Motor Learning

- How people learn and relearn movement skills.
- Key principles of Neural Plasticity emphasized¹
  1. Salience
  2. Intensity
  3. Specificity
- Emerging findings in the field of motor learning. Accelerated Skill Acquisition Program (ASAP)²
  - A patient centered program incorporating Skill, Capacity and Motivation

Optimizing performance through intrinsic motivation and learning.³

The OPTIMAL theory of motor learning:
  1. Autonomy
  2. Enhanced Expectations
  3. External Focus

Knowledge Translation

Knowledge Translation: Active process that facilitates the introduction of new evidence into practice and may identify optimum strategies to close the gap between the research and clinical practice.⁵

Knowledge Broker: Facilitate collaborative knowledge exchange working with stakeholders to enhance capacity to access and apply knowledge.⁵
MOTIVATION

SALIENCE
The nature of the training experience dictates the nature of the plasticity. The activity has significance. Utilize intrinsic drive to facilitate active participation.

Self Efficacy
An individual’s belief in his or her ability to achieve goals. An important predictor of behavior.

Autonomy
The need to actively participate in determining one’s own behavior

**Motivation can be positively influenced by levels of enjoyment and engagement**

<table>
<thead>
<tr>
<th>Salience</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you want to accomplish in therapy?</td>
</tr>
<tr>
<td>What are your top three goals?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self Efficacy</th>
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</thead>
<tbody>
<tr>
<td>How many times can you do this before you lose quality?</td>
</tr>
<tr>
<td>Are you ready to make it harder?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Autonomy Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which activities do you choose for the circuit?</td>
</tr>
<tr>
<td>How could we increase the balance challenge?</td>
</tr>
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</table>

Goal: Complete EMT training post-TBI  
Goal: Wanting to be able to stand on the dock and fish
INTENSITY

Challenge Point Framework
Manipulation of conditions of practice to modify task difficulty. Theoretical framework for the progression of functional task training. The learner is actively involved in problem solving.

**PHYSIOLOGIC** (Aerobic/Strengthening): Task specific HIIT/Circuit and impairment mitigation focusing on strengthening

**NEUROMUSCULAR**: Error Augmentation

**MONITOR INTENSITY**
*Fairly Light* - **Hard** - **Very Hard**

**Optimal Challenge Point**

**HRmax** = 208 - (.7 x age)

**HRR** = **HRmax** - **HRrest**

**40% THR** = (.4**HRR**) + **HRrest**
**ATTENTION**

**Knowledge of Performance:** feedback regarding the *quality of the movement* during a task.

**Knowledge of Results:** feedback regarding the learner’s success in *meeting the task-specific goal.*

**Providing specific results can improve outcomes**

**External Focus:** Attention is directed at the movement *effect* as compared to attention focused on *one’s body movement.*

**External focus facilitates production of effective and efficient movements patterns**

- Avoid references to body movement and maintain focus on the goal
- Rhythmic Auditory Stepping, Counting steps out loud, Focus on external measurement

<table>
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<tr>
<th>Date</th>
<th>Outcome Measure</th>
<th>Fitness Tracker intervention</th>
<th>Steps/day</th>
</tr>
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<td>May 2018</td>
<td>10m walk: <em>0.25 m/s</em></td>
<td>No</td>
<td>&lt; 1,500 (estimated)</td>
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<td>10m walk: <em>0.43 m/s</em></td>
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</table>

**Change in Behavior**

Patient initiating walks with his wife, going to the YMCA, doing chores at home.

**Clinical Outcome**

Meaningful difference in gait speed, improved endurance, patient organizing “Fitbit” challenges amongst his friends in his support group!

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**Example of Step Activity Monitoring**

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**Example of Outcome Measure Chart for KR**

<table>
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<tr>
<th>DATE</th>
<th>30 Sec Sit to Stand</th>
<th>Gait Speed in m/s</th>
<th>2MWT</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/24</td>
<td>Assist of left UE and feet in stride left foot back</td>
<td>Unable to walk without assist – officially 0m/s</td>
<td>Unable to perform</td>
</tr>
<tr>
<td>9/25</td>
<td>Assist of left UE and feet in stride left foot back</td>
<td>Amb 10’ min. assist with SBQC</td>
<td>Unable to perform</td>
</tr>
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**Walking Speed to Use for KR**

SUMMARY

Many aspects and theories drive motor learning.

Understand the underlying impairments that have the biggest impact on your patient.

Stay focused on adjusting the M.I.A. of the session to improve patient outcomes.

Always re-evaluate after each intervention to assess benefit and adjust when needed.

Include your patients in decision-making and Have Fun!

NOTES FROM CASES
REFERENCES


General References from Presentation

MOTIVATION

Can I proactively build up sense of choice and patient control?
“How many times do you think you need to do this to increase your confidence?”

Can I include patient in decision making?
“How can we increase the intensity?”

INTENSITY

What conditions could I adjust?
Speed, Weighted vest, Circuit training, High intensity interval training. *Monitor HR*

What other ways can I add a challenge? Eyes closed, Dual task – cognitive/visual/auditory (singing, words start with K, etc).

ATTENTION

Which outcome measure results could I share with my patient?
Gait speed, timed sit to stand, etc

Could I adjust feedback to utilize an external focus?
Counting steps with walking instead of cueing to take a bigger step.
Summary of Motor Learning Research:
- In primates with a focal ischemic infarct, functional reorganization of the undamaged motor cortex was accompanied by behavioral recovery of skilled hand function.
- Rehabilitative training can shape subsequent reorganization in the adjacent intact cortex.

- Repetitive motor activity alone does not produce functional reorganization of cortical maps.
- Motor skill acquisition, or motor learning, is a prerequisite factor in driving representational plasticity in M1.

- Neuroscience research has made significant advances in understanding experience-dependent neural plasticity, and these findings are beginning to be integrated with research on the degenerative and regenerative effects of brain damage.
- This article identifies 10 principles of experience-dependent neural plasticity and considerations in applying them to the damaged brain.

- The ASAP approach emphasizes integration from a broad set of scientific lines of inquiry including motor learning, neuroscience, and psychological science of behavior change.
- Three overlapping essential elements: skill acquisition, impairment mitigation, and motivational elements, are integrated.

- Describes the effects of practice conditions in motor learning (contextual interference, knowledge of results) within the constraints of performer skill level and task difficulty.
- Proposes that learning is related to the information arising from performance, which should be optimized depending on the skill of the performer and the difficulty of the task.
- Suggests that motivational and attentional factors contribute to performance and learning by strengthening the coupling of goals to actions.
- Focuses on research regarding condition that enhance expectancies, influence autonomy support, and direct an external focus of attention.

- Behavioral research distinguishes the immediate performance that accompanies practice and long-term performance that reflects permanence in the practiced skill.
- Practice performance may not reflect long-term retention.

- Physical therapists use a great variety of motor learning options in their treatment sessions.
- Despite differences in their patient’s abilities, the therapists consistently used the clinical reasoning process of reflection and reassessment to determine their motor learning strategy.

**Motivation:**
- 59 subjects post-stroke completed performance assessments (SS gait speed, 6MWT, TUG, Berg Balance Scale, FGA, Walk 12, ABC), activity assessments (Step Watch Activity Monitoring (SAM)), and participation assessments (Stroke Impact Scale-Participation).
- Self-efficacy mediates the relationship between performance and activity and participation post stroke, reinforcing that activity and participation are more complicated than just targeting performance.

- 16 individuals post-stroke completed a 4-week goal centered activity monitoring program with a Step Activity Monitor (SAM).
- Identifying and developing strategies to overcome perceived barriers may be critical for success in improving “real world” walking activity.
- Persons with PD completed a task with a stabilometer. One group was provided a choice in when they could use a balance pole, the other group was told when they were allowed to use the balance pole.
- The group with autonomy support demonstrated improved learning compared to the group without autonomy support.

- Participants completed a spatiotemporal motor task in either a task-relevant choice group (feedback schedule) or a task-irrelevant choice group (armband color).
- Results showed significantly greater learning in the task relevant group compared to the task irrelevant and no choice groups.

- Participants completed 40 trials of 4, six-step stepping sequences in a random order.
- Each sequence offered different amounts of choice opportunities about the next step via visual cues (4 choices; 1 choice; gradually increasing choices, and gradually decreasing choices).
- Errorless learning enhances retention, autonomy supportive practice enhances retention, increasing error opportunities combined with autonomy supportive practice enhances retention.

**Intensity:**
- HR and accelerometer data was measured for 7 consecutive days, 24hr/day on the second week and the last week of admission.
- During PT, 61.6% of time was spent sedentary, and in OT 76.8% of time was spent sedentary.
- Overall, 86.9% of waking hours were spent sedentary.

- 88% of respondents agreed that aerobic exercise should be incorporated into stroke rehabilitation, but 84% perceived at least 1 barrier.
- Perceived identified barriers include: limited ability to exercise at training level (71.6%), balance impairments (69.1%), cognitive/perceptual impairments (67.9%), short length of stay (79.0%), lack of exercise equipment (51.9%), and lack of time (45.7%).
- A descriptive, longitudinal study with heart rate and activity monitoring of PT and OT sessions in an acute inpatient stroke unit at biweekly intervals, 2 to 14 weeks post stroke.
- Time per PT session in target heart rate zone was low (2.8 min) and per OT session was negligible (0.7 min).

- Literature review indicates HIIT has emerged as a potentially effective alternative to moderate-intensity continuous exercise.
- Preliminary evidence from 10 studies report HIIT associated improvements in functional, cardiovascular, and neuroplasticity outcomes post stroke.

- Similar to the cardiovascular system, skeletal muscle requires a workload of ~60% of maximum available strength (1RM) to increase in strength.

- Tested the hypothesis that the relative effort to execute ADLs is higher in older adults compared to younger adults.
- For healthy older adults, the difficulty with performing ADLs may be that they are working at a higher level of relative effort compared to their maximum capability than the absolute functional demands imposed by the task.

- Four people with chronic stroke participated in 4 weeks of multidirectional stepping reaction training.
- Participants demonstrated improved community-level walking balance, as determined by the Community Balance and Mobility Scale.

- Adaptation is defined in this article as the process of adjusting a movement to new demands through trial and error practice; motor adaptation is a short-term learning process.
- Locomotor adaptation training research via split-belt treadmills and limb weighting shows that adults with chronic stroke are capable of improving weight-bearing and spatiotemporal symmetry, at least temporarily.

- This systematic review indicates that perturbation based balance training appears to reduce fall risk among older adults and individuals with Parkinson’s disease.

- The most practical methods in clinical settings might be treadmill-based systems and therapist-added perturbations. Multiple perturbation types and multiple directions might be of most benefit.
- Perturbation based training appears to be a feasible and effective approach to falls reduction among older adults in clinical settings.

Attention:
- Two groups of individuals with stroke in inpatient rehabilitation: one group was provided daily reinforcement of speed feedback after a daily 10m walk, and another group was provided no reinforcement of speed.
- Daily feedback regarding gait speed produced gains in walking speed large enough to permit unlimited, slow community ambulation at discharge from inpatient rehabilitation.

- A recent CPG identifying a core set of outcome measures for clinical practice
- Outcome measures identified includes: Berg Balance Scale, ABC scale, FGA, 6 minute walk test, 10 meter walk test, and the 5 times sit to stand.

- The effectiveness and efficiency of motor skill performance is affected by the individual’s focus of attention.
- An external focus on the movement effect appears to reduce mental effort.
- Movements are executed faster with an external focus, presumably as a result of greater fluidity and smoothness in movement production.

- Participants performed a jump and reach task under external focus (focus on the rungs of the measurement device) or internal focus (focus on the fingers with which the rungs were to be touched).
- Jump height was greater with those with an external focus, and EMG activity was generally lower with an external focus.

**Michael Case Study:**

- Multi-center, randomized, controlled, single-blind study to test the feasibility of using high intensity exercise to modify symptoms of PD.
- Assigning participants into usual care (wait list controls), moderate intensity exercise (4 days/week at 60-65% HR max), or high intensity exercise (4 days/week at 80-85% HRmax).
- The goals of this Phase II study are to determine if participants can exercise at moderate and high intensities; to determine if exercise yields benefits consistent with meaningful clinical change; and to document safety and attrition.


- 11 participants with PD completed 42 trials in one session of perturbations on a platform that oscillated forwards and backwards with variable amplitude and constant frequency.
- Participants with PD demonstrated retention and improvement of automatic postural responses with practice.

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