Dual Task Activity and Physical Therapy after Brain Injury

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Pre-Test

- PT is not necessary for individuals post- brain injury if they can transfer, walk and negotiate stairs without assistance: true or false
- Asking a client to walk while carrying their purse is an example of a divided attention task: true or false
- Obtaining a measurement of dual task cost in assessment can be helpful for goal setting: true or false
- Exercise has no effect on cognition: true or false

Objectives

- To examine how cognition and attention affect an individual’s mobility
- To discuss and interpret outcome measures utilized by Physical Therapists to assess the effect of cognition on motor performance
- To illustrate the importance of maintaining an active lifestyle to optimize cognitive function
- To discuss the importance of interdisciplinary communication

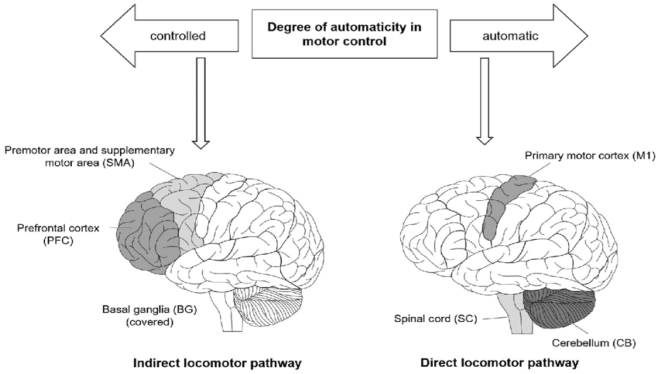
What is Gait?

- The pattern an individual uses to move within the environment
- Ambulation includes a diverse set of activities
  - Simple gait with a single task
  - Gait with simultaneous cog tasks (dual-task gait)
  - Complex gait (uneven surfaces, crowded environment, obstacle avoidance and navigation)
- The ability to walk while simultaneously attending to other people, tasks or environmental cues is important for independent community living
- Daily living requires the ability to balance and walk while performing other tasks

Why should PT’s consider cognition?

- Gait requires attention
- Impaired cognition reduces attentional resource allocation, which compromises gait stability
- Motor impairments after brain injury increase the amount of attention required for single task ambulation, leaving decreased resources available for a secondary task
- The association between gait and executive function increases if:
  - Gait task is challenging
  - Normal gait pattern is altered
- Decreased cognition leads to increased fall risk

The Role of Cognition in Gait



- Single task or simple gait
  - More automatic
  - Subcortical locomotor processing with little executive control
- Dual task gait
  - Frontal lobe executive functioning occurs to process simultaneous cognitive and motor demands
- Complex gait tasks
  - Higher order cortical processing to plan and execute each movement

How does attention impact motor tasks?

- Selective: filtering of stimulus information, focus on relevant information while disregarding extraneous stimulus
  - Noisy, crowded PT gym
- Sustained: maintain attention to a task over a period of time
  - Fatigue, activity tolerance
- Divided: Ability to carry out more than one task at a time
  - Tasks must have separate goals: I.e. walking while carrying a cell phone is much different than walking while texting
  - Walk and talk; walk and text; walk and dribble a ball
- Alternating: rapid shifting of attention from one task to another
  - Responding to a challenging environment while walking and talking
  - Dynamic, unpredictable everyday environment

How does cognition affect mobility and balance?

Yogev, et al. 2008.

- Evidence links changes in executive function and attention to gait disturbances
- Impairments in executive function may include: decreased insight, volition, planning, purposive action, action monitoring, cognitive inhibition, etc
  - May impact the ability to walk efficiently and safely

What About Dual Task Activities?

- Dual task assessment allows discrimination of deficits that may be missed during single task gait
- Dual task intervention amplifies gait variability
- Dual task gait speed more accurately reproduces the demands of walking in the real world
- Dual task walking abilities may be a sensitive predictor of fall risk
- Dual task costs are larger in neurologically impaired patient population.
    - Compounded effects of both the cognitive and motor deficits on an individual's ability to function
    - Tasks that were automatic prior to injury, become more attention demanding

Cognitive Task Complexity and Gait Stability

Howell, et al; 2014.

- Objective: Examine how gait was affected by cognitive tasks of varying complexity following concussion
- Testing protocol: 1 single task gait activity, 3 dual task gait activities of increasing complexity
- Increased COM displacement as complexity of task increased
- More complex dual tasks revealed more deficits than dual task activities of lower complexity
- Take home message: Consider the complexity of the dual task to the individual, to observe subtle deficits in mobility and to identify more complete recovery after concussion

Dual Task and Tandem Gait Performance

Howell, et al 2017

- Objective: to compare single task and dual task tandem gait performance after concussion
- Testing protocol: 3 trials of tandem gait in single and dual task conditions
- During dual task condition, subjects with concussion demonstrated decreased velocity, decreased cadence and increased center of mass displacement compared to healthy control subjects
- Take home message: Utilizing a concurrent cognitive task during tandem gait assessment elicits more subtle motor impairments, and identifies persistent impairments for a longer period of time

How does decreased attention affect mobility?

