Motor learning in pediatric rehabilitation: theory, research, and practice

AACPDM 2017: Breakfast Seminar
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Learning objectives

• To understand motor learning (ML) theory
• To become up-to-date on ML evidence and current ML research in pediatric rehabilitation
• To understand and increase the application of ML approaches in clinical practice.
Overview

• Theory and evidence
  – Motor learning strategies
  – Evidence relevant to pediatric rehabilitation
• Research
  – Current projects from Australia and Canada
• Practice
  – Clinical application
• Case studies
  – Interactive discussion

Definitions

Motor control
• The study of reflexive and voluntary movements that control human and animal movement
• The ability to regulate or direct the mechanisms essential to movement
  
Shumway-Cook & Woolacott 2012

Motor learning
• Aspect of motor control concerned with the acquisition (or re-acquisition) of novel action or movement
• Set of processes associated with practice leading to a relatively permanent change in the capacity for skilled action

Zwicker & Harris 2009
Theories of motor behaviour

Therapy practices are based on assumptions derived from theories

1. Reflex theory
2. Hierarchical theory
3. Motor programming theories
4. Dynamic systems theory

Zwicker & Harris 2009, Shumway-Cook & Woollacott 2012

Dynamic systems theory

- Movement emerges from the interaction of multiple elements that self-organised based on certain dynamic properties of the elements themselves
- Elements are within task, environment and the individual

Movement involves
- Action
- Perception
- Cognition

Bernstein 1967, Thelen & Smith 2007, Zwicker & Harris 2009
Considerations for ML

Implicit learning
• “Learning which progresses with no or minimal increase in verbal knowledge of movement performance..and without awareness”

Explicit learning
• “Learning which generates verbal knowledge of movement performance..involves cognitive stages within the learning process and is dependent on working memory involvement”

Stages of skill acquisition
• Cognitive → associative → autonomous

Motor Learning Variables

Grounded in theory and evidence, they are the building blocks of motor learning strategies

(Levac, 2011)

• How a therapist operationalizes motor learning

• Includes frequency, type, duration, intensity, practice schedule
Motor Learning Principles

Evidence-based statements guiding motor learning variable manipulation

(Levac, 2011)

- What does the research say about the manipulation of a ML variable in a specific clinical population?
- Can ML research findings in other populations be applied in paediatric neuromotor populations? (re: acquisition, retention, transfer, generalization of motor skills)

Motor Learning Strategies

The observable therapeutic actions involving selection, manipulation, application of motor learning variables according to client- and task-specific factors with consideration of motor learning principles to promote motor learning

(Levac, 2011)

- The result of clinical decision-making
- Client-specific factors
- Task-specific factors
Stop and think
Pair and share

- To what extent does ML contribute to therapeutic interventions?
- Are there any client-specific factors that influence your selection of MLS?
- Are you confident you are maximising MLS in your practice?

Evidence in pediatric rehabilitation

- Upper limb approaches with ML elements (CP)

<table>
<thead>
<tr>
<th>Bimanual upper limb intervention</th>
<th>Constraint Induced Movement Therapy</th>
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<tbody>
<tr>
<td>Goal directed, carefully chosen, intensive repetitive practice of tasks</td>
<td>Constraining affected upper limb</td>
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<tr>
<td>Use of objects to provoke actions through perceptual skills</td>
<td>Intensive practice</td>
</tr>
<tr>
<td>Strong evidence across ages</td>
<td>Implicit &gt; explicit learning</td>
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<tr>
<td></td>
<td>Strong evidence in older &gt; younger children</td>
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Hoare and Greaves 2017
Evidence in pediatric rehabilitation

• Gross motor approaches with ML elements
  —Functional therapy Ketelaar et al 2001
  —Motor learning coaching Bar-Haim et al 2010
  —Hand and arm bimanual intensive therapy including lower extremity (HABIT-ILE) Bleyenheuft et al 2015

• General approaches
  —Cognitive Orientation to Occupational Performance (DCD) Polatjko et al 2001
  —Neuromotor task training (DCD) Niemeijer et al 2007
  —Activity-based therapy Lowing et al 2009, Valvano 2004
  —Goal-directed training Mastos et al 2007, Lowing et al 2009

ML in gross motor skills training
ML in gross motor skills training

<table>
<thead>
<tr>
<th>Bike skills training in children with cerebral palsy (CP)</th>
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<tr>
<td>- Melbourne, Victoria, Australia</td>
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<tr>
<td>- Assessor blind multisite RCT (n = 60)</td>
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<tr>
<td>- Key inclusion criteria</td>
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<tr>
<td>- CP, GMFCS I-II, ages 6 - 15</td>
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<tr>
<td>- Goals around training two-wheel bike skills</td>
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<tr>
<td>- Outcomes</td>
</tr>
<tr>
<td>- Goal attainment (GAS)</td>
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<tr>
<td>- Bike skills, self-perception, physical activity, functional skills, attendance/involvement</td>
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</table>
Bike skills training intervention

Key elements:
- Task-specific
- Goal-directed
- Intensive
- Clinician-mediated
- Group-based
- Parent involvement
- Ecological setting

Bike skills training intervention

Additional motor learning elements

<table>
<thead>
<tr>
<th>What the therapist says:</th>
<th>What the therapist does:</th>
<th>Practice is:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Regular child controlled feedback - knowledge of results</td>
<td>• Observational learning</td>
<td>• Bike-specific</td>
</tr>
<tr>
<td>• Problem solving cognitive strategies</td>
<td>• Scaffolds exercise for just right challenge (task and environmental modification)</td>
<td>• Whole &gt; part</td>
</tr>
<tr>
<td>• Coaches parents/child</td>
<td>• Facilitates implicit and explicit learning</td>
<td>• Variable and consistent</td>
</tr>
<tr>
<td>• Analogy learning</td>
<td>• Physical guidance</td>
<td>• Random and blocked</td>
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<tr>
<td></td>
<td></td>
<td>• Mental imagery</td>
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<tr>
<td></td>
<td></td>
<td>• Encourages transfer</td>
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<td></td>
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<td>• Age and stage appropriate</td>
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Comparing Lokomat® Robotic Gait Training with traditional gym-based physiotherapy

- Two gait-related interventions, each using a ML approach
- Cross-over RCT (GMFCS I-IV) - Toronto, Canada
  - CoPIs V Wright & D Fehlings
- RCT (GMFCS II & III) - partnered with Edmonton and Chicago - CoPIs V Wright & L Pritchard-Wiart

Outcomes
- GMFM-66 (primary outcome), GMFM Stand/Walk, 6 MWT
- COPM and Goal Attainment Scale (GAS)

Lokomat Intervention

Key elements:
- **Goal-directed**
- Working from a menu, but *individualized* to fit Lokomat possibilities
- Encouraged to consider the whole range of ML strategies when planning each session
- **Intensive**
- **Repetitive**
Lokomat training intervention

Additional motor learning elements

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<th>What the therapist says:</th>
<th>What the therapist does:</th>
<th>Practice is:</th>
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<tbody>
<tr>
<td>• Instructions and feedback can be knowledge of performance and/or knowledge of results</td>
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<td>• Tasks are linked to everyday activities</td>
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<td>• Promotes problem-solving</td>
<td>• Physical guidance modified based on Lokomat settings</td>
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<td></td>
<td>• Practice recommended outside therapy to promote transfer of skills</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Facilitates implicit and explicit learning</td>
<td>• Whole and part</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Variable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Progressive</td>
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<tr>
<td></td>
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<td>• Random or blocked</td>
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Comparing motor learning and strength-based training: an RCT

• Children with CP (GMFCS I/II, ages 10+)
  - 16 sessions, 6-weeks of motor learning (BeFAST) or strength-based (BeSTRONG) training (A Hilderley & V Wright, Pedal with Pete funding)

• BeSTRONG’s key elements:
  • Intensive functional strength training
  • Menu-based to standardize treatment and encourage PT to avoid ML strategy use

• Outcomes:
  • Challenge (primary outcome) and COPM
Be Strong cont.

• ML strategies were, for the most part, successfully kept out of the intervention
• However, analysis of session videos showed that four ML strategies were used:
  - Encouragement*
  - Feedback on what was done well*
  - Repetition (key part of strength training)
  - Whole practice (functional strength focus)
• Some strategies* are a natural part of what we do in our interventions to maintain engagement

Practical application of motor learning strategies

Motor Learning Strategies Rating Instrument (MLSRI-20)

—Outcome measure
—Rates the extent to which 20 different MLS are used within a video-recorded treatment session
—Comparison between treatment sessions, treatment approaches, therapists, and/or children
—Self-reflection
Using MLSRI-20 to plan practice

1. Organization of the Session
   = “Practice Is”

1. Therapist Actions
   = “What the Therapist DOES”

1. Therapist Verbalizations
   = “What the Therapist SAYS”

*refer to handout for list of 20 MLS

More on planning your session...

Child’s Characteristics
   – Interests
   – Age
   – Cognitive abilities, learning style, etc...

Goals
   – Child and family
   – For each therapy session

Task
   – Environment
   – Equipment
   – Therapeutic modalities
Stop and think

• What factors influence your MLS selection?

Case discussion

Laurie
13-year old female
CP, Spastic diplegia
GMFCS II

Goal: To ride a two-wheeled bicycle independently with friends and family around the holiday park
Case discussion (continued)

Julian
6-year old male
CP, hemiplegia
GMFCS III

Goal: To be able to dribble a soccer ball during his adapted soccer match.

Stop and think
Pair and share

• On reflection, how can you optimize intervention through integrating motor learning in your practice?