If you are viewing this course as a recorded course after the live webinar, you can use the scroll bar at the bottom of the player window to pause and navigate the course.

This handout is for reference only. Non-essential images have been removed for your convenience. Any links included in the handout are current at the time of the live webinar, but are subject to change and may not be current at a later date.

No part of the materials available through the continued.com site may be copied, photocopied, reproduced, translated or reduced to any electronic medium or machine-readable form, in whole or in part, without prior written consent of continued.com, LLC. Any other reproduction in any form without such written permission is prohibited. All materials contained on this site are protected by United States copyright law and may not be reproduced, distributed, transmitted, displayed, published or broadcast without the prior written permission of continued.com, LLC. Users must not access or use for any commercial purposes any part of the site or any services or materials available through the site.
Technical issues with the Recording?

- Clear browser cache using these instructions
- Switch to another browser
- Use a hardwired Internet connection
- Restart your computer/device

Still having issues?

- Call 866-782-6258 (M-F, 8 AM-8 PM ET)
- Email customerservice@PhysicalTherapy.com
Factors which Influence Motor Learning - Merging Psychological and Movement Science Evidence into Practice

Jill Seale, PT, PhD, NCS

Learning Outcomes

After this course, participants will be able to:

- Define the basic motor learning principles of practice and feedback.
- Identify at least two psychological or cognitive variables that impact motor learning, including autonomy support, attentional focus, and expectancies.
- Identify at least four principles necessary for effective practice in persons with neurological injury, with a focus on the perspectives of cognitive, psychological, and social sciences.
- Identify at least three evidence-based models of motor learning, including the psychological and cognitive factors.
- List at least five treatment strategies that incorporate psychological and cognitive variables into practice conditions in order to enhance motor learning and outcomes.
Motor Learning Defined

- Acquisition and/or modification of movement
- After injury, reacquisition of movement skills lost
- Processes associated with practice or experience leading to permanent changes in skill
Concepts of Motor Learning

- **Process** of acquiring capability for skill
- Results from **experience** or **practice**
- Can’t be directly measured; **inferred** from behavior
  - Typically measured by delayed retention (or transfer) tests
    - Winstein & Schmidt, 1990
- Produces relatively **permanent** changes in behavior
  - Schmidt & Lee, 2011
- Learning can only be assumed to have taken place when patient can perform task effectively and without thinking about it in a variety of circumstances and contexts
  - Carr and Shepherd, 1982

Motor Learning Emerges from…

Newell, 1991
The “Familiar” Factors in Motor Learning

- Practice Levels
  - “Most important factor in retraining motor skills is amount of practice”

- Feedback
  - Intrinsic
  - Extrinsic
    - Knowledge of Results (versus Knowledge of Performance)
    - Shumway-Cook A, Woollacott MH, Motor Control – Translating Research into Clinical Practice, 2017

Guidance Hypothesis

- Information provided via feedback guides learner to correct movement, improving performance during practice; frequent feedback has negative effect
  - Salmoni et al, 1984

- Schmidt, 1991 predicts that properties of augmented feedback are beneficial for motor learning when used to reduced error, but detrimental when relied upon
Support of Guidance Hypothesis

- Study by Weinstein in 1994
  - 2 feedback types (presentation, KR), 2 feedback frequencies (high, fade)
  - High frequency physical guidance: poorest retention
  - Both high frequency feedback conditions resulted in least accuracy in transfer
- F/U study with patients with stroke, 1995 – SAME RESULTS

The “Familiar” Factors in Motor Learning

- Practice Conditions
  - Massed v Distributed
  - Constant v Variable
  - Random v Blocked
    - Contextual Interference
  - Whole v Part
  - Transfer
  - Mental Practice
  - Guidance v Discovery Learning
Complex skill versus simple skill learning

- Situations of low processing demands
  - Benefit from practice that increases load and challenge
- Extremely high load conditions
  - Benefit from conditions that reduce load to more manageable levels
- More feedback may be required to optimize complex skill learning
- Variables that influence mainly complex skill learning:
  - Attentional focus
  - Observational learning

How do we do that?