- Impairment in divided attention may reduce adaptability to challenging environments
  - i.e. obstacles, uneven paths
  - Community environment is dynamic and unpredictable
  - More challenging to safely and effectively maneuver around obstacles while being cognitively engaged in a secondary task
- Brain is challenged to prioritize between two tasks
  - Poor insight or awareness may lead to poor prioritization while dual tasking
  - This may increase the likelihood of falls

How does cognition affect community mobility?

Feld et al, 2018.

- Dual task gait speed may provide an explanation for decreased community activity and participation
  - Many independent ambulatory stroke survivors take fewer steps per day than recommended for health benefits
  - Dual task gait speed is more accurate to real world mobility vs.. single task gait speed in a controlled environment
  - If an individual displays difficulty during dual task gait with a decrease in speed, they will most likely be less efficient in community mobility, leading to decreased confidence and decreased participation outside of the home

Dual Task Assessment Tools in PT

- Outcome measures primarily focus on divided attention
- Important role in walking in multi- tasking and changing situations
- The cognitive task is usually given as a distracter
- May represent impaired brain capacity to share cognitive resources between walking and an attentionally demanding task
- Clinical implications for fall risk

Examples of Dual Task Assessment Tools

- Motor-cognitive dual task: TUG, TUGc, WWT, FSST, FSSTc
  - FSSTc is not a formal, researched measure. I utilize it for a more challenging dual task assessment due to increased complexity of task and directions
- Motor dual task: FGA, TUGm, CB & M
- Memory: WART, FSST, FSSTc

Dual Task Cost/Effect

- Formula: $\frac{\text{(Dual task time- Single Task time)}}{\text{Single Task time}} \times 100 = \%$ dual task cost
- Measures the increased cost of involvement of cortical attention processes while walking
- Generally measured by decreased velocity in motor performance with the addition of cognitive task
- Common goal of a <10% dual task cost
  - standard used in the BESTest
- Common tests measured: TUGc, FSSTc, WWT
- Example: TUG: 10”, TUGc: 14”; Dual Task Cost: 40%

Interdisciplinary Teamwork

- Discuss appropriate cognitive task selection
  - Communicate with SLP and OT to determine specific areas of cognitive challenge
  - Can the patient be successful performing cognitive task
  - But is the task challenging enough to elicit a dual task cost--i.e. Verbal fluency, digit span, serial subtractions, etc
- Consistency of loading of attention over time
  - Fatigue with cognitive tasks in addition to physical tasks
  - Fatigue with repetition of tasks within one session
  - What happens when the client participates in multiple therapy sessions in one day
  - Performance in the afternoon vs. the morning
- Changes in performance in distracting environment
  - Perhaps client performs well with cognitive tasks while seated in quiet office with SLP, but has difficulty with similar tasks in distracting PT gym or functional cognitive tasks in OT

Secondary Cognitive Task Selection

Silsupadol, et al 2006

List generation	Visual discrimination tasks
Random digit generation	Counting backward
Visual spatial task	Visual imaginary spatial tasks
N-Back task	Subtract or add number to letter
Memorization	Tell story
Opposite directions	Spell words backwards
Stroop task	Say a complete sentence

Dual Tasking and Real Life

- Real life is constant multi-tasking, in unstructured and distracting environments
- PT is generally performed in more distracting setting, which may be the case in the work or home environment
  - Increased challenge to selective attention
  - Challenge sustained attention due to increased cognitive fatigue in this environment

Dual Tasking and Real Life

- Physically taxing activities as performed in PT help to assess client's ability to sustain attention with fatigue
  - Important to factor in patient’s endurance with return to full work day or normal daily participation
- Divided attention--will the client be able to maintain a conversation with a colleague in the hallway, while ambulating
  - Will they be able to recall information they receive while standing or ambulating
  - Or will all of their energy be focused on maintaining balance?
  - Or will they focus on cognitive task, and be at risk for falls?

