Advancing the clinical application of dual-tasking: Addressing systems impairments in the dual task taxonomy

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Mike Studer, PT, MHS, NCS, CEEAA, CWT, CSST
Brady Whetten, PT, DPT, GCS

APTA CSM February 17, 2017
Disclosures

- Tara McIsaac reports no disclosures
- Lisa Muratori reports no disclosures
- Nora Fritz reports no disclosures
- Mike Studer reports no disclosures
- Brady Whetten reports no disclosures
Learning Objectives

• Define dual-task in operational terms
• Describe the measurement of dual-task interference.
• Understand the importance of task selection and instruction, and the impact on dual-task performance.
• Discuss the interference resulting from simultaneous task performance in healthy individuals and people with neurologic dysfunction, and the implementation of dual-task training in patient populations.
Overview

• Dual-task operationally defined
• Review current evidence of neural networks underlying dual-task processing
• Measurement and factors influencing dual task performance
• Role of a dual-task taxonomy and application in the clinic
• Dual-task interference related to system impairments: cognitive, auditory, visual, manual
• Case studies and Q&A with audience members
Dual-task interference effects: clinical considerations in measurement, assessment and intervention

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A.T. Still University
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APTA CSM February 17, 2017
Dual Task Defined

...the concurrent performance of two tasks that can be performed independently and have distinct and separate goals.

Each task performance can be measured independently as a single task

McIsaac, Lamberg & Muratori 2015 Biomed Res Int
Why Use Dual Task Paradigms?

• Ecological validity – assess everyday function
• To assess cognitive and executive function
  – Ability to process information and attend
• To assess gait and safety risk
• To assess functional progression
Neural networks of dual tasking

• Dual task interference may occur due to use of similar systems or brain regions

• Increase processing capacity or efficiency?

• Networks of two single tasks are likely made more efficient for dual tasking and integrated into a single network by linkage of distinct brain areas (Wu et al 2013 NeuroImage)
Measuring dual-task performance
Classic dual-task paradigm

1. Measure performance of each task in isolation (single-task)
   - Gait alone
   - Cognitive task alone (sitting)

2. Measure performance of each task while performed concurrently (dual-task)
Purpose of measurement

• To quantify limitations across systems
  – Develop treatment goals
• To characterize the pattern of dual-task interference related to modality
• To address attentional prioritization
  – Attentional biases, implications for safety
• To evaluate treatment effects
How to measure

- **Absolute measures**: single-task and dual-task parameters (e.g., gait speed)
- **Relative measures**: dual-task effect (cost/benefit)

\[
\text{DTE (\%)} = \frac{\pm (\text{dual task} - \text{single task})}{\text{single task}} \times 100
\]
Patterns of cognitive-motor interference

Plot gait DTE against cognition DTE to understand the nature of the interference

Motor-Cognitive Dual Task

Pre = mutual interference, cognitive task prioritized
Post = improved gait interference at a cost to cognitive interference
Motor-Motor Dual Task

Pre = mutual interference, near equal priority
Post = Slightly improved gait interference, no change in buttoning interference, or priority

adapted from Plummer & Eskes 2011
Measuring effects of task difficulty on prioritization of simulated driving tasks

Accelerator pedal tracking
Gradual press / release

Accelerator pedal tracking
Steep ramp

Arm task DTE (%)
Neg = cost; pos = benefit

Foot task DTE (%)
Neg = cost; pos = benefit

Controls
PD off
PD on

No trade-off
single-task performance level
1:1 trade-off
Factors influencing dual-task interference

- **Task Factors**
  - Complexity of task
  - Goal of task

- **Individual Factors**
  - Capability, reserve, autonomy & expectancies
  - Systems integrity (impairment) & function
    - Vestibular, visual, somatosensory, cognitive, cardiopulmonary, autonomic, musculoskeletal
  - Prior experience (novelty of task)

- **Contextual Factors**
  - Instructions
  - Hazards
  - Distractions, complexity
Considerations of conditions

- Vestibular impairment
- Peripheral neuropathy
- Mild cognitive impairment
- Stroke
- Parkinson disease
- Multiple Sclerosis
- Huntington’s disease
The Dual Task Taxonomy: Applicability in the Clinic

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School of Health Technology and Management
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Disclosures

• Dr. Fritz reports no disclosures
• Dr. Muratori reports no disclosures
Learning Objectives

• Define dual-task relative to a dual-task taxonomy
• Describe how a taxonomy offers broad categories for task analysis
• Demonstrate how a dual-task taxonomy can be applied for clinical care of individuals with neurologic diagnoses.
Dual Task Defined

...the concurrent performance of two tasks that can be performed independently and have distinct and separate goals.

Each task performance can be measured independently as a single task.
Classic dual-task paradigm

1. Measure performance of each task in isolation (single-task)
   – Motor or cognitive task measured discreetly as baseline for dual-task trials.

2. Measure performance of each task while performed concurrently (dual-task)
What is a Taxonomy?

• Taxonomies are organizational systems that allow for the grouping of a specific topic or concept
• Taxonomies usually have some inherent degree of order built into them although the method to move from a lower to a higher degree of order may not be linear
• A taxonomy can provide a common language for clinicians to frame assessment and intervention
What is the **Dual Task Taxonomy**?

- A framework for *single* and *dual* task selection and task analysis
  - Requires clinical decision making regarding deficits that are being measured or targeted for intervention.
    - Clinicians must understand movements as they relate to the task constraints.
  - Is flexible in application to include all possible dual task pairings so that an entire picture of dual task cost can be considered.
    - Tasks do not inherently *belong* to a category but depend on specific patient and task interactions.
Building a taxonomy

<table>
<thead>
<tr>
<th>Task Novelty</th>
<th>Task Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH</td>
<td>HIGH</td>
</tr>
<tr>
<td>LOW</td>
<td>LOW</td>
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</table>

Performer Characteristic
### Building a Taxonomy

<table>
<thead>
<tr>
<th>TASK TYPE</th>
<th>Task Novelty</th>
<th>Task Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SINGLE MOTOR</td>
<td>LOW</td>
<td>LOW</td>
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<tr>
<td></td>
<td>HIGH</td>
<td>HIGH</td>
</tr>
<tr>
<td>SINGLE COGNITIVE</td>
<td>LOW</td>
<td>LOW</td>
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<td>HIGH</td>
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<tr>
<td>MOTOR-</td>
<td>LOW</td>
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<tr>
<td>MOTOR</td>
<td>HIGH</td>
<td>HIGH</td>
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<tr>
<td>MOTOR COGNITIVE</td>
<td>LOW</td>
<td>LOW</td>
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<tr>
<td></td>
<td>HIGH</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

- Single Motor tasks are generally easier (LOW complexity) than Single Cognitive tasks (HIGH complexity) for the same level of novelty.
- Motor tasks tend to be more complex (HIGH complexity) than Motor Cognitive tasks (LOW complexity) for both LOW and HIGH novelty levels.
# Building a Taxonomy

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<tbody>
<tr>
<td>SINGLE MOTOR</td>
<td>LOW</td>
<td>LOW</td>
<td>Walking with a cup of water</td>
</tr>
<tr>
<td></td>
<td>HIGH</td>
<td>Tree Pose</td>
<td>Walking with crutches</td>
</tr>
<tr>
<td>SINGLE COGNITIVE</td>
<td>LOW</td>
<td>Counting to ten</td>
<td>Calculating a tip</td>
</tr>
<tr>
<td></td>
<td>HIGH</td>
<td>Saying the alphabet backward</td>
<td>Paced auditory serial addition task (PASAT)</td>
</tr>
</tbody>
</table>
## Building a Taxonomy

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<td>MOTOR-MOTOR</td>
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<tr>
<td>MOTOR COGNITIVE</td>
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# Building a Taxonomy

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<tr>
<td>MOTOR</td>
<td>LOW</td>
<td>HIGH</td>
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<tr>
<td>-MOTOR</td>
<td>HIGH</td>
<td>Walking over moving obstacles</td>
</tr>
<tr>
<td></td>
<td>LOW</td>
<td>Walking while tapping index and thumb together as fast as possible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Walking while eating popcorn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Walking while texting on a cell phone</td>
</tr>
</tbody>
</table>
Recommendations for using the dual task taxonomy in the clinic:

1. Have a clinical hypothesis that you wish to test with the patient.
2. Select tasks that target areas of interest for your patient. Understand the task goals and constraints on movement.
3. Use dual task assessment to measure key aspects of the motor and/or cognitive task performance in single and dual-task conditions.
   a. Be sure that single tasks have clear objective measures
   b. Use more than one combination of tasks
4. Determine the relationship between outcomes and clinical deficits for targeted interventions.
5. Evaluate changes in one task in relation to the other as part of a dual task intervention.
## Categorizing Interventions

### Motor
- **Walking**
  - Forward
  - Backward
  - Obstacles
- **Balancing**
  - SOT
  - Dynamic weight shifting
  - External perturbations
- **External Cueing**
  - Speed
  - Stride length
  - Timing/metronome

### Cognitive
- **Listening to music**
- **Listening to talk-radio**
- **Verbal fluency**
- **Answer autobiographical questions**
- **Serial 3-subtraction**
- **Information processing tasks**
- **Counting backwards**
- **Auditory choice reaction time task**
- **Visuospatial task of pattern matching**
Clinical application of the dual-task taxonomy:

COGNITIVE, MANUAL, AUDITORY, VISUAL

Mike Studer, PT, MHS, NCS, CEEAA, CWT, CSST

APTA CSM February 17, 2017
Hierarchy of modalities

• Cognitive
• Visual
• Auditory
• Manual

Which one is highest or most demanding?
Do any of the “others” NOT include cognitive?
Screening DT tolerance across four modalities of concurrent tasks:

Tenets of screening:

1. Overlapping of modalities will happen
2. Testing is *not* intended to be task-specific or functional
3. Test EACH primary and distracter alone
4. Dual task CAN enhance primary motor
5. To cue, or not to cue…? Prioritization must be consistent…
**Intervention** across four modalities of concurrent tasks:

Tenets of *intervention*:

1. Overlapping of modalities will happen
2. Intervention MUST be task-specific/functional
3. Interventions consider patient preference
4. Underestimate patient expectations in DT
5. Follow DT with single
6. Either vary or choose NOT to cue prioritization
Intervention across four modalities of concurrent tasks:

Questions of motor learning:

1. How do we know who will respond to DT?

2. How do we know when to introduce DT?
Intervention across four modalities of concurrent tasks:

**Responders** will:

- Increase vigilance in forewarned DT training
- Be able to accept a reduction in performance
- Demonstrating improvements in single task (primary)
- Have capacities/experience in secondary task (single)
Intervention across four modalities of concurrent tasks: Timing

Primary tasks should:

• Be safe to perform with the available assistance: PT, BWS, harness/tracking, etc.

• Be improving in performance through practice
Intervention across four modalities of concurrent tasks: Timing

Primary tasks should:

• Have potential (motor control and resources) remaining to reduce impairments such as:
  - Ankle inversion
  - Genu recurvatum
  - Fall
  - Fear

• Consider prognosis (cognitive and motor)
Intervention across four modalities of concurrent tasks: Content

• Review “tenets of intervention”

• Consider modality of DT based on:
  Functional reality of this patient
  Screened tolerances and intolerances
  Psychological response to error/need for success
Intervention across four modalities of concurrent tasks:

Tenets of intervention:
1. Overlapping of modalities will happen
2. Intervention MUST be task-specific/functional
3. Interventions consider patient preference
4. Underestimate patient expectations in DT
5. Follow DT with single task
6. Either vary or choose NOT to cue prioritization
Intervention across four modalities of concurrent tasks: Progression

Increasing complexity of primary and/or secondary tasks

Increasing novelty of primary and/or secondary tasks

Functional demands of the person’s environment
  Home, work, avocation, sport
  Psychological response to error/need for success

Multi-task - tolerance, expectations, functional demand
Re-measure

• Use measurable change to guide your efforts
• Use tests that are sensitive and specific
• Be willing to challenge yourself:
  
  Is WHAT I am doing working or not: FITT
  
  Frequency
  Intensity
  Type
  Time
Case Studies
Case Study – HD

Nora Fritz, PhD, PT, DPT, NCS
Elizabeth Ulanowski, PT, DPT, NCS
Health Condition
Huntington’s Disease

Body Functions and Structures
- MoCA: 25/30
- UHDRS-TMS: 41
- TFC: 11
- Self-reported difficulties with attention
- New onset depression and anger issues

Activities
- Independent in home
- Independent with ADLs
- Goes to the gym with friends
- Walks

Participation
- Does not work (formerly photographer for the Air Force)
- Participates in HD exercise group 1x/wk
- Participates in intensive therapy every 4 months

Environmental Factors
- Lives with husband and son
- Unable to manage bills
- Manages the household including: son’s activities, cleaning, cooking, grocery shopping and vacation planning

Personal Factors
- Age: 32
- Married, 1 child (age 12)
- Symptom duration: 6 years
- Military veteran
Goal of Taxonomy in This Patient

- Assessment/Evaluation of dual-task deficits
- Guide for where to begin/target intervention
<table>
<thead>
<tr>
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<th>Task Novelty</th>
<th>Task Complexity</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Single Motor</td>
<td>Low</td>
<td>Walking 5.41</td>
<td>Walking over obstacles 7.17</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Walking with trekking poles 7.23</td>
<td>Walking with trekking poles over obstacles 8.38</td>
</tr>
<tr>
<td>Single Cognitive</td>
<td>Low</td>
<td>Reciting the alphabet</td>
<td>Name fruits/vegetables#</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Reciting alternating letters of the alphabet</td>
<td>Name items in a forest (or another abstract concept)#</td>
</tr>
<tr>
<td>Type of Task(s)</td>
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<td></td>
<td>High</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Dual Motor-Motor</td>
<td>Low</td>
<td>Walking + drinking a cup of water (5.50)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Tapping the foot as fast as possible + drawing a cube (\approx 3) cubes</td>
<td></td>
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<tr>
<td></td>
<td>High</td>
<td>Walking over obstacles while texting on a cell phone (open ended question) (9.05)</td>
<td></td>
</tr>
<tr>
<td>Type of Task(s)</td>
<td>Task Novelty</td>
<td>Task Complexity</td>
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<td><strong>Low</strong></td>
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<tr>
<td></td>
<td></td>
<td><strong>High</strong></td>
<td></td>
</tr>
<tr>
<td>Dual Cognitive-Motor(1)</td>
<td>Low</td>
<td>Walking + saying the alphabet 5.98</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Walking + performing a word generation task (words starting with L) 7.35</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Walking over obstacles while naming fruits/vegetables 7.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Walking over obstacles + naming items in a forest (or another abstract concept) 8.68</td>
<td></td>
</tr>
<tr>
<td>Dual Cognitive-Motor(2)</td>
<td>Low</td>
<td>Walking + counting to 100 5.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Walking with trekking poles + naming all the clothing you might find in a closet 9.17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Walking with trekking poles + subtracting by 3's 6.31</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Walking with trekking poles + subtracting by 7's 7.81</td>
<td></td>
</tr>
</tbody>
</table>
Where to start intervention?

• Single Motor, Single Cognitive, Dual Motor-Motor:
  – Largest declines seen when the task is highly complex and highly novel.

• Dual Cognitive-Motor
  – Declines seen with:
    • Increases in MOTOR task novelty
    • Increases in MOTOR task complexity
    • Increases in COGNITIVE task novelty
    • Increases in COGNITIVE task complexity
  – Cognitive tasks that require:
    • Word generation or abstract ideas/concepts (vs. math)
Case Study - Dizziness

Brady Whetten, DPT, GCS
LM - dizziness

- B fistula with surgery May 2016
- Presented to PT Aug 2016 with significant dizziness & dystonia
  - Unable to drive or ride as passenger
  - Required min A to ambulate 281’ (2 min) – severe ataxia
  - DHI 78/100 - severe
  - Constant head tremor
- Progress eval (2 months after starting PT)
  - Single TUG – 9.00 sec
  - TUG cognitive – 11.06 sec
  - TUG manual – 15.24 sec
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<td></td>
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<tr>
<td></td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Single Motor</td>
<td>Low</td>
<td>Seated balance</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Single limb stance</td>
</tr>
<tr>
<td>Single Cognitive</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Dual Motor-Motor</td>
<td>Low</td>
<td>Standing balance while reaching and placing cones</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Walking on a treadmill while reaching and placing cones in diagonal pattern</td>
</tr>
<tr>
<td>Dual Cognitive-Motor(1)</td>
<td>Low</td>
<td>Pushing weighted cart around obstacles while doing alphabet backwards</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Pushing weighted cart around obstacles while naming objects in the OR</td>
</tr>
<tr>
<td>Dual Cognitive-Motor(2)</td>
<td>Low</td>
<td>Turning in a circle with EC while counting backwards by 3</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Turning in a circle while listing controls in an airplane</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Walking on a treadmill while changing directions and naming state capitols</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Walking on a treadmill while changing directions and throwing a ball</td>
</tr>
</tbody>
</table>

Dizziness
LM case study

• Progress eval (6 weeks later)
  – Single TUG – 9.00 sec → 7.35 sec
  – TUG cognitive – 11.06 sec → 7.68 sec
  – TUG manual – 15.24 sec → 10.68 sec
• 2 min walk – 281’ w/ mina → 493’ no AD
• DHI – 78/100 (severe) → 28/100 (mild)
• Now able to drive, ride as passenger w/out sx’s
• Has returned to work
Case Study: Stroke (JR)

JR is a 72 y.o.m. s/p CVA 10/2015
No language, swallowing, or visual impairments

Chief complaint on evaluation (2/2015). Inability to walk independently. Additionally reliant on AFO + SPC

Goals: Return to independent gait without device and brace
       Improved R UE function to gross functional assist
       Return to recreational swimming, hiking, IADLs
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<tbody>
<tr>
<td>Single Motor</td>
<td>Low</td>
<td></td>
<td>Walking on treadmill, .6mph with L UE support</td>
<td>Walking on treadmill 1.2mph without UE support</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td></td>
<td>Walking .9mph on treadmill in BWS without UE support, eyes closed</td>
</tr>
<tr>
<td>Single Cognitive</td>
<td>Low</td>
<td></td>
<td></td>
<td>Reciting Stroop through “”M” (alpha-numeric)</td>
</tr>
<tr>
<td>Dual Motor-Motor</td>
<td>Low</td>
<td></td>
<td></td>
<td>Walking without device, retrieving items out of a bag that is being carried by the more-impaired hand</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td>Standing and reaching-out to pour water from the more impaired side, to an empty cup in the less-impaired side + returning</td>
<td>Walking on levels surface without a device, using agility-ladder overlay, while pouring one empty cup into another/&quot;dry exchange&quot;</td>
</tr>
<tr>
<td>Dual Cognitive-Motor(1)</td>
<td>Low</td>
<td></td>
<td>Sitting with eyes closed on cushion, naming financial indexes across world economies.</td>
<td>Walking on low pile carpet without assistive device. Recalling a grocery list presented verbally during the walk.</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dual Cognitive-Motor(2)</td>
<td>Low</td>
<td></td>
<td>Standing eyes open firm surface, feet apart/comfortable stance, reciting world mountain peaks.</td>
<td>Four Square Step Test (FSST) without device. Naming college mascot w each quadrant</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
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</table>
Initial presentation

- 2MWT: 174’ with min A; SPC and R AFO
- 4SST: 53 seconds; SPC and R AFO

- Unable to stand in conditions #2 and #4 of CTSIB – eyes closed
Since the initial examination...

- 2MWT: 174’ improved to 310’ WITHOUT SPC or AFO
- 4SST: 53 sec. AFO/cane → 17 sec. WITH SPC
  27 sec. without SPC

- Now able to stand in conditions #2 and #4 of CTSIB – eyes closed
- Now able to carry objects R UE maintaining 85% top gait speed
Case Studies: Parkinson disease - freezing

APTA CSM February 17, 2017

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PD with freezing & falls

• Dx in 2001 at age 40 y.o.
  – DBS in 2012 (R GPi) and 2014 (L GPi)
  – H & Y stage 3
• Chief Complaint on Eval (March 2016):
  – Falls several times / day (15x/wk), with lacs & bruising
• Goals:
  – Reduce falls and injuries
  – Get back to cycling (stopped several years ago)
<table>
<thead>
<tr>
<th>Type of Task(s)</th>
<th>Task Novelty</th>
<th>Task Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Single Motor</td>
<td>Low</td>
<td>• Walking with trekking poles</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>• Walking forward over obstacles while carrying pitcher</td>
</tr>
<tr>
<td>Single Cognitive</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Dual Motor-Motor</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Dual Cognitive-Motor(1)</td>
<td>Low</td>
<td>• Foam beam balancing twist to transfer ball behind, <strong>reciting Countries</strong></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>• Walking backwards over obstacles (HiHurdle) <strong>conversing on phone</strong></td>
</tr>
<tr>
<td>Dual Cognitive-Motor(2)</td>
<td>Low</td>
<td>• Sidestepping to numbered targets (verbally cued)</td>
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<tr>
<td></td>
<td>High</td>
<td>• From crouch, stand up while turning and <strong>answering phone</strong></td>
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<tr>
<td></td>
<td></td>
<td>• Sidestepping to numbered targets (self-directed-phone #, counting up / down, etc)</td>
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<tr>
<td></td>
<td></td>
<td>• Multidirectional walking on treadmill, turning to cue, <strong>and holding conversation</strong> (Goal)</td>
</tr>
</tbody>
</table>

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TEXTOS

1. Walking with trekking poles
2. Obstacle walking progression
3. Multi-limb coordination progression
4. Twist reach balancing progression
5. High-step/hurdles walking progression
6. ZigZag Sidestepping progression
7. Multi-direction treadmill-walking progression
8. Freezing-Falls context practice
<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>Eval - March 2016</th>
<th>End of bout -10 weeks</th>
<th>4 weeks post</th>
<th>16 week post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falls</td>
<td>15 / week</td>
<td>0 last week</td>
<td>1 in 4 wks</td>
<td>3 in 12 wks</td>
</tr>
<tr>
<td>MoCA</td>
<td>26/30</td>
<td>29/30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NFoG-Q</td>
<td>14/28</td>
<td>9/28</td>
<td>8/28</td>
<td></td>
</tr>
<tr>
<td>MiniBEST</td>
<td>21/28</td>
<td>22/28</td>
<td>21/28</td>
<td></td>
</tr>
<tr>
<td>FoGA single-task</td>
<td>11/36</td>
<td>7/36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FoGA dual-task</td>
<td>23.5 s</td>
<td>20.7 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FoGA cognitive</td>
<td>27.7 s</td>
<td>25.9 s</td>
<td></td>
<td></td>
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<tr>
<td>10MWT comfortable</td>
<td>1.79 m/s</td>
<td>1.83 m/s</td>
<td>1.33 m/s</td>
<td>1.98 m/s</td>
</tr>
<tr>
<td>10MWT fast &amp; safe</td>
<td>NA</td>
<td>2.17 m/s</td>
<td></td>
<td></td>
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<tr>
<td>Cycling (self-report)</td>
<td>Stationary – NA</td>
<td>Stationary • &gt;80 rpm</td>
<td>Mtn. bike • &gt;80-90 rpm</td>
<td></td>
</tr>
<tr>
<td>Cycling cadence (rpm)</td>
<td>15 min 2x/wk</td>
<td>• 25 min 2x/w</td>
<td>• 60 min, 3x/w</td>
<td></td>
</tr>
<tr>
<td>Cycling freq. &amp; duration</td>
<td>NA</td>
<td></td>
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</tr>
</tbody>
</table>
Summary

Dual task:
- 2 simultaneous tasks
- Can each can be performed and measured alone?
- Do they have separate goals?

Complex single tasks require processing
- can be more than some dual tasks
- depends on novelty & complexity of each task
- Influenced by capability of systems
Questions & Discussion