Newell, 1991

Manipulation of one of these?
Physical Assistance versus Physical Guidance

- Physical guidance:
  - Participant may become dependent
  - Demonstrate less effective learning once guidance is removed

- Physical Assistance:
  - Provide support for learning thereby facilitate achievement of movement goal
  - Provide more freedom for exploratory activities
  - May reduced demands to manageable level
  - May increase efficiency of learning

How do we translate to rehabilitation?
Expanding the definition of motor learning

- Not just acquisition of movement or movement pattern
- Includes the following:
  - Cognitive processes
  - Affective reactions
  - Attentional focus
- Collaborating to meet task demands

Now let’s move forward to the “less familiar”…
The cognitive/psychological factors which influence motor learning.
Motivational and Attentional Effects on Performance and Learning

- Motivation
  - Enhanced Expectancies
  - Autonomy
- Attention
  - External Focus

Motivational Effects of Feedback on Motor Learning

MOTIVATION
Motivational Function of Feedback

- Motivational properties DIRECTLY impacts affect learning
- “thought to energize task interest and encourage continued effort, persistence and attention to goal accomplishment through evidence of performance progress”

Autonomy Support and Enhanced Expectancies

- Autonomy
  - Increases motivation, performance, and learning
  - Mediated by self efficacy

- Expectancies
  - Focus on positive feedback
  - Has positive effect on self efficacy
    - Sanli et al 2013; Wulf, 2007; Wulf et al 2012
Enhanced Expectancies

- Warn and prepare for further positive outcomes, impact cognitive, emotional and motor preparatory activity
- Influence goal setting and increase positive affect
- Buffer against responses that would detract from optimal performance
- Couple goals with desired outcomes
When do you provide feedback?

- After relatively good trials OR relatively poor trials?
- When feedback provided after good trials:
  - More effective learning
  - Intrinsic motivation higher
  - Perceived competence higher
  - Greater self-confidence and arousal management
  - Suggests feedback that emphasizes good performance over poor performance
    - May increase motivation to persist
    - Facilitate learning process and greater automaticity
      - Badami R et al, Res Q Ex Sport, 2012; Badami et al, Res Q Ex Sport, 2011.

Autonomy
Autonomy and some related terms

- **Autonomy**
  - To act following own beliefs and values while exercising some control over some aspect of environment
  - Self-control

- **Competence**
  - Ability to do something successfully or efficiently

- **Autonomy + competence: essential for psychological growth and well-being**

Autonomy Support

- Facilitate learning indirectly by enhancing expectancies
- Role of autonomy for triggering switches between neural networks needed for given task success (efficient goal-action coupling)
- Perception that actions have effects on environment important for motivation
- Heighten sense of personal agency and personal expectations for positive outcomes
Self-Efficacy

- Self-efficacy
  - Belief in your competence to produce certain tasks
  - Degree to which one believes in his own self-efficacy:
    - Affects quality of cognitive, affective and decisional processes
    - Impacts motivation
    - Impacts intention to persist

But what kind of choice?

- Can be something incidental to task
  - Ball color in golf or throwing tasks
- Can be task-relevant
  - Delivery of feedback
  - Frequency of skill demonstrations
  - Use of assistive devices
  - Practice schedules
  - Other practice conditions
Are all choices equal?

- Task-relevant and task-irrelevant choices not equally beneficial for motor skill learning
- Choices should be directly related to task attempting to learn
  - Feedback
  - Repetition schedule
  - Task difficulty
  - Modeled demonstrations
- Challenges idea that motivation is root cause for learning advantages
- Suggests that learning advantage mechanism influenced by informational factors, associated with task-related processing activities such as error-estimation

Social-Comparative Feedback

- Giving learners opportunity to decide after which trials they want to receive feedback enhances learning
- Learners in control of feedback preferred feedback after (perceived) successful trial
- Giving feedback after trials of good performance resulted in more effective learning than when feedback given after poor trials
- Favorable normative comparisons increase self-efficacy, positive self-reactions and task interest AND enhanced learning
- Negative normative feedback and no normative feedback resulted in similar levels of learning
  - Lewthwaite R, Wulf G, Q J Exp Psychol, 2010; additional studies summarized within paper
More on Social Comparative Feedback

- Effects of normative feedback fast acting, almost immediate
- Led to different degrees of skill learning
  - Qualitative differences in control of movement
  - More automatic movement adjustments
- Conviction of being “good” or “poor” influenced performance
- “better group” found feedback more useful, compared with “worse group”
- Even those in “worse group” more automatic in movements compared to control

How does this work?

- Link between motivational manipulations to modulation of motor learning
- Positive affect linked to dopamine processing that supports sequence learning
- Negative affect may increase need for reallocation of attentional resources to self-regulatory efforts at thought or affect suppression or substitution
- Negative affect may decrease or interfere with memory processing
Link to Focus of Attention

- Adoption of more **self-related** focus of attention
- Constrain motor system... compromise ability to maintain steady posture
- Result in degradation of learning

More on this later!

Self-Controlled Practice and Feedback

- Allowing learners control over:
  - Delivery of feedback
  - Use of physical assistive device
  - Presentation of movement demonstrations
- Enhances learning compared with external control
- Possible mechanisms:
  - Enhances motivation
  - Results in deeper info processing
  - Equates to improved retention and transfer
Self-Controlled Practice and Feedback

- Autonomy protects perceptions of competence/enhances motor learning
  - Choosing when to receive feedback resulted in higher levels of self-efficacy and end of practice AND superior motor learning on retention
    - Chiviacowsky S, Psychol Sport Ex, 2014
  - Benefits of self-controlled learning can be prevented by depriving learners opportunity of experiencing competence through good performance

However… regarding self-controlled learning AND competence

- Both the group that received high perceived competence/self-controlled feedback AND the group that received only self-controlled feedback experienced higher self-efficacy, performed with greater accuracy, and less variability.
- Lower perceived competence has negative effect, higher perceived competence + self-controlled... may not be necessary (or may have additive effect?)
- Maybe autonomy support is enough by itself to boost perceived competence/self-efficacy and learning
Focus of Attention

- Focus of attention – External v. Internal
  - External: focus on effects of one’s movements have on environment
  - Internal: focus on body movements
- Feedback promoting external focus:
  - Enhances performance AND learning
  - Promote automaticity
- Frequent feedback with external focus does not negatively impact learning/retention
  - Wulf et al, 2010
External Attentional Focus

- Duel role:
  - Directs attention to task goal
  - Reduces focus on self

- External focus on primary task – connects goals to actions

- Contributes to success which... Enhances Outcomes!

Results of External Focus

- Increased accuracy of task
- Lower EMG activity
  - Enhanced movement economy
    - More effective coordination between agonist and antagonist muscle groups
    - More discriminate motor unit recruitment
  - Reduction of "noise" in motor system
  - EMG affects "spread" to muscle groups not in performer's focus of attention
    - Internal focus may constrain no only body part focused on, but perhaps even who motor system
But why?

- Constrained action hypothesis
  - Conscious attempt to control movements with internal focus
  - Results in constraint on motor system and disruption of automatic control processes
  - Focus on movement effect (external focus) allows unconscious, automatic processes to control movement
    - More effective performance and learning

Distance between action and its effect

- Focus on more distant effects enhances learning
  - Promotes utilization of more natural control mechanism
  - Mediated by automatic control processes
- Focus on proximal effects results in performance and learning decrements
  - Constrains regulation of control processes
External Focus – Always Superior?

- Effects of Attentional Focus on UE Training in Chronic Stroke
  - Subjects with moderate to severe UE impairment
  - 4 wk training using robotic device
  - No differences in retention comparing external to internal focus
  - “Dosage and practice appear to be pivotal”
    - Kim et al, Arch Phys Med Rehabil, 2017

Wulf, G. APTA CSM, 2014
Triple Play

- **Enhanced Expectancies**
- **External Attentional Focus**

Motor Learning

- **Autonomy Support**

Additive Effect

- Combination of 2 of these factors enhanced learning, relative to presence of only 1

- Practice that incorporated all 3 factors resulted in more effective learning than did all other conditions that included only 2 factors

- The 3 conditions that included 2 factors produced similar learning effects regardless of which factors were included
OPTIMAL Theory of Motor Learning

- Optimizing Performance Through Intrinsic Motivation and Attention for Learning
- Motivational and attentional factors contribute to performance and learning by strengthening the coupling of goals to actions
- Enhanced expectancies and an external focus propel performers’ cognitive and motor systems in productive “forward” directions and prevent “backsliding” into self- and non-task focused states

Accelerated Skill Acquisition Program (ASAP)

- Three overlapping essential elements—skill acquisition, impairment mitigation, and motivational enhancements—are integrated
- 8 principles
  - Ensure challenging and meaningful practice
  - Enhance capacity through overload and specificity
  - Preserve natural goal-directedness of movement organization
  - Drive task-specific self-confidence HIGH through performance accomplishments
    - Weinstein C et al, JNPT, 2014
Going a little off topic....