Patient Education on Physical Activity and Cognition

- Importance of maintaining an active lifestyle--prevent cardiovascular disease, DM, obesity, decrease BP, increase bone density, improve cognition, etc.
- Physical inactivity is one of the most prominent risk factors for cognitive impairment, in addition to increasing fatigue, depression, pain and generalized deconditioning
- People who walk daily have a reduced risk of developing dementia
- Aerobic exercise increases blood flow, which can assist in short term memory
- Exercise has been shown to have a positive effect on immediate executive function
- Cardiovascular exercise has a positive effect on neuroplasticity and motor recovery

Protective Effects of Exercise on Cognition

- Aerobic and resistance training intervention decreased the inflammation that may relate to cognitive aging (Steward et al, 2007)
- Physical activity increases the release of positive hormones (such as growth factors) which help with continued brain development, neuroplasticity, neuroprotection (Cotman et all, 2007)
- Chronic aerobic exercise intervention studies have shown improved sleep quality
    - Poor sleep quality may leave brain vulnerable to neurotoxin effects

The Role of Physical Activity

- Exercise intensity is the main factor to influence exercise-enhanced motor learning
- Performing a bout of high-intensity interval training may improve retention of motor skills, when performed immediately before or after practicing a new skill
  - May accelerate motor learning between sessions
  - May strengthen procedural memories

  Charalambous, et al. 2017
- Combine motor components of PT HEP with specific cognitive activities that are recommended by SLP
  - Greatest improvements in balance and mobility testing following a combination of motor and cognitive dual task gait training (An, et al; 2014)
  - Variable directions also demonstrate increased performance (alternating focusing on cognitive component of task during one trial, next trial focus on maintaining speed of motor task)

Research for HEP

Perione, et al, 2014.

- Objective: To determine if a dual task home exercise program will help diminish balance deficits
- All participants received traditional PT 3x/week for 7 weeks.
- Intervention group also performed a dual task home program 6x/week for 7 weeks
- Intervention group with greatest improvement in balance, per Balance Evaluation System Test (BEST test)

Research and Dual Task Training

Fritz, et al 2013.

- 26 year old female s/p MVA with severe TBI
- Acute inpatient rehab setting, post-injury day 46
- Control: Standard Physical Therapy x 19 days
- Intervention: Standard PT (Mobility training) paired with specific secondary cognitive and motor tasks x 7 days
- Greater improvements on WWT, Trails test, gait speed, stair descent after dual task intervention period

Patient Examples

- Patient A
  - 22 year old male with diagnosis TBI s/p fall
  - Address deficit area of memory, in conjunction with sports specific activity
  - PT Intervention: Suicide drills with recall of specific physical task at specific colored cone; able to recall activity and number of repetitions immediately and 20 minutes later
  - Potentially useful outcome measure: WART

Patient Examples

- Patient B
  - 70 year old male, with diagnosis of SDH
  - Able to perform a single task (i.e. walking, stepping over low hurdles)
  - Rapid fatigue with simple and complex tasks
  - PT intervention: Hurdle negotiation with addition of list generation--cessation of both cognitive and physical task; decreased ability to clear hurdles successfully
  - Potentially useful outcome measures: WWT, FSST

Patient Examples

- Patient C
  - Diagnosis L MCA CVA
  - Poor prioritization during dual tasking
  - Diminished balance response during dual tasking, requiring increased assist from PT to regain balance
  - High fall risk
  - PT intervention: Static/ dynamic balance tasks with list generation or serial subtraction
  - Potentially useful outcome measures: Push and Release Test, FSST

Patient Examples

- Patient D
  - Diagnosis of 20 year history of TBI
  - Poor prioritization during dual tasking, delayed balance reaction responses during dual task performance
  - PT intervention: Word generation during dynamic gait/ balance tasks with instruction to prioritize physical task performance, avoid timing word generation with stepping
  - Potentially useful outcome measures: FSST, WWT

Patient Examples

- Patient E
  - Diagnosis of L occipital infarction
  - Poor ability to dual task (significant decreased cadence) or follow multi step directions
  - PT intervention: Word generation during treadmill walking; FSST with ball pass hand to hand (slow, but improved ability compared to FSST with serial subtraction)
  - Potentially useful outcome measure: FSST, TUGc, WART

Patient Examples

- Patient F
  - Diagnosis of L MCA CVA
  - Decreased ability to dual task, recall multi step directions, slowed processing
  - PT intervention: Dynamic gait tasks with list generation, with different tasks to perform depending on cone color; dynamic gait tasks with change in task to abstract command (i.e. calling out a color to switch direction, etc)
  - Potentially useful outcome measure: FSST with a cognitive component; push and release to assess reaction time

Summary

- It is important to assess the effect of cognitive changes on a clients mobility
- Dual task assessment measures can be quick and easy to utilize
- Dual task cost gives physical therapists an objective measurement to help analyze change and assist with goal writing
- Interdisciplinary communication is vital for a thorough, comprehensive approach to work with and help the client
- Exercise has an important role in maintaining and improving cognitive function

Post-Test

- PT is not necessary for individuals post- brain injury if they can transfer, walk and negotiate stairs without assistance: true or false
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Questions?