Impacting Patient Outcomes Through Strategic Motor Learning Interventions Case-Based Approaches for PT & OT

Beth Tarduno, MEd, OTR/L, CNDT

Objectives

• Define motor learning & basic motor learning principles.
• Compare & contrast different motor learning strategies to improve function
• Integrate motor learning into everyday clinical intervention for improved function.

Definitions

• Motor Control:
  The study of the nature and control of movement, focusing on understanding movement already acquired
• Motor Performance:
  Refers to the performance of a skill, but not for the long term
• Motor Learning:
• Recovery of Function:
Motor Learning

Neuroplasticity
“The brain's ability to reorganize itself by forming new neural connections throughout life.”
“Change in neuron function or structure where adjacent cortical areas take over for other areas.”
“Driven by changes in behavioral, sensory, and cognitive experiences or demands.”


How Plasticity Happens
Activity is introduced in Challenging Environment
↓
Changes in Neural Signals
↓
Reorganization & New Neural Connections
↓
Changes in Function

Requirements for Learning
- Knowledge of the Goal
- Practice
  - Motor/Mental/Visual
  - Part/Whole
  - Random/Blocked
- Interest in the activity
- Feedback
  - Type & Timing
  - Task specificity/Task oriented
  - Challenge/Intensity
Overview of Intervention

- Assessment
- Identify Impairments
- Standardize Test
- Decide your intervention strategies
- Retest for results
- Determine if strategies need to be changed
- Challenge with improvements
- Keep focus on function

Assessment

UE Quick Assessment

Motor Learning

Individual
Task
Learning
Environment
Knowledge of the Goal

- Understanding
  - the process
  - the components
  - the sequence
  - the end result

Mount, J. 2014

Pre-Test

Practice/Repetitions

- Research supports increased repetition for learning
  - Motor
  - Mental
  - Visual
Types of Practice

- Motor (Task-Oriented Training)
- CIMT or mCIMT
- Repetitive tasks practice
- Augmented activities (to task-oriented)
- Mirror Therapy
- Mental Practice/Covert Rehearsal
- Action Observation (Visual)

CIMT vs. mCIMT

<table>
<thead>
<tr>
<th>CIMT</th>
<th>mCIMT</th>
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<tbody>
<tr>
<td>1. Daily 6 hours/day 7 days/week training</td>
<td>1. 30 min to 3 hrs/day 2-5 days/week</td>
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<tr>
<td>2. 90% waking hours restrained</td>
<td>2. Less restrained &lt;6 hours/day</td>
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<tr>
<td>3. Two week intensive</td>
<td>3. two-10 weeks (distributed over time)</td>
</tr>
<tr>
<td>4. Intensive repetitive practice</td>
<td>4. Less intensive training over time</td>
</tr>
<tr>
<td>5. ADLs, repetitive, shaping</td>
<td>5. ADLs, repetitive, shaping</td>
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- 19/20 studies + findings on at least one outcome measure on CIMT & mCIMT
- 6/7 studies + ADLs and participation
- All studies found maintained gains in UE function over 6 months
- No significant difference between the groups
- More compliance with mCIMT

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Repetitive Task Practice

- Includes:
  - Goal-directed individualized tasks
  - Task-specific movements
  - Task related movements

Repetitive Task Practice

- Review of 17 articles:
  - 13 looked at improvement in UE functional-all improved
  - 9 looked at improvement in balance & mobility- all improved
  - 4 studies looked at activity/participation- all improved

Task Specific

- Task Specific: For retention (performance)
  - Variety: For generalization and retention
  - Increase “challenge-point” for learning and retention
  - Allow errors for problem solving for transfer
  - Give them choices in the activity

“… in order to appropriately challenge the learner at a "desirable" level of functional task difficulty, the practice environment should change as the learner's skill level changes.

Iman, F., Valizade, R., 2011
Mirror Therapy

- Affected extremity is hidden behind a mirror
- Stronger extremity performs simple to complex movements &/or functional activities
- Encourage movement of the affected extremity
- Sensory cortex integrates with motor cortex

Mirror Therapy - Evidence

- 15 minutes 2X/day 6 days/week (Lancet)
  - Subjective feedback + from patients for improvement
  - Two neurologists graded movement = all +

- One hour/day 5 days/week (Michielsen, et al)
  - FM assessment baseline & 6-months
  - fMRI- baseline & 6 months- activation of primary motor cortex

Mirror Therapy - Evidence

- Level I study- 25 min 2X/day 5X/week X 4wks (Lee, Cho, & Song, 2012)
  - FMA, Brunnstrom stages, and Manual Function Test
  - All tests + outcomes
  - Authors concluded mirror therapy is effective in UE and function recovery

- Review of 14 studies/ 567 individuals/ RCT's and randomized cross-over trials (Theime, et al 2012)
  - + for motor function, ADLs, and visual spatial neglect
  - Evidence + for adjunct to “normal rehabilitation of stroke”
Mental Imagery

- Cognitively rehearsing a physical skill in the absence of actual movements
- Combined with traditional task-specific/oriented practice

Studies:
- 3/7 studies + for improved UE function and activity/participation
- Supportive evidence to implement as an adjunct to traditional therapy

Mental Practice

- Page (2007) compared mental practice (MP) + physical practice (PP) to PP plus a placebo of relaxation exercises (PI)
- 36 patients randomly assigned (mean 3.6 yrs post CVA & moderate motor deficits)
- 30 minutes PP/week x 6 weeks - all patients
- 30 minutes/week PP + MP or PP + PI group

Mental &/or Physical Practice

- Functional Task Practiced
  - Reaching for and grasping a cup or object
  - Turning a page in a book
  - Proper use of a writing utensil
Mental &/or Physical Practice

**Table 3. Patient Scores on the FM and ARAT Before and After Intervention**

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<thead>
<tr>
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<th>FM</th>
<th>ARA</th>
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<tbody>
<tr>
<td></td>
<td>PRE</td>
<td>POST</td>
</tr>
<tr>
<td>MP</td>
<td>31.03</td>
<td>30.75</td>
</tr>
<tr>
<td>PP</td>
<td>31.75</td>
<td>36.75</td>
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Note: PRE indicates mean score obtained during pretreatment period; POST, mean score obtained during posttreatment period; Change, POST - (PRE + PP)/2. Exact P values for the F test comparing the change scores for the 2 groups are P=0.0001 for the FM, and P=0.0001 for the ARA. These significant change scores are denoted by **.

Hypothesis about Mental Practice

- Motor improves due to the learner
- Thinking about what can be tried
- Predicting consequences based on practice
- Integrating the sequence of the task
- Activating mirror neurons

Mental Practice

Video
Visual (Action) Observation

- Patients watched 6 minute video of an activity prior to actual practice
- Simple tasks (moving tissues between hands) to complex (manipulating cup, turning on faucet)
- fMRI—activation of frontal & parietal lobes during observation
- Improvement thought to be due to activation of mirror neurons


Learning from Others

Task= free weight squat lift, 30# bar weight w/ squats

Watching videotapes by themselves hindered learning and did not contribute to learning
- Without guidance there is too much information
- There may be lack of knowledge of what is important
- May be too distracting to watch themselves.
- Critical for distinct directions with voice over

McCullagh, P., 1997
Supported by Maltar, A.A., 2005
How about a Challenge?

Monkey study:
- Press lever to avoid shock, then added a sound to recognize tone to avoid shock
  1) Any tone- press lever
  2) A tone in a specific range- press lever ***
  3) Specific tone- press lever
- *** Area of cortex to process sound increased, but not when the task increased in unsuccessful range

Kleim, J.A., 2014

Challenge

Monkey study:
- Really easy - No change in cortical structure
- Really hard – No change in cortical structure
- “Sweet Spot”- Change in cortical structure
  “Just Right Challenge”

Kleim, J.A. 2014
Shumway-Cook, A., Woollacott, M.H., 2001

Challenge/Summary

Reaching Intervention.mp4
Motor Practice: Cortical Changes in Mapping

Monkey Study:

Day 1: Maps got larger - 400 reps, rested
Day 3: Maps were smaller but with training increased again with 2,000 reps
Day 8: Maps stayed large - total 6,000 reps

* Day 3-8 is when they maxed out
* Healthy brain reorganized in 8 days due to repetition
* May help us to determine LOS and intensity
(Kleim, 2014)

Strength Practice


• Spaghetti pieces – tested for amount of spaghetti strands they could break off
  • 4-5 pieces = 1 Rep Max
  • Practiced 10 sets of 10: 4X/day X 4 weeks
  • Increased to breaking off 13 strands

Strength training: no change in cortical mapping, but increased blood vessels

Strength Training

• 15 articles reviewed - Level I research
  • All provided evidence regarding effectiveness of strength/exercise
    • UE function (11/15)
    • Balance & mobility (8/11)
    • Improved activity/participation (11/13)

Nilsen, DJM, et al 2015
Conditions of Practice

- Distributed versus Massed
- Random versus Block
- Variable versus Constant
- Specific versus contrived/simulated

Distribution versus Massed

Describes sequence of practice & rest times

- Distributed Practice: Rest time between trials is equal to or greater than practice time
  - 10 seconds practice to 10 second or > rest time

- Massed Practice: Rest time between trials is less than practice time

Meta-analysis reviewed 116 studies—distributed practice = better performance during acquisition & better retention
- Better performance during acquisition is believed to be due to resting from fatigue
- Better retention may be better due to ability to intrinsically integrate the information and reminisce on the performance.

Distribution versus Massed

Considerations

• Patient can not have as many practice trials with distributed if the treatment time is limited (30 min session)
• When there is limited time, massed practice allows for more practice.
• If fatigue doesn’t occur, massed practice may be better

Random vs. Blocked Practice

• Blocked: Practicing one task repeatedly, then moving on to the next task.
  
  TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
Constant vs. Variable Practice

- **Constant**: Practicing one variation of one task
  - Example: Sit to stand from the same wheelchair

- **Variable**: Practicing multiple variations of one task
  - Example: Sit to stand from many surfaces

Constant vs. Variable Practice

- **Constant**: Best for individuals with Alzheimer's Disease or cognitive deficits. (Dick, 2003)

  - Best for children learning skills even more than adults. (Shapiro and Schmidt, 1989)

What it takes to be an expert?

- 3 million cigars to be an expert at age 60's
- 1.6 million bats hit
- 750,000 pitches

(Mark, J. 2014)
Repetitions

• Repetition alone, without usefulness or meaning in terms of function, is not enough to produce increased motor cortical representations
• Consider circuit training- stations set up in the clinic
• Inform patients how the activity will help to achieve the goal

Bayona et al, (2005)

Post Test

Summary

• Practice is necessary for learning motor skills
• Retention improves with practice and challenging tasks
• Adjuncts to “traditional therapy”
  • Mental practice
  • Visual observation
  • Mirror therapy
• Knowing the goal and components is critical
• Keep the “just right challenge” in mind
• Implement evidence based into your practice
• Keep the tasks functional
References

References


