INTEGRATION OF MOTOR LEARNING STRATEGIES IN TASK ORIENTED TRAINING POST-STROKE

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Feb 23, 2021

CANADIAN BEST PRACTICE RECOMMENDATIONS FOR STROKE CARE

6. Therapy should include repetitive and intense use of **patient-valued tasks** that challenge the patient to acquire the necessary skills needed to perform functional tasks

6.1 **Task and goal-oriented training** that is repetitive and progressively adapted should be used to improve performance of selected lower-extremity tasks such as sit to stand, walking distance and walking speed.

5.1 Patients should engage in training that is meaningful, engaging, repetitive, progressively adapted, **task-specific and goal-oriented** in an effort to enhance motor control and restore sensorimotor function.

10. Treatment to improve **functional communication** can include language therapy focusing on: Production and/or comprehension of words, sentences and discourse, (including reading and writing); and Conversational treatment

OBJECTIVES

- Identify and understand key evidence-based motor learning strategies to optimize the impact of task-oriented training in patients and clients with history of stroke.
- Plan and apply key motor learning strategies during sessions with patients/clients with different functional assets and challenges.
- Develop and implement an unsupervised practice plan incorporating motor learning strategies.
- Develop and implement a motor learning-informed assessment plan for patients/clients with stroke.

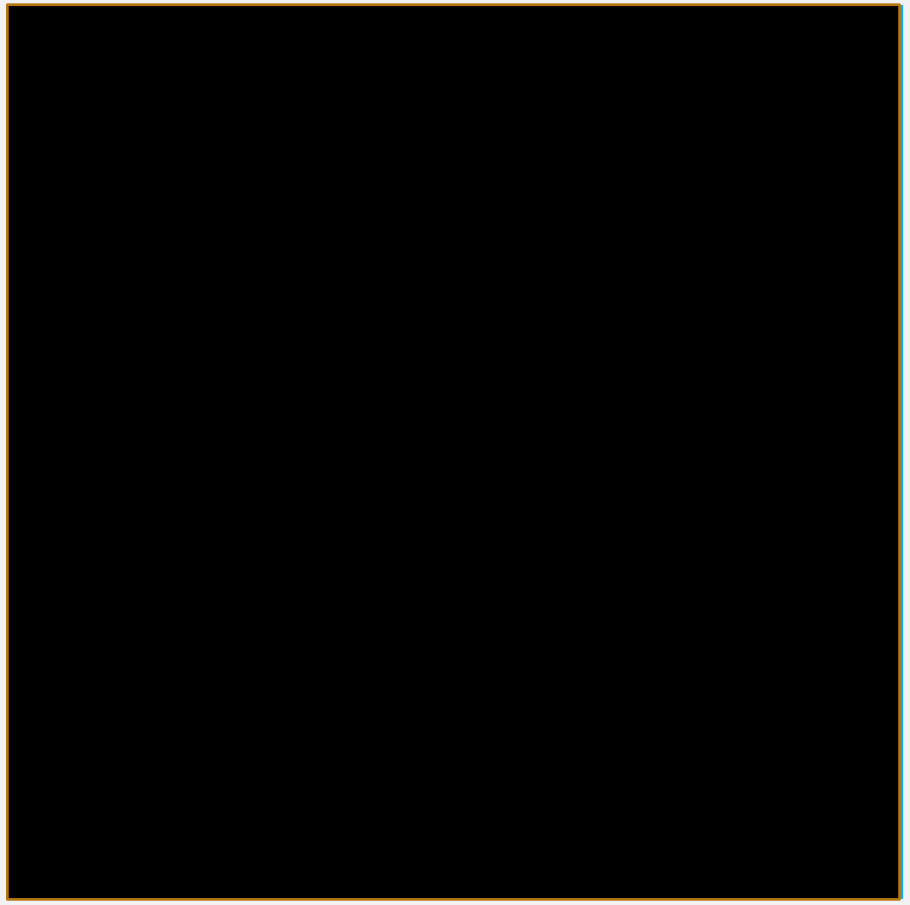
OUTLINE

Time	Activity
12:30 - 12:45	Introduction
12:45 - 1:45	Overview of ML concepts and strategies
1:45 – 1:50	Introduce Case 1
1:50 - 2:00	Break and assign to break out rooms
2:00 – 2:30	Work through Case 1 in small groups
2:30 – 2:55	Discuss Case 1 in large group
2:55 – 3:00	Introduce Case 2
3:00 – 3:30	Work through Case 2 – small groups
3:30 – 3:50	Discuss Case 2 in large group
3:50 – 4:00	Wrap up

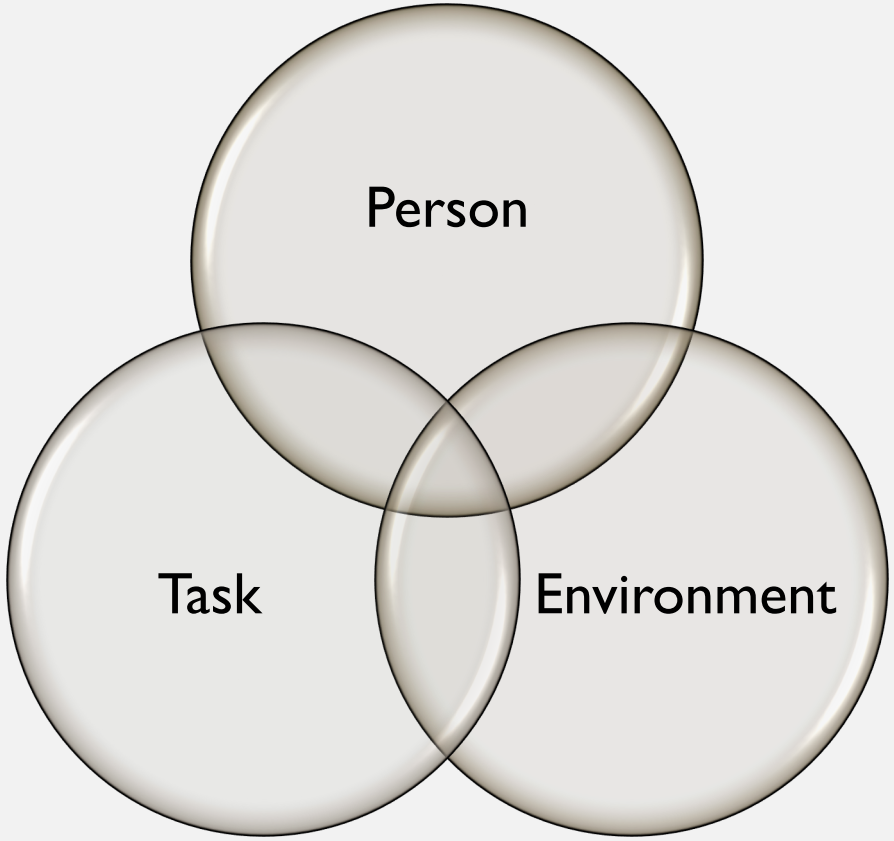
CAVEAT

- There is no one correct motor learning strategy
- The optimal strategy is dependent on the specific characteristics of the person, task and environment…and can change from one day to next
- Aim of workshop is to help identify what ingredients or variables you may adjust or change in order to optimize motor skill learning and functional recovery

WHAT ARE THE ACTIVE INGREDIENTS OF TASK ORIENTED TRAINING FROM A MOTOR LEARNING PERSPECTIVE?



