Motor Skill Training in People with Chronic Low Back Pain: An Alternative to Traditional Therapeutic Exercise?
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Lecture Outline

Concept of Motor Skill Training and Key Principles

I. Definitions of motor learning
   A. Motor learning = the acquisition and/or modification of movement
   B. Motor learning = a set of processes associated with practice or experience leading to relatively permanent changes in the capability for producing skilled action [Shumway-Cook and Woollacot 2007]
   C. Motor learning ≠ motor performance

II. Two conceptual models of motor learning that are useful for rehabilitation practice
   A. Systems 3-stage model [Newell 1991]
      1. Stage 1 = Novice; Simplify the movement by reducing the degrees of freedom to be controlled.
      2. Stage 2 = Advanced; Increase the number of degrees of freedom that are controlled.
      3. Stage 3 = Expert; Recruit all the necessary degrees of freedom in the most efficient and coordinated way, allowing for performance optimization.
   B. Fitts and Posner 3-stage model [Fitts and Posner 1967]
      1. Cognitive stage = requires a great deal of attention to understand the nature of the task, develop strategies, and determine how to evaluate performance.
      2. Associative stage = requires a moderate amount of attention to select the best strategy and refine the skill.
      3. Autonomous stage = requires little attention to perform the skill
   C. Other relevant issues for rehabilitation are defining the goal, selecting or developing the appropriate strategies given the available ‘body’, and understanding relevant and irrelevant aspects of the environment.

III. Structuring practice and feedback to optimize learning

   A. What to practice?

<table>
<thead>
<tr>
<th>Principle</th>
<th>Insights and implementation in animal models and motor learning studies</th>
<th>Implementation in clinical practice</th>
</tr>
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</table>
   | Practice of a movement or action results in improvement in that movement or action | Animals practice functional movements  
Human studies always have people practice what is to be learned | Practice the action or task the person wants to be able to do |

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B. How much to practice?

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<tbody>
<tr>
<td>Large amounts of practice are required to truly master a motor skill</td>
<td>Animals perform 100s of repetitions daily for months</td>
<td>Large amounts of task-specific practice are likely needed</td>
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<tr>
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<td>Animal and human studies have not determined an optimal dose [amount of active ingredient, frequency, duration] for motor skill training</td>
<td>Limit rest breaks and provide encouragement to keep practicing</td>
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<td>Brain reorganization continues for a time after behavior plateaus [Lang et al. 2015]</td>
<td>Practice will be needed outside of therapy sessions</td>
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<td>Consider ways to encourage practice even after therapy services have ended</td>
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C. How to set up practice?

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<tr>
<td>Learning requires solving the motor problem, note rote repetition of over-learned tasks</td>
<td>Brain reorganization occurs with learning, not simply repetition</td>
<td>Tasks or actions should be graded to challenge the motor capabilities of the individual</td>
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<td>Progression of difficulty level is important as capabilities increase</td>
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<td>Set up the environment for continued practice and discovery learning</td>
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<tr>
<td>Variable practice conditions are optimal for learning and generalization [Ex: Hidler et al. 2009]</td>
<td>Animal models and human studies primarily are interested in a single task, under limited conditions – for the purpose of science</td>
<td>Keep the essential movement components the same, but vary the context, environment, etc.</td>
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<td>Variation can be accomplished within and across tasks</td>
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<tr>
<td>Practice of the whole action or task results in better learning than practice of parts, unless the task can be broken down into clearly separable components</td>
<td>Animal models and human learning studies practice whole actions or tasks</td>
<td>Practice the action or task the person wants to be able to do in its entirety whenever possible</td>
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<td>If the components are practiced separately, be sure to occasionally practice as a whole</td>
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D. How to keep someone interested?

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<td>Optimal learning occurs with high levels of motivation and engagement</td>
<td>Animals are food-deprived, and the task is to retrieve food, creating very high levels of motivation and engagement</td>
<td>Individuals identify goals and tasks to practice</td>
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<tr>
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<td>Remind the individual how</td>
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</table>
E. How to provide feedback?  

<table>
<thead>
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<th>Principle</th>
<th>Intrinsic vs. Extrinsic feedback</th>
<th>Implementation in clinical practice</th>
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<tbody>
<tr>
<td>Learning does not occur in the absence of feedback</td>
<td>Learning does not occur in the absence of feedback</td>
<td>Actions or tasks have clear goals so it is easy for the individual to determine success</td>
</tr>
<tr>
<td>Intrinsic feedback is optimal for promoting self-learning and generalization</td>
<td>Animals and humans have clear intrinsic feedback on each trial, e.g. did/did not eat pellet, cursor ‘explodes’</td>
<td>Solicit and develop the individual’s skill with intrinsic feedback; avoid external feedback as much as possible</td>
</tr>
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Rationale and Assessment

I. Rationale for motor skill training in people with chronic low back pain (LBP)

A. Exercise is one of the primary non-surgical approaches used worldwide for managing LBP, however, which exercise to use for which patient is still not resolved.

B. Link between improved strength, flexibility, and control and pain free performance of functional activities is unclear.

