Dual-task gait training: If, who, when, how?

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# Session outline

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<td>8:05-8:55</td>
<td>Appraisal of current evidence for interventions to improve dual-task performance</td>
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<td>8:55-9:05</td>
<td>Translating evidence into practice: potential barriers to implementation</td>
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<td>9:05-9:50</td>
<td>Moderated panel discussion with clinical and scientific experts, and audience members</td>
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<td>9:50-10:00</td>
<td>The bottom line, final Q&amp;A</td>
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Inspiration for this session

• Our own experiences trying to provide dual-task training interventions in clinical trials
  • Much harder than it sounds on paper!
  • *May* not be considerably more efficacious than “easier” interventions
• Unclear clinical significance of pooled treatment effects in systematic reviews and meta-analyses
  • Does effort outweigh benefit?
• Conversations with clinicians
  • Have they already figured out what works?
Session learning objectives
At the conclusion of this course, participants will be able to:

1. Describe the methods and protocols used to train dual-task walking in neurologically-impaired patient populations
2. Synthesize the current state of evidence for dual-task gait training and other interventions for improving dual-task walking performance
3. Explain the potential difficulties of implementing dual-task gait training in mobility-impaired populations
4. Evaluate whether dual-task gait training is an appropriate approach for patients on an individual basis, and adapt intervention protocols for realistic clinical implementation
Semantics #1: “Dual-task gait training” vs “training dual-task walking”

• Goal of training: To improve gait-related dual-task performance

• Methods:
  • Dual-task gait training
    • Task-specific practice of dual-tasking
  • Other methods of exercise and gait training
    • Any intervention approach that measures treatment effects on dual-task walking can provide insight into how we can improve dual-task performance

*We review evidence for both types of approaches, when it exists*
Semantics #2: “Dual task” = two discrete tasks

- Two discrete tasks
  - e.g., walking while counting backwards
  - e.g., walking while bouncing a ball

- An attention-demanding walking task
  - e.g., walking while carrying a cup

*We focus on training true “dual-tasks”*

*Dual-task training may improve gait during attention-demanding tasks, but this is not our focus*
Appraisal of evidence to improve dual-task performance: Multiple sclerosis

Jake Sosnoff, PhD
Associate Professor
University of Illinois at Urbana-Champaign
Dual-task gait training in MS | Why?

• Cognitive-motor interference (CMI)
• Cognitive impairments affect 65% of people with MS
• Walking impairments affect 85% of people with MS
Dual-task gait training in MS | Why?

• Mobility = Ability to move from place to place

Das & McCollum, 1988; Patla & Shumway-Cook, 1999
Dual-task gait training in MS | How?

Measuring cognitive-motor interference

• Dual-task paradigm

Wadja & Sosnoff, 2015
Dual-task gait training in MS | Why?

**Significance of CMI**

- Decrease in gait velocity – negatively impact activities of daily living
- CMI related to falls and fall risk in geriatric (Beauchet et al., 2008), Parkinson’s disease (Hausdorff et al., 2003) and MS

*Wadja, Motl, & Sosnoff, 2013*
Dual-task gait training in MS | If?

Results from two studies:

1. Computerized Cognitive Training on Cognitive Motor Interference in MS (Pilot grant - Consortium of MS Centers)

2. Project DUETS : Dual Task Exercise Training in MS (NMSS ILLOT018, RG-1507-05433)
Dual-task gait training in MS | If?
Home-based computer cognitive training

Interventions (12 weeks)
- Intervention: home-based computer brain HQ training
  - 3 x 30 min sessions
  - Progressive cognitive games focused on attention, processing speed, visual search
- Control: Computer-based search
  - Weekly assignment
  - e.g., booking a flight

Outcomes (pre and post intervention)
- Assessments pre & post intervention
  - Timed 25-Foot Walk
    - Single and dual task (alternating letters)
  - Symbol Digit Modalities Test
    - Cognitive processing speed
Dual-task gait training in MS | Who?
Home-based computer cognitive training

• 29 individuals with MS (20 females)
• 57 years old (25-79 years)
• EDSS 6.0 (4.0-6.5)
Dual-task gait training in MS | If?
Home-based computer cognitive training
Dual-task gait training in MS | If?
Home-based computer cognitive training
Dual-task gait training in MS | If?
Home-based computer cognitive training

Summary

• Home-based computerized cognitive training appears to have no effect on walking, thinking, or their interaction

• Consistent with the notion that “brain training” has limited generalization towards functional improvement (Simons et al., 2016)
DUETS Trial (Sosnoff et al, 2017)

Best evidence example
Dual-task gait training in MS
Dual-task gait training in MS | How?

• Randomized controlled trial
• Dual-task training versus single-task training
• 1 hour, 2x/week for 12 weeks
  • Control: 30 mins gait, 30 mins balance each session
  • Intervention: 30 mins gait/balance, 30 mins dual-task training
  • Progressive
• Assessments pre and post intervention
  • Timed 25-Foot Walk – single and dual task (alternating letters)
  • Symbol Digit Modalities Test – cognitive processing speed

Sosnoff et al, 2017
Dual-task gait training in MS | Who? If?

• n=19 (10 females); 55.8 ± 10.8 years; EDSS 2.5

• Gait speed:
Dual-task gait training in MS | If?

- Cognitive processing speed:
Dual-task gait training in MS | Summary

• Small improvement in distracted walking in the intervention group
  • No change in control group
  • No change in cognition

• Small sample size precludes any firm conclusions
• Safe – may be more advantageous to training walking and cognition in isolation

• More research is necessary
Appraisal of evidence to improve dual-task performance: Parkinson’s disease

Valerie Kelly, PT, PhD
Associate Professor
University of Washington
Dual-task gait training in PD

• Does dual-task (DT) gait training work in PD?
• For whom?
• When? Early in the disease? In advanced PD?
• How should training be structured?
Dual-task gait training in PD | Why?

Do dual-task gait impairments impact people with PD?

• Related to activity and participation?
• Associated with falls?
• A common concern of people with PD?

Fuller et al., 2013; Heinzel et al., 2016; Kelly et al., 2012; Lamont et al., 2017; Smulders et al., 2012
The DUALITY Trial  (Strouwen et al, 2014 & 2017)

Best evidence example
Dual-task gait training in PD
Dual-task gait training in PD | How?

Gait & cognitive tasks training...

• **Dual-task intervention**: simultaneously
  • Instructions: fixed priority with divided attention; progress to variable focus

• **Control intervention**: separately
  • Cognitive task trained while sitting
Dual-task gait training in PD | How?

**Dosage:**
- 6 weeks of at-home PT-led intervention
- 40 min/session, 2x/week
  - Dual task: 30 min combined walking and gait training
  - Control: 15 min of cognitive; 15 min of gait training
- +30 min of independent exercise 2x/week
Dual-task gait training in PD | How?

**Cognitive tasks:**
- Verbal fluency
- Working memory
- Discrimination & decision-making
- Mental tracking
- Reaction time
Dual-task gait training in PD | How?

Criteria for progression:

• Control: Flawless performance at starting level
• Dual task: No noticeable interference
Dual-task gait training in PD | Who?

Eligibility criteria:
• Diagnosis of PD, Hoehn & Yahr Stage II-III (on med)
• Stable medications and/or DBS parameters
• Able to walk 10 minutes
• Presence of dual-task interference
Dual-task gait training in PD | If?

Dual-task gait speed, untrained task (auditory Stroop)

<table>
<thead>
<tr>
<th></th>
<th>Base 1</th>
<th>Base 2</th>
<th>Post</th>
<th>12 wk</th>
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</thead>
<tbody>
<tr>
<td>DT</td>
<td>91.41</td>
<td>95.06</td>
<td>105.61</td>
<td>103.32</td>
</tr>
<tr>
<td>Control</td>
<td>92.57</td>
<td>94.26</td>
<td>103.09</td>
<td>99.90</td>
</tr>
</tbody>
</table>
Dual-task gait training in PD | If?

Secondary outcomes:

- **Cognitive task**: no change → improvement
- **Falls**:
  - No difference between groups
  - No change with training
Dual-task gait training in PD | Who?

Subgroup analyses:
• Hoehn & Yahr (high v. low)
• Cognitive impairment (MoCA <27)
• Falls (with v. without)
• FoG (with v. without)
Dual-task gait training in PD | If?

The DUALITY Trial (Stouwen et al, 2017)

• Dual-task gait impairments in PD can improve
  • Separately train gait & cognitive tasks → automaticity
  • Training dual-task performance → task integration
  • Improvements did not exceed MCID

• Transfer to untrained tasks

• No increased risk of falls
Dual-task gait training in PD | Summary

• Targeting dual-task walking in PT
• Advanced disease (Hoehn & Yahr stage IV)
• Medication fluctuations
• Generalizability to functional tasks
Appraisal of evidence to improve dual-task performance:

Stroke

Prue Plummer, PT, PhD
Associate Professor
University of North Carolina at Chapel Hill
Dual-task training after stroke: Evidence overview

• Many “dual-task training” studies did not measure dual-task outcomes
  • Cannot assess if dual-task training improves dual-task performance

• 3 systematic reviews
  • Lee & Choi, 2012¹ – only 1/7 studies was intervention
  • Wang et al, 2015² – “dual-task interventions on gait and balance outcomes”
    • Included non-dual-task interventions
    • Did not include any dual-task outcomes
    • Compared only post-treatment scores, not change scores (treatment effects)
  • Plummer & Iyigun (in review) – any intervention on dual-task gait speed
    • Quantified treatment effects from 12 intervention arms from 7 studies, including 5 RCTs
Dual-task gait training after stroke | How?

**Dual-task interventions:**

- Cognitive-motor dual-task training protocol\(^3,4,5\)
  - Counting, memory, verbal tasks
- Motor-motor dual-task training protocol\(^4,6\)
  - Raising an umbrella, pressing buttons on a mobile phone, bouncing or kicking a ball, beating a castanet
- Little information provided about task prioritization during practice
- Usually different tasks than those used in outcomes
Dual-task gait training after stroke | How?

Non dual-task interventions:

• Treadmill walking in virtual environment

• Single-task practice of everyday walking tasks

• Biofeedback during virtual animated tasks + inpatient rehab

• Conventional physical therapy (without dual-task training)

• Exercise program involving balance and moderate aerobic challenge

• Eccentric resistance exercise training of paretic lower limb
Dual-task gait training after stroke | How?

**Dosage:**
- Varied duration, frequency, and intensity
- Usually 30 minutes, 3x/wk for 4-8 weeks
Dual-task gait training after stroke | Who?

- Mostly chronic stroke (> 6 months post stroke)
- Mean ages 49-71 years
- No cognitive impairment (MMSE, MoCA)
- Mild to moderate gait speed impairment at baseline
  - 0.45-1.0 m/s single-task
  - 0.31-0.71 m/s dual-task
- Walking with or without an assistive device (under reported)
Dual-task gait training after stroke | How?

Dual-task outcome measures:

• Walking while...
  • Counting forwards or backwards
  • Reciting consecutive/alternate letters of alphabet
  • Auditory Stroop task
  • Auditory clock task
  • Spontaneous speech

• Prioritization instructions under-reported, but usually no specific instruction (i.e., “do both tasks...”)

• Performance on non-gait task rarely measured and rarely compared in single and dual-task conditions
Dual-task gait training after stroke | If?

Synthesized evidence
Plummer & Iyigun, in review

Study name | Intervention group | n | weight (%) | MD [95% CI]
---|---|---|---|---
Cho, 2015 | DTGT | 11 | 5.21 | 0.11 [0.01, 0.20]
Lee, 2017 | DTGT | 11 | 7.32 | 0.09 [0.01, 0.16]
Liu, 2017 | Cognitive DTGT | 10 | 5.24 | 0.07 [-0.02, 0.16]
Plummer, 2014 | DTGT | 7 | 7.26 | 0.04 [-0.03, 0.12]
Liu, 2017 | Motor DTGT | 9 | 8.08 | 0.01 [-0.06, 0.08]
Rand, 2010 | Ex + recreation | 11 | 5.56 | 0.06 [-0.03, 0.15]
Fernandez-Gonzalo, 2015 | Resistance training | 12 | 1.96 | 0.06 [-0.11, 0.22]
Lee, 2015 | Biofeedback + ex | 10 | 18.45 | 0.05 [0.02, 0.08]
Cho, 2015 | STGT | 11 | 14.03 | 0.02 [-0.03, 0.06]
Lee, 2017 | STGT | 11 | 4.82 | 0.00 [-0.09, 0.10]
Lee, 2015 | Sham feedback + ex | 10 | 17.52 | -0.02 [-0.05, 0.01]
Liu, 2017 | Conventional PT | 9 | 4.53 | -0.02 [-0.12, 0.08]

Dual-task interventions
Non dual-task interventions
Overall
Test for overall effect: Z = 2.57, p = 0.01

Heterogeneity for overall effect: Tau=0.03, Q=19.20, df=11 (p=0.06), I²=42.7%
Dual-task training vs Single-task training
(4 comparisons from 3 RCTs)

<table>
<thead>
<tr>
<th>Study name</th>
<th>DTGT n</th>
<th>STGT n</th>
<th>weight (%)</th>
<th>MD [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cho, 2015</td>
<td>11</td>
<td>11</td>
<td>34.22</td>
<td>0.09 [-0.01, 0.20]</td>
</tr>
<tr>
<td>Lee, 2017</td>
<td>11</td>
<td>11</td>
<td>23.54</td>
<td>0.08 [-0.04, 0.21]</td>
</tr>
<tr>
<td>Liu, 2017 (cognitive DTGT)</td>
<td>10</td>
<td>9</td>
<td>18.76</td>
<td>0.09 [-0.05, 0.23]</td>
</tr>
<tr>
<td>Liu, 2017 (motor DTGT)</td>
<td>9</td>
<td>9</td>
<td>23.48</td>
<td>0.03 [-0.09, 0.16]</td>
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Overall
Test for overall effect: Z = 2.48, p = 0.01

Heterogeneity for overall effect: Tau=0, Q=0.6, df=3 (p=0.90), I² = 0%
Dual-task gait training after stroke | If?

Treatment effects on non-gait task and “dual-task interference”?

• Consistent absence of reporting of dual-task effects on non-gait task

• Implications for drawing accurate conclusions about improvements in dual-task gait speed

Plummer & Iyigun, in review; Plummer et al, 2014
Dual-task gait training after stroke | Summary

• Exercise and/or gait training can improve dual-task gait speed
• Clinical significance of treatment effects is unclear
• Dual-task training *may* be superior to single-task training
• Inadequate assessment of dual-task performance in most existing studies
• Unknown if dual-task strategy changes or capacity or coordination is improved
  • Insights from new studies?¹⁰
Translating evidence into practice: Potential barriers to implementation of dual-task gait training

• Challenges implementing dual-task training in mobility-impaired populations
• Implications for cognitively-impaired populations
• Progressing the cognitive challenge in dual-task training
• WHEN to implement?


Reference (Parkinson’s disease)


References (stroke)