OPTIMAL MOTOR LEARNING STRATEGY DEPENDS ON…

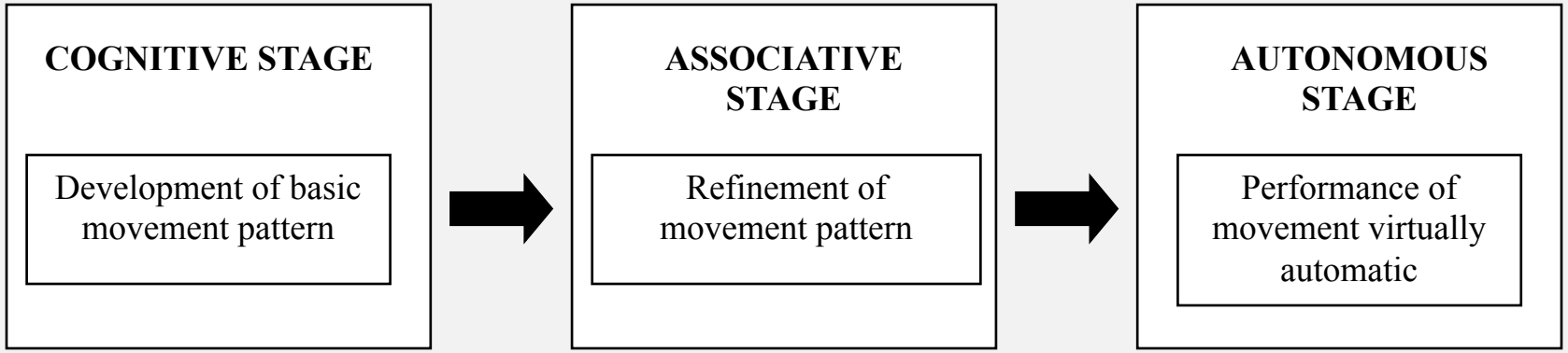


What Characteristics of the Patient/client do we need to consider

- Level of experience – Stage of Learning
- Capabilities, Impairments and Limitations
  - Cognitive status
  - Attentional capacity
  - Mood, motivation
  - Sensation and sensory integration/perceptual status
  - Motor control
  - Postural control
  - Musculoskeletal system
  - Endurance/Exercise tolerance
- Social context, resources

Person

FITTS AND POSNER'S STAGES OF LEARNING



Novice learners may benefit from early success in performance and limiting cognitive demands early in practice

Person

AT WHAT STAGE OF LEARNING IS YOUR PATIENT?

Considerations:

- What activity/skill?
- What previous experience does the person have with that skill?
  - Experience pre and post-stroke
- Based on the definitions – where do you think they are?
- High cognitive load, errorful, variability of performance
- How will this impact our approach/expectations?

Task

- **Discrete -** recognizable beginning and end point defined by the task
- **Serial** - combine a series of discrete skills with a specific order of actions
- **Continuous -** no recognizable beginning and end point;

- **Simple -** involve a simple motor program that produces an individual movement response
- **Complex -** involve multiple actions and motor programs combined to produce a coordinated movement response

- **Environmental context may make task more or less complex**
  - **Closed** – stable, predictable – e.g. walking across quiet gym
  - **Open** – changing, unpredictable environment – e.g. walking through a crowded room carrying a cup of hot coffee

- **Environment may make movement easier or harder**
  - e.g. standing up from a high seat vs low seat; sliding hand across a table to grab cup vs reaching up to high to grab cup off shelf
  - Transferring to toilet in confined space

- In what environment is the task typically performed?
- How can you manipulate the environment to make it harder, or easier?

COGNITIVE EFFORT

COGNITIVE EFFORT

- Motor learning strategies that encourage problem solving, active engagement, and cognitive effort tend to improve learning
- Better to be an **active** learner rather than **passive** recipient
- However – must consider the task, the personal experience and resources of the learner/patient
- Must also consider the cumulative impact of different motor learning strategies on overall challenge level

PRACTICE

PRACTICE VARIABLES THAT IMPACT LEARNING

- What
  - Specificity of practice
  - Part vs whole task practice
  - Variability
- When
  - Practice schedule
- How much
  - Amount of practice

SPECIFICITY OF PRACTICE

Learning is optimized when practice conditions resemble the conditions of typical task-performance

- ***If we want to improve walking, then we must practice walking***

But…what does the walking task look like?

WALKING-TASK DEFINED…

Rhythmic repetition of the complete gait cycle.

Smooth advancement of the body through space with the least energy expenditure.

(Waters and Mulroy 1998)

OR IS WALKING REALLY SOMETHING MORE?

WHEN OLDER ADULTS WALK IN THE COMMUNITY…

- Slopes (65% of trips)
- Stairs (47%)
- Uneven terrain(60%)
- Change direction
- Crossed busy streets (35%)
- Mean Distance = 366 m
- Fast and slower speeds
- Distractions/dual task (58%)
- Motor - Carried packages
- Cognitive – navigation, talking

(Shumway Cook et al. 2002)

CHOOSING PRACTICE ACTIVITY

SPECIFICITY OF PRACTICE

- Use of real objects or tools where possible
- Practice conditions should be meaningful to learner
- Environments should reflect the environment where the task will be performed

PART VS WHOLE PRACTICE

- Best strategy depends on the nature of the task
  - Serial
  - Discrete
  - Continuous

PART VS WHOLE TASK PRACTICE

Part Practice

- Discrete and Continuous tasks should be practiced as a whole
- Part-practice of isolated gait components less effective than whole task of walking.

(Winstein 1988)

When possible - gait should be practiced as a WHOLE TASK

Whole Practice

PART VS WHOLE TASK PRACTICE

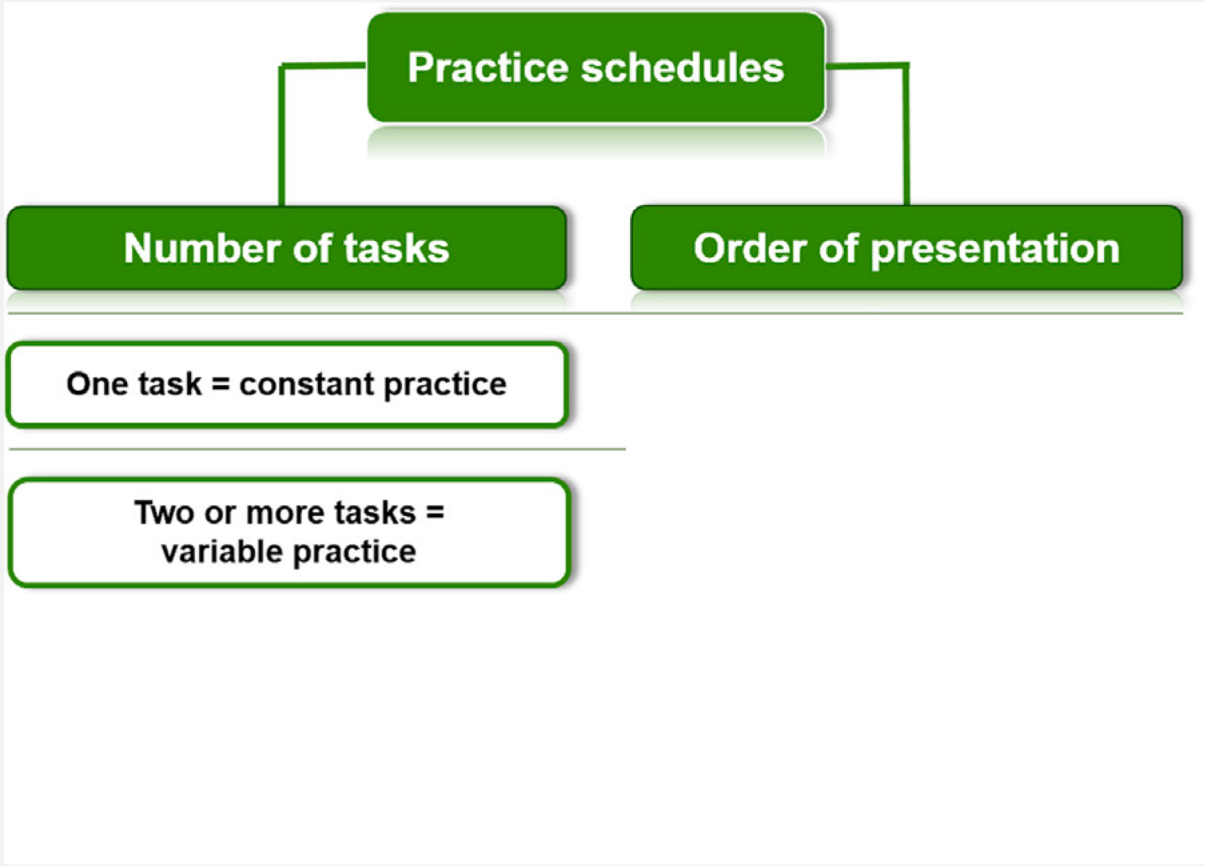
Part Practice ⟷ **Whole Practice**

- **Serial** tasks may be broken down and practiced in parts
- Dressing, wheelchair transfer
- Learning order of parts different strategy than motor skills
- Task should reflect real task

PRACTICE - SCHEDULE

CONSTANT VS VARIABLE PRACTICE

CONSTANT VS VARIABLE PRACTICE



CONSTANT OR VARIABLE PRACTICE

Constant Practice

Variable Practice

Repetitive practice of a single task under identical conditions

Variable practice helps develop a stronger 'schema' or motor program for a particular task or motor skill

(Schmidt and Lee, 2018)

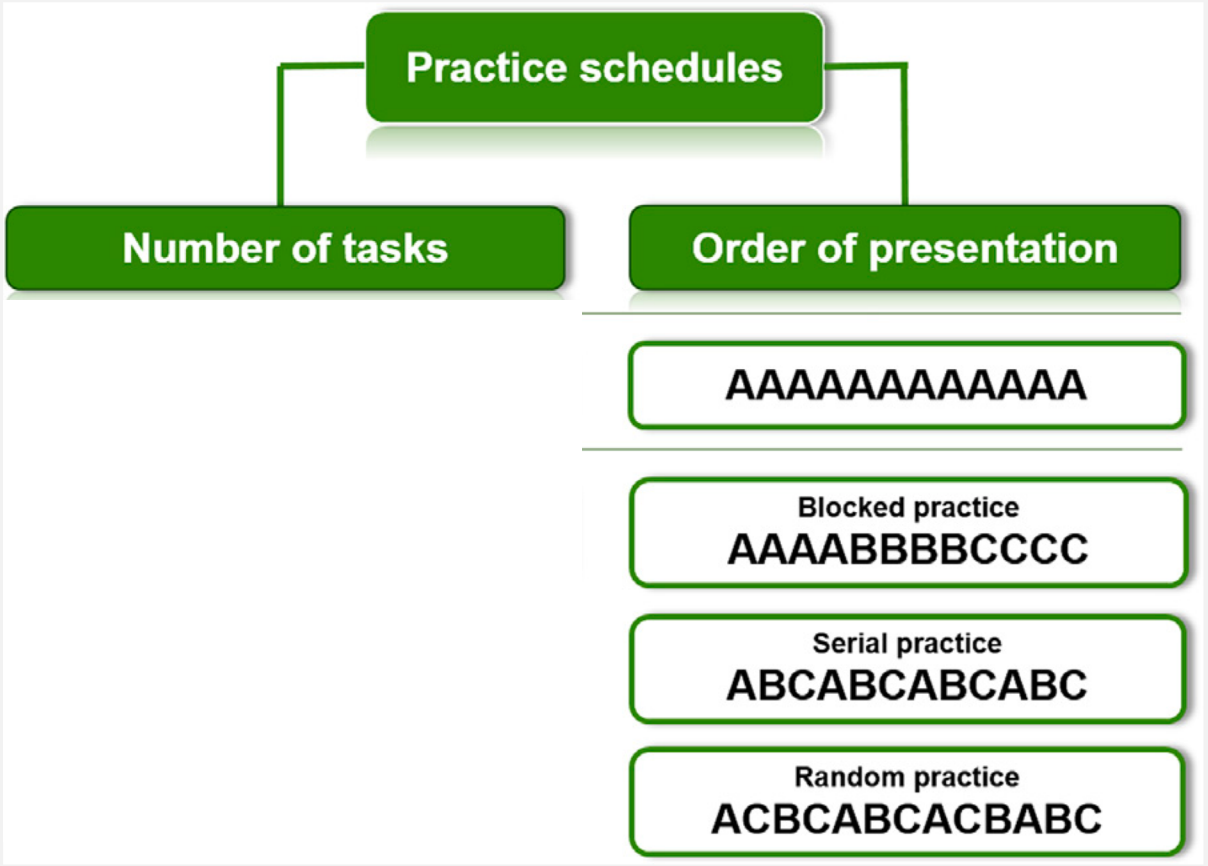
Repetitive practice of a task under a variety of conditions




Variable practice should improve ability to perform skills in various real-life conditions




ORDER OF PRACTICE



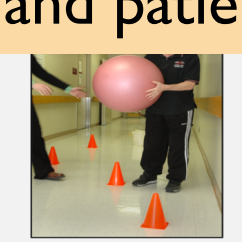
ORDER OF PRACTICE

BLOCKED PRACTICE ⟷ **RANDOM PRACTICE**

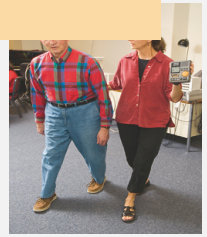
Random practice encourages repeated problem solving and tends to improve retention and transfer in healthy adults and patients with stroke

Better for reach and grasp, feeding, ADL, and mobility tasks after stroke

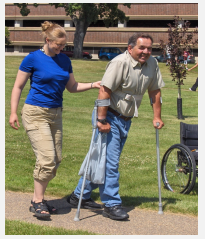




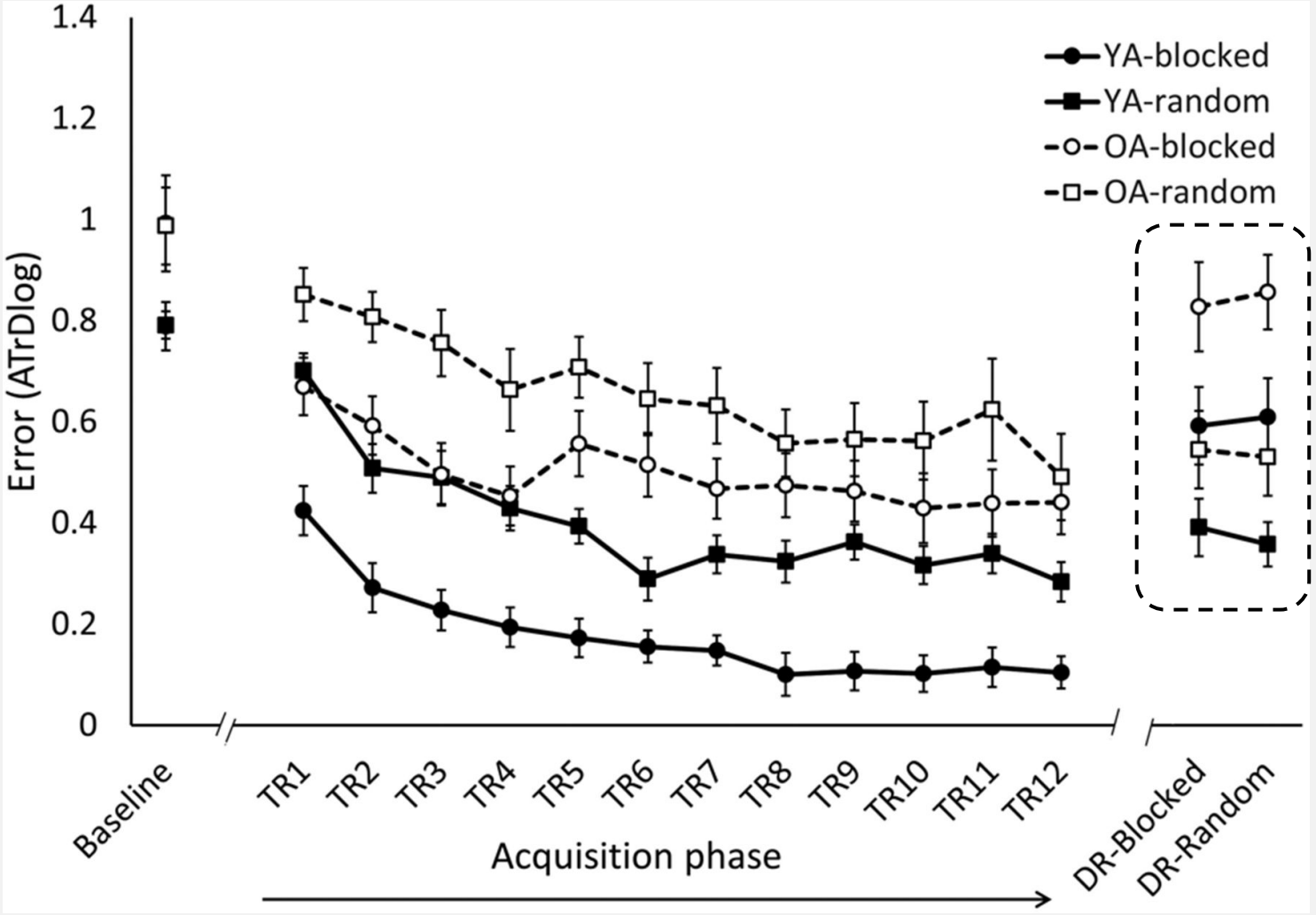





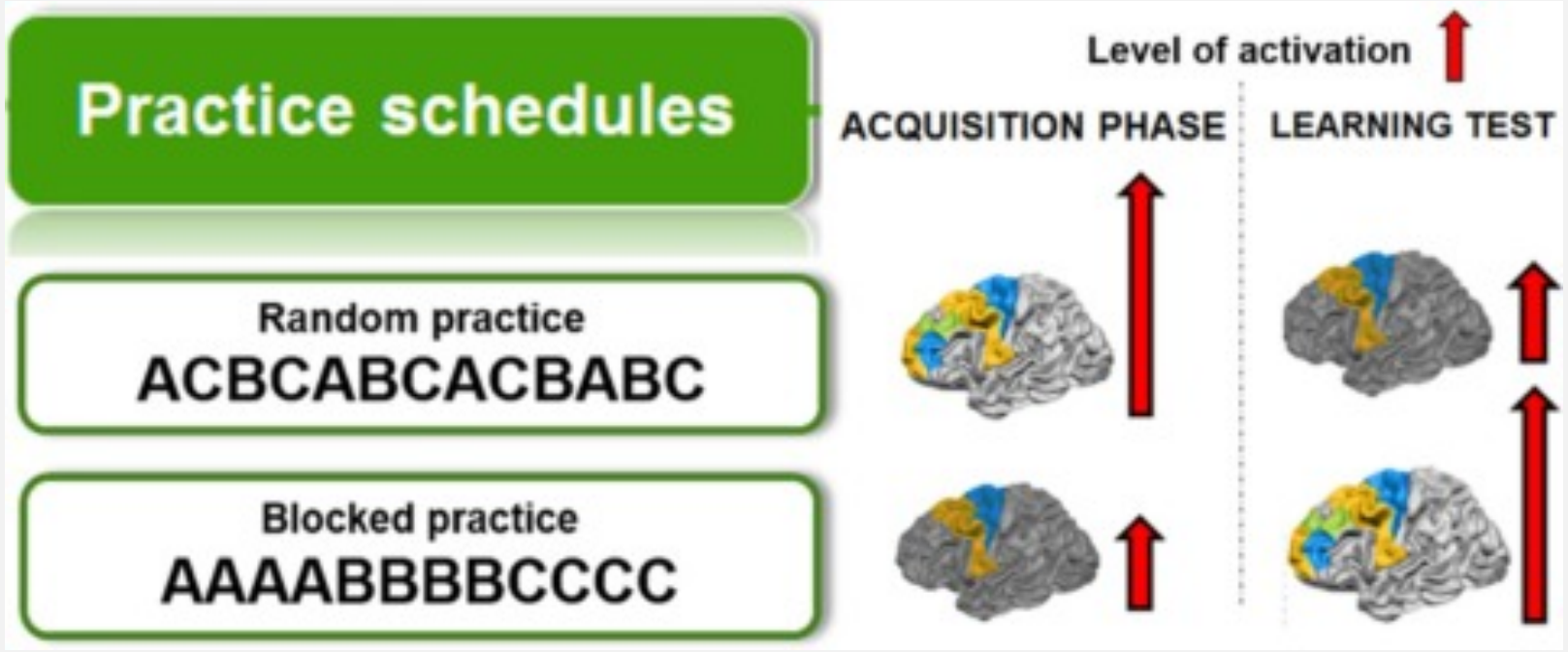
Improved learning (retention) with random practice in older (OA) and younger adults (YA)

Lower error = better learning



Lisa Pauwels et al. J. Neurosci. 2018;38:3333-3345

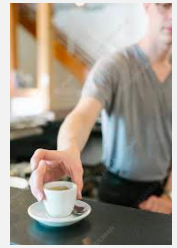
CONTEXTUAL INTERFERENCE



CONTEXTUAL INTERFERENCE

Low CI

High CI

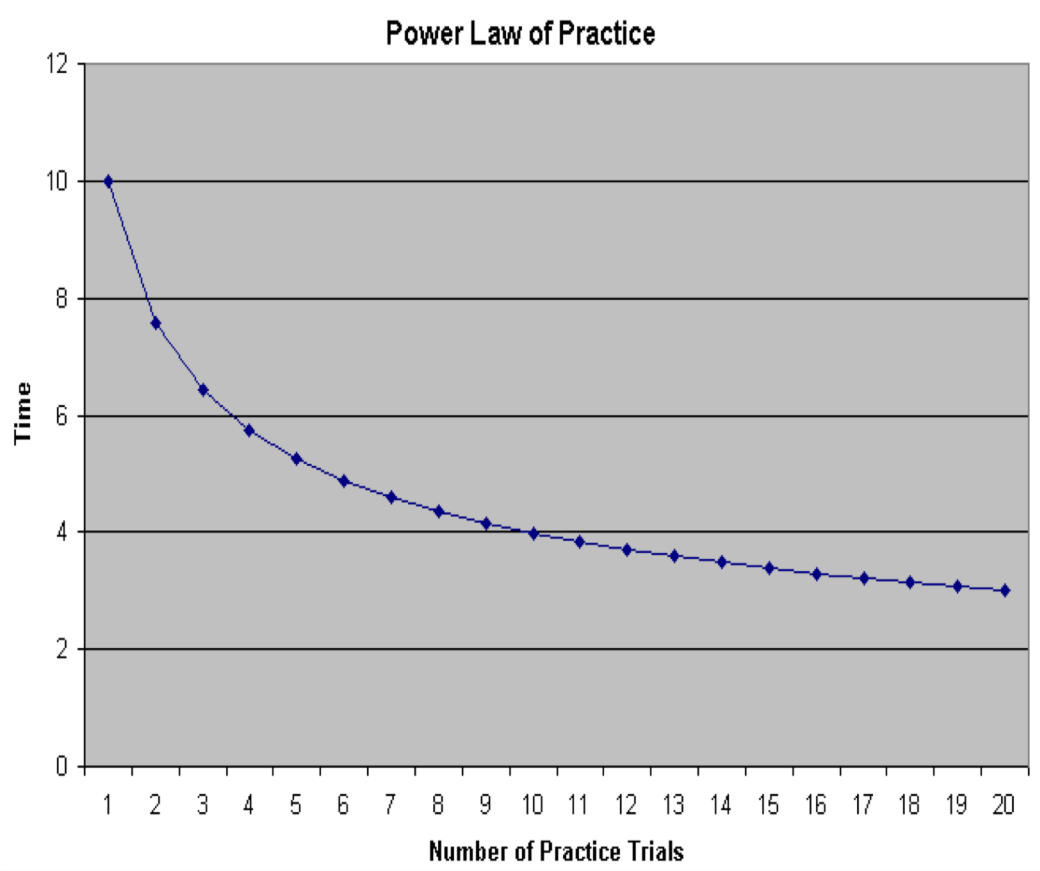



PRACTICE - AMOUNT

AMOUNT OF PRACTICE

- Motor skill learning requires practice
- Learning increases with increased amounts of practice
- In stroke, 16 additional hours of walking practice associated with improved walking outcomes

(Kwakkel et al.,2004)



AMOUNT OF PRACTICE

How much practice do patients experience during rehab?

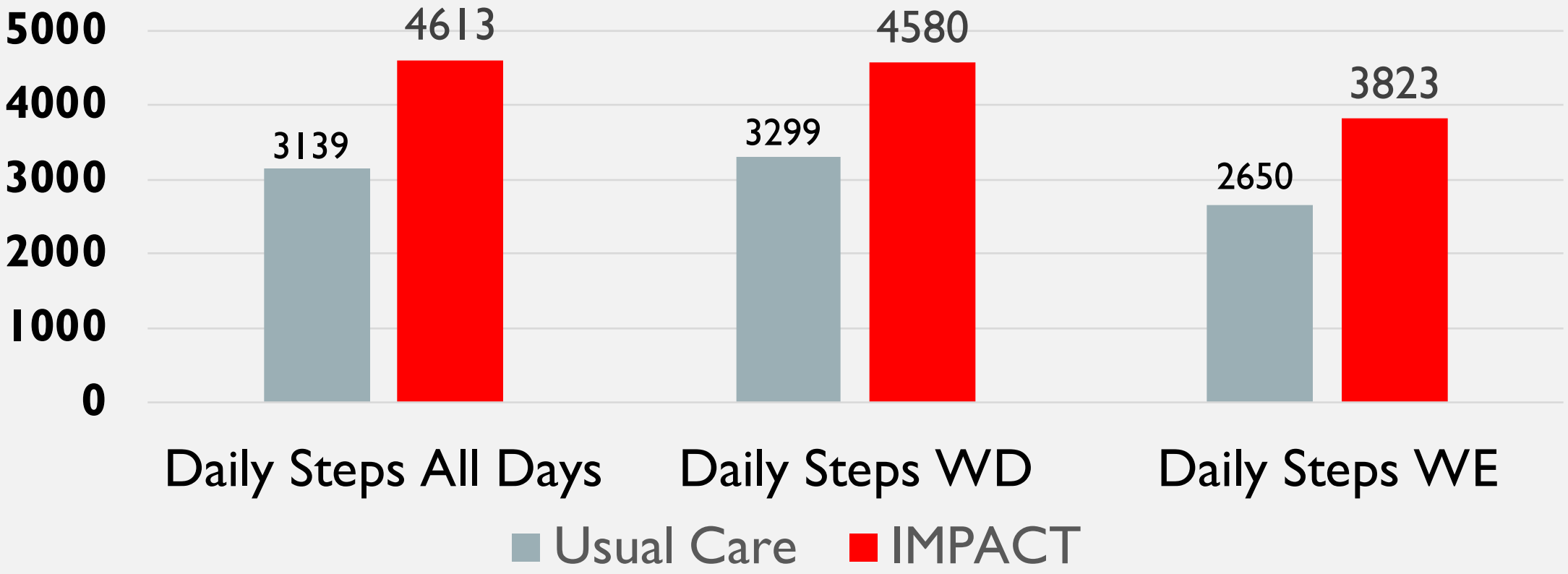
- Observed OT and PT stroke rehab sessions
- Arm and Hand
  - Only 32 (95% CI = 20–44)
- Standing and Walking: 84% lower extremity sessions included walking ☑
  - Only 249 (± 20) steps during inpt treatment
  - Only 501 (± 64) steps during outpt treatment
- Improvements are being made in increasing therapist-focused stroke rehabilitation intensity – Ontario

Lang et al. 2009

ENCOURAGING PRACTICE OUTSIDE OF THERAPY

- Independent Mobility and Physical ACTivity (IMPACT) Program
  - **Autonomy** - Goal setting, self-selected negotiated activity plan
  - **Accountability** - self-monitoring and reporting
  - **Activity** – performance of walking task-oriented activities between therapy sessions
- Usual Care period (n=11) vs. IMPACT period (n=12)
- IMPACT began walking-related activity outside of therapy 5 days sooner than usual care
- Patients admitted during the IMPACT period – took more steps on weekdays and weekend days

RESULTS: DAILY WALKING ACTIVITY USUAL CARE VS IMPACT PERIOD



IMPACT period – Took more steps on weekdays and weekend days

- Began activity outside of therapy 5 days sooner than usual care

Activity #___: Pre-Standing with Arm Rests

Instructions

- *Starting Position*: seated in a chair with both feet on the floor.
- Shift your weight forward and lift your bottom slightly off the chair.
- Push up through your hands on the arm rests.
- Do not stand up all the way – see photo.
- Slowly lower back down, do not fall back onto the chair.

AM		PM	
Noon		Evening	

How many times?	Supervision required?

Alternative Alert!

A little EASIER: do not lift up quite as high, sit on a higher chair.
A little HARDER: sit on a lower chair.

Take a step forward

If you want to progress to a MORE CHALLENGING activity, try Activity #__ "Pre-Standing without Arm Rests".

Take a step back

If this activity is TOO CHALLENGING, try Activity #__ "Sitting and Shifting Weight".

INCREASING AMOUNT OF PRACTICE WITHOUT MOVING

PRACTICE WITHOUT MOVING OBSERVATIONAL LEARNING

- Observation of video (or demonstration) of person performing task with intent to imitate – e.g. reaching to pick up and place down a cup
  - Protocol example: Watch 2 minutes +/- physical task practice

  Proposed mechanism: engage same motor areas as during real action execution - therefore induces neural plasticity

  Effective in UE function (Borges 2018), Gait (Sarasso, 2015)

  Aphasia – evidence that watching videos of gestures improve verb use (Marangolo 2014)

  Swallowing – Watching video of person swallowing apple – activates same swallowing networks as activated with actual swallow (Jing 2020)

PRACTICE WITHOUT MOVING
MENTAL PRACTICE

- Audio guided imagery – 2-3 minutes relaxation + 20 - 30 min of visualizing different functional activities
- Visual (imagining seeing yourself doing the movement)
- Kinesthetic Imagery – imaging the feeling associated with performing the movement
- Effective, particularly when paired with PT/OT – for UE function (Stockley 2020), balance and mobility (Guerra 2017)
  - Cognitively intact or MCI
  - Patients with most severe impairments benefited the most

FEEDBACK, GUIDANCE AND INSTRUCTION

FEEDBACK VS INSTRUCTIONS

- Instruction: Communication directed at the patient regarding a desired action or how to perform a desired action or skill
- Feedback: Communication that provides information based on previously observed movement attempts, intended to influence or modify subsequent attempts
  - Fb may be given as further instruction – "Next time, bend you knee more as you swing your leg."

FEEDBACK – TYPE

Inherent (Intrinsic) Feedback

Visual
Somatosensory
Proprioception
Auditory

Augmented (Extrinsic) Feedback

Knowledge of Performance	Knowledge of Results
Information about the nature of the movement itself	Information about the outcome of the movement

Mode:
Visual, Auditory, Tactile, Haptic

FEEDBACK - TIMING

Concurrent

Feedback provided **during** performance of task/movement

Terminal

Feedback provided after performance of activity
- Can be **Immediate** or **Delayed**

Frequency

High frequency – feedback provided after every attempt
Low frequency – provided after a number of attempts

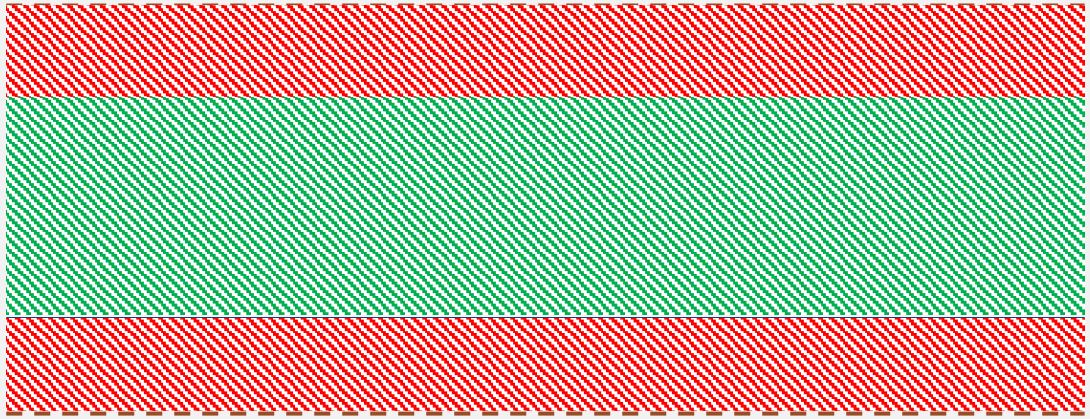
Faded

Start with high frequency feedback and fade intermittent feedback over course of treatment

FEEDBACK - TIMING

Bandwidth

Feedback provided when error falls below or above set threshold



SELF-EVALUATION AND LEARNING

"Ask before telling"

- Encouraging learners to self-evaluate their performance before giving feedback may enhance learning
- Theory
  - trains people to utilize and interpret their internal feedback mechanisms
  - prevents dependence on feedback and guidance
- Research primarily in discrete UE tasks in healthy adults

SELF-EVALUATION
LEARNING AN UNFAMILIAR GAIT PATTERN

- Gait study with young adults
- Task: Learn to walk with an altered gait pattern