C. Primary reason people with chronic LBP return to physician is inability to perform everyday functional activities (McPhillips-Tangum et al. 1998)

D. Data to suggest importance of performance of everyday functional motor skills and adherence (Van Dillen et al. 2012)

E. Use of motor skill training as a form of exercise to improve performance of functional activities

F. Neural adaptations associated with motor skill training (Adkins et al. 2006)

G. Useful for long-term management of LBP condition

II. Assessment to Design Treatment Program

A. Self-report measures of importance
   i. Numeric pain rating scale (Jensen et al. 1994)
   ii. Patient-specific functional scale (Stratford et al. 1995)
   iii. LBP flare-ups (Von Korff 1994)
   iv. Adherence

B. Standardized examination to classify LBP condition (Van Dillen et al. 1998; Van Dillen et al. 2003; Van Dillen et al 2009)
   i. History
1. Focus on activities associated with worsening of LBP or difficult to perform due to LBP

ii. Clinical tests of movements and positions – primary tests
   1. Judgments of impairments in movement and alignment
   2. Symptoms monitored

iii. Modified tests of movements and positions – secondary tests
   1. Systematic modification of impairments in movement and alignment
   2. Symptoms monitored

iv. Classification of LBP based on responses to loading and altered movements and alignments associated with loading (Van Dillen et al. 2003; Trudelle-Jackson et al., 2007)

v. Contributing factors
   1. Sensory
   2. Muscle activity
   3. Joint extensibility/stiffness
   4. Strength

vi. Major findings

Design, Implementation, and Progression: Specific Considerations and Challenges

I. Selection of Activities
   A. Patient-selected activities will be most salient to the patient (Kleim and Jones 2008).
      i. Optimally the patient will select:
         1. Most painful activities
         2. Most frequently performed activities
      ii. Patient may select other activities based on his perception of his abilities
      iii. Patient may have difficulty identifying problematic activities. Use a list of common problematic activities to prompt him.
      iv. Assign homework for patient to identify additional activities

II. “Selling” the treatment to the patient
   A. Pt preference influences adherence to treatment (Ferreira et al, 2013).
   B. This is a new and different type of treatment
      i. Not traditional physical therapy “exercises”
      ii. Not compensatory strategies
   C. Practice of using the appropriate movement patterns and muscle activation within the context of his functional activities
      i. Skill, endurance, and strength training induce different adaptations in the nervous system. Strengthening a muscle does not ensure the patient will use that muscle when he needs it (Remple et al. 2001, Adkins et al. 2006).
      ii. Reinforce idea that functional activity will become exercise. This results in the large dose of practice required to master a motor skill (Lang et al. 2015).
      iii. Explain to patient by relating to skill acquisition in sports
         1. If you want to be a better baseball pitcher, then you would practice pitching rather than simply stretching and strengthening the shoulder.
   D. Changing the patient’s symptoms on the first visit is important for buy in:
i. If the “better” way of moving doesn’t hurt and the less optimal way does, then it helps the patient to buy in to making the change.

ii. Increased pain during treatment is associated with low adherence (Jack et al. 2010).

III. Educational Principles

A. The patients are divided into subgroups based on the Movement System Impairment classification system and education is based on the patient’s diagnosis (Sahrmann 2002).

B. Educational principles emphasize the patient’s preferred movement pattern and the contribution of this movement pattern to his problem. Example: flexion/rotation:
   i. The primary contributors to your low back pain symptoms are repeated movements and prolonged positions of bending, twisting, and side bending
   ii. Repetition of bending, twisting, and side bending movements and positions occurs across the day during all daily activities
   iii. Repetition of bending, twisting, and side bending movements and positions irritates your low back tissues, resulting in LBP symptoms
   iv. Symptoms persist or recur because you move in the same direction all day and constantly irritate your low back tissues
   v. Treatment focuses on modifying/变更 how you perform daily activities so that you don’t flex, rotate, or side bend your low back repeatedly across the day

C. Use consistent language to reinforce principles during education and training, i.e. bending and twisting

IV. Structuring Practice

A. 60 minute treatment sessions. Practice 3 activities.

B. For each task:
   i. Essential components of the task
   ii. Separable components of each task
   iii. Example: Lifting
   iv. Picking up object
      1. Stands the appropriate distance from the object
      2. Positions his feet shoulder width apart
      3. Lifts object
   v. Placing object in same or different location
      1. Positions himself the appropriate distance in front of the object
      2. Places object back in original location or moves object to a different location

<table>
<thead>
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<th>Key Principles – Based on Movement Diagnosis</th>
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<tbody>
<tr>
<td>Picking up object</td>
<td>Bend in hips, do not bend or twist low back</td>
</tr>
<tr>
<td>Placing object in same or</td>
<td>Bend in hips, do not bend or twist low back</td>
</tr>
<tr>
<td>different location</td>
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C. Make every attempt to simulate functional environment and practice in context.
   i. Placement of objects/person within the environment
   ii. Environmental constraints
iii. Temporal aspects of completing the task – achieved with scenarios (for example, practice putting purse into a drawer after walking into the office and sitting in a chair rather than taking purse in and out of a drawer)

D. Task needs to be increasingly difficult to require the patient to solve a motor problem (Perez et al. 2004) → grade tasks to make them more/less difficult

E. Example, lifting:

F. Lifting: Grading the task (least to most difficult):

vi. Object shape: small object, regularly shaped larger object with handles, irregularly shaped object

vii. Weight: light weight, heavy weight, vary weight between trials

viii. Position of object to be lifted: directly in front of patient, off midline, farther away, on a shelf, inside another object (cart/trunk of car)

1. Flexion: lower is more difficult

2. Extension: higher is more difficult

ix. Position for object to be placed: back in the same place, different place, vary between trials

x. Speed of performance: slowly, