table>

- Saturday, Friday, Thursday...
- 97, 94, 91....
- 99, 92, 85....

Motor

Cognitive

Time
Speed
Step length
% difference
FOG episodes

Depression
Fatigue
Cognition

The cognitive contribution to gait

Clinical evaluation

Therapeutic remediation

Attention please!

Gait & postural control

Principles to reduce interference:
- Increase capacity (motor)
- Increase capacity (cognitive)
  - Divided attention
  - Focused attention

Pharmacology

Cognitive

Motor-cognitive

Exercise
Multiple task-training: divided attention

Task prioritisation

Task prioritisation

Task prioritisation
Cognitive compensation

Normal gait  Attention

Immediate effect of novel preparatory cues on dual task gait

Mak et al., 2013

Dual tasks

Un Cued  Cued
• External cueing and attentional focus are common strategies
• Cognitive impairments
• Reduction in FOG (immediate and with training)
• Improved obstacle clearance and turning
• Cueing and Motor imagery improves retention of training

• ? Cue dependency

• Emerging but limited evidence to support exercise to improve cognitive function
• Executive function
• No agreement on type, intensity, dose
• More work needed

Cognitive training in Parkinson disease
Cognition-specific vs. noncognit-specific training

Table 1: Cognitive improvement and training exposure across group

<table>
<thead>
<tr>
<th>Group</th>
<th>Training Exposure</th>
<th>Cognition Improvement</th>
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<tr>
<td>Cognit.</td>
<td>30 hours</td>
<td>50% increase</td>
</tr>
<tr>
<td>Noncognit.</td>
<td>30 hours</td>
<td>10% increase</td>
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Notes: Cognit. = cognitive, Noncognit. = noncognitive, Hours = training hours, P-value = statistical significance.
Combined motor and cognitive training targets both systems simultaneously.

Reducing cognitive motor interference

- External cues and attentional strategies improve dual task performance
- Task prioritisation also aids dual-task performance
- Complex task practice improves dual-task performance
- Immediate and training effects observed – practice impt!
- Complex motor/cognitive training may enhance cognition and reduce interference
- Enhanced motor and cognitive performance – enhanced capacity and attentional control?

Translation into clinical practice!

- Should we train?
- Who to train?
- How to train?

- Dual tasks can be trained
- Cognitive intact – care with MCI/dementia
- Care with FOG
- Cues or attentional strategies – aid prioritisation
- Component practice + whole practice + dual/multi-practice
- Motor imagery and cueing may facilitate retention of training (learning)
- Cue dependency

? Cue dependency
Acknowledgements

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