  Determine their preferred Step Length : Cadence Ratio

  Learn to walk with an altered ratio – e.g. shorter step length/increased cadence

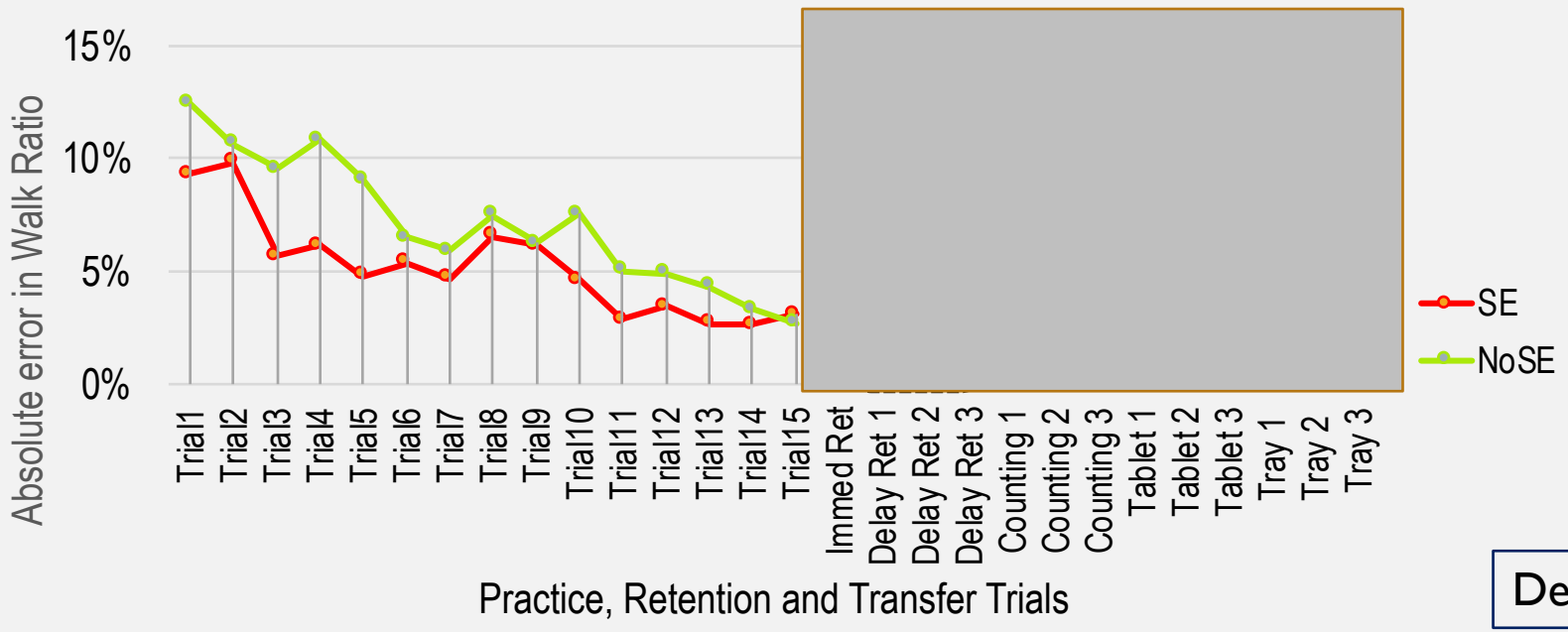
  Practice Conditions

  Feedback with no self-evaluation

  Self-evaluation followed by Feedback

DePaul et al. 2019

SELF-EVALUATION
LEARNING AN UNFAMILIAR GAIT PATTERN



DePaul et al. 2019

Self-evaluation seems to result in improved learning of a complex gait-related task in cognitively intact healthy adults. Further research is required in other tasks and individuals with stroke

FEEDBACK

High Frequency/ Immediate/ narrow bandwidth

Low cognitive effort Promotes dependence on feedback

If patient is cognitively intact, Feedback should:

- Provides information about <u>outcomes</u> as well as <u>movements</u>
- Lower frequency prevents dependence
- Encourage self-evaluation + correction

Low Frequency/ Delayed, Summary Wide bandwidth

High cognitive effort, Learn to self Evaluate

FEEDBACK

High Frequency/ Immediate

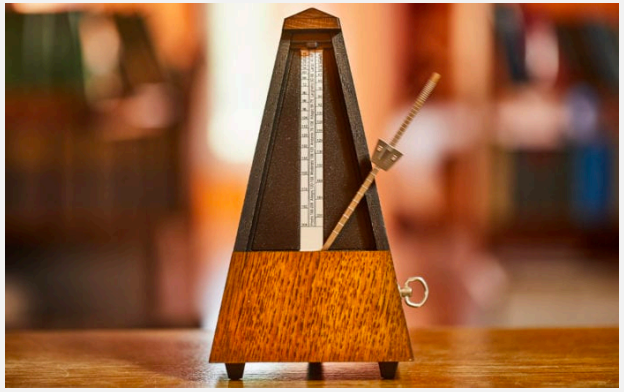
Low Frequency/ Delayed, Summary

Patients with cognitive impairment may benefit from increased feedback frequency

Low cognitive effort Promotes dependence on feedback

High cognitive effort, Learn to self Evaluate

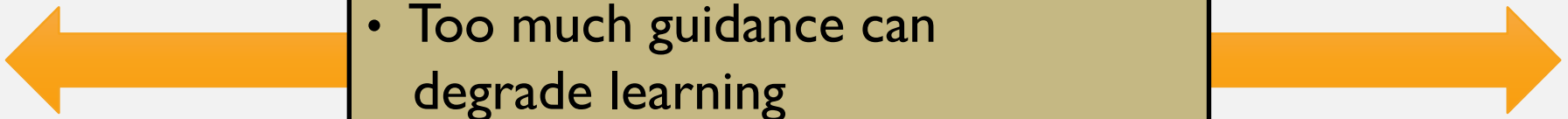
GUIDANCE



GUIDANCE HYPOTHESIS

- Predicts that the guiding properties of augmented **feedback or other form of guidance** (physical, auditory) are beneficial for motor learning but detrimental when relied upon.
- Heavily guiding forms of feedback or cueing will lead to improvements in performance while guided, but promote dependence and impede learning

GUIDANCE



- Too much guidance can degrade learning
  (Winstein 1996)
- Therapist handling better than Robotic guidance when treadmill training
  (Hornby 2008)
- No research on handling and overground walking

Heavy Guidance/ Errorless Practice

Low Cognitive Demand

Minimal Guidance Trial and Error Practice

High Cognitive Demand

INSTRUCTIONS – FOCUS OF ATTENTION

Internal Focus

Focus on the body or components of the movement

External focus usually best for performance and learning of motor skills

Theory: Internal focus may constrain automaticity

External Focus

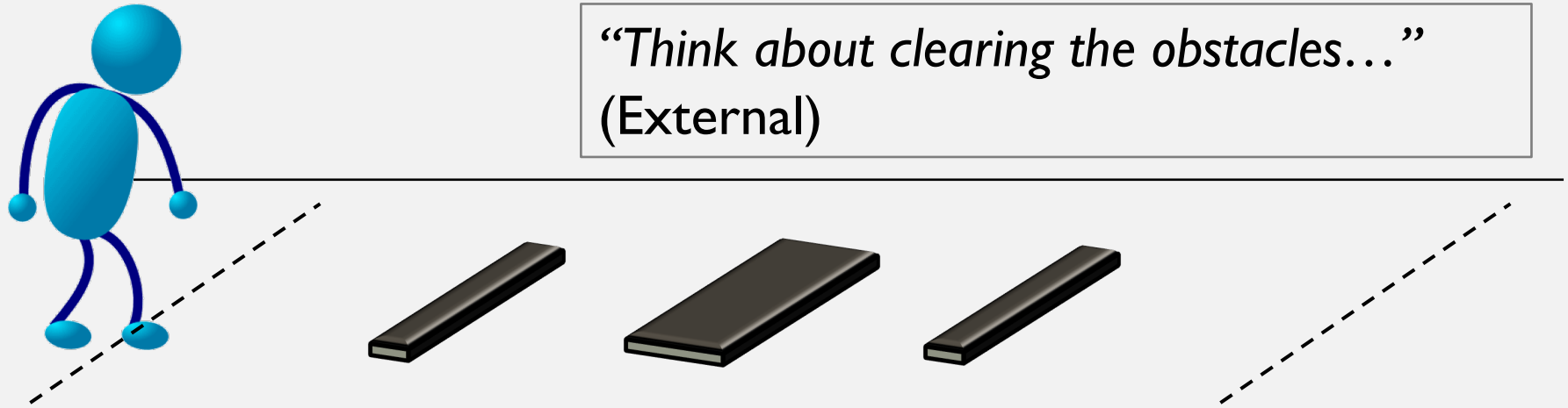
Focus on environment or the results of the movement

(Peh et al., 2011, Wulf 2016)

FOCUS OF ATTENTION AND WALKING STUDY

"Think about bending your knee and raising your foot..." (Internal)

"Think about clearing the obstacles…" (External)