The power of observation

- Viable method of practicing complex motor skills
  - More to see and be extracted from observation of complex task
  - Offers opportunity to engage in processing that could not occur in early practice
  - Providing observational practice during rest intervals increases training efficiency

- Observation of other learners performing increases training efficiency
Combining Action Observation and Motor Imagery

- Motor imagery: cognitive process in which subject imagines performance of movement without action
- Action observation: observation of actions performed by others
- BOTH **activate same neural structures** responsible for actual execution the action
- Evidence that concurrent AO+MI:
  - Elicits increased activity in motor regions
  - More direct impact on motor outcomes

AO + MI Example

- Effect on balance training
- 3 groups of participants (healthy)
  - MI (imagined postural exercises)
  - AO+MI (observed videos of performance of postural exercises AND imagined being person in video)
  - CON (non-active control)
- Stand without perturbation and during perturbed stance
- Post exam: significantly decreased postural sway in both active groups
Three Cheers for Your Patients:
Why Celebrating Therapy Gains is So Important
WebPT

https://www.webpt.com/blog/post/three-cheers-for-your-patients-why-celebrating-therapy-gains-is-so-important

Three Cheers

- Lack of engagement and connection
- Their solution – CELEBRATE therapy wins
- Positive reinforcement over negative to change behavior (and make it stick)
- Generic praise is NOT enough
- Need true engagement
- How do you foster true engagement?
- How do you celebrate?
Patient-Centered Care

- The IOM (Institute of Medicine) defines patient-centered care as: “Providing care that is respectful of, and responsive to, individual patient preferences, needs and values, and ensuring that patient values guide all clinical decisions.” May 15, 2015

People First Language

- What does that mean?
- Maybe easier to define what it is not!
People First Language

- Our words and the meanings we attach to them create attitudes, drive social policies and laws, influence our feelings and decisions, and affect people's daily lives and more. How we use them makes a difference. People First Language puts the person before the disability, and describes what a person has, not who a person is. Using a diagnosis as a defining characteristic reflects prejudice, and also robs the person of the opportunity to define him/herself.
  - https://www.thearc.org/who-we-are/media-center/people-first-language

Picker’s 8 Principles of Patient Centered Care

- Respect for patient’s preferences
- Coordination and integration of care
- Information and education
- Physical comfort
- Emotional support
- Involvement of family and friends
- Continuity and transition
- Access to care
  - Principles of Patient-Centered Care. Available at: http://pickerinstitute.org/about/picker-principles/
Patient-Centered Goal Setting

- Patient-centered goal setting is primary way of enhancing patient centeredness
- Improves outcomes and satisfaction
- Recommended and/or required in practice
- Highly personal
- Can be critical for motivation

Is this really happening?

One study from inpatient stroke rehabilitation:
- Privileging of certain goals and unknown nature of engaging patients and families in goal setting
- Despite having a process of identifying pt/family goals, clinicians not really patient-centered in their selection of goals to address
- Other factors exist that compete with and limit our capacity to be patient-centered
- “Rarely straightforward translation of patient wishes into agree-upon written goals”
  - Levack WMM et al, Patient Education and Counseling, 2011
“Only the patient can make the decision that a goal is worth working for.”
-Payton et al

Common Themes….

- Goals to action coupling
Putting it all together with patient cases

Video One
Bob is a 60 year old male who was extremely fit, but still had a hemorrhagic stroke 6 months ago. He was left with very dense hemiplegia of his R UE and LE extremity, and significant expressive aphasia.

Strength in his lower extremity has improved to grossly 3-3+ proximally (except quads which are 4) and 2-3s distally.

Gait speed is slow (.5 m/sec), ambulating with R AFO and walking stick; typical pattern

Goals: walk without AFO and device, return to typical household chore caring for yard and pool, return to cycling and running
How can you utilize tools from course to....

- Increase gait speed?
- Structure next session where you hope to address challenge gait in terms of balance, divided attention, degree of intensity?
- Increase activation and strength of proximal musculature?
- Progress toward patient’s goals?

Questions?

- jseale27@sbcglobal.net