24 adults = 9 with stroke, 15 healthy

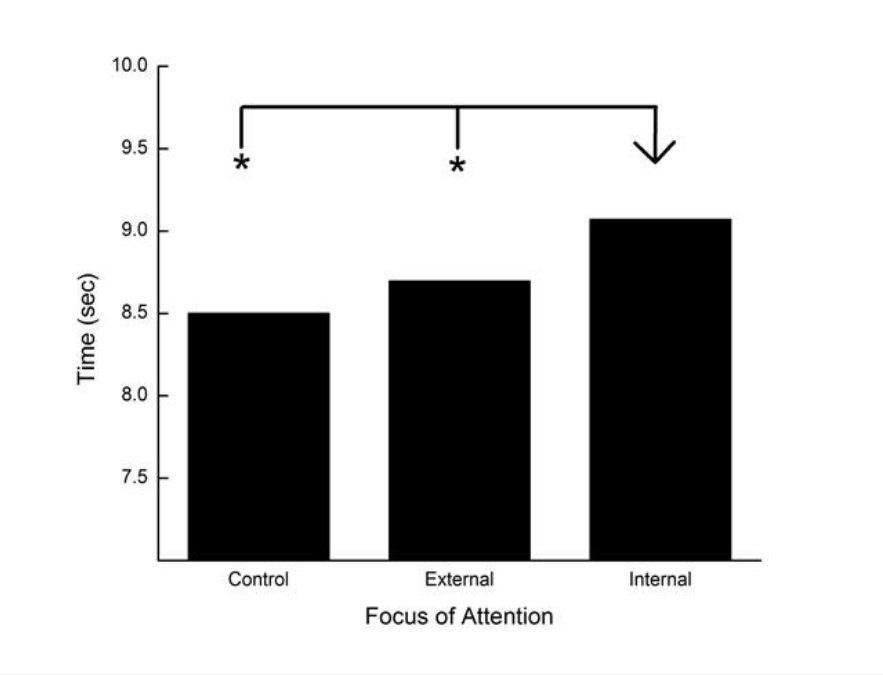
Walking with obstacles under 3 conditions

1) No Focus instructions, 2) External, 3) Internal

Outcomes: Time and Number of steps

FOCUS OF ATTENTION AND WALKING

- Most participants self-selected external focus during control trials
- Participants walked slower and took more steps under internal focus conditions
- Internal FOA degraded performance in stroke and healthy participants



MOTIVATION


THAT'S IT! I'M THROUGH LEARNING TODAY!
© 1993 Watterson/Distributed by Universal Uclick

MOTIVATION

- Practice and feedback conditions that are motivating – facilitate learning
- Conditions that **enhance learner's performance expectancies** or **promote autonomy** have been shown to facilitate motor learning in healthy and rehab populations

Schmidt et al., 2019

ENHANCING EXPECTATIONS

- Experience success
- Provision of feedback on positive trials
- Perceived difficulty of task
  - ”Active people like you usually perform well on this task”
- Social Comparison: Perceived positive performance relative to others
  - “You performed that test better than most other people your age”

Schmidt et al., 2019

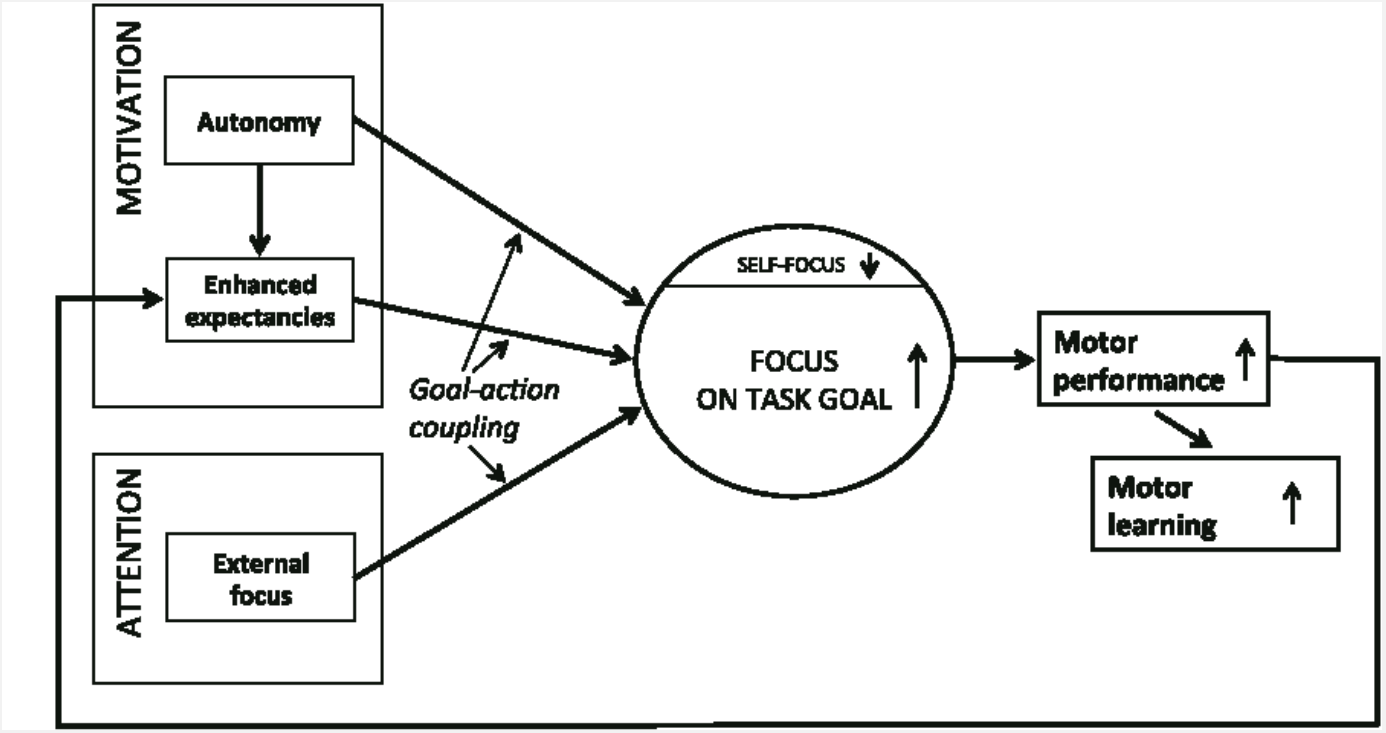
AUTONOMY PROMOTING STRATEGIES

Autonomy

- Engagement in planning practice/treatment
- Self-regulation of feedback schedule
- Involvement in non-training related decision making

Schmidt et al., 2019

OPTIMAL THEORY OF MOTOR LEARNING



Schmidt et al., 2019

APPLICATION

- Engaging older adults in goal setting, self-regulation and decision making can be challenging
  - Limit number and complexity of choices
  - Identify what is meaningful and important to patient
- Reward centres in brain - less activation in individuals with stroke (Widmer 2019) – may require increased levels of positive feedback, praise, encouragement?

QUESTIONS?

CASES

CASES

Case 1 – Mr. Gill

- small group discussion – about 30 minutes
- develop a treatment plan incorporating motor learning strategies
- Large group discussion – be prepared to share your great ideas

Case 2 – Ms. James

- small group discussion 20 minutes
- - develop treatment plan particular to Ms. James – contrasting with Mr. Gill
- - Large group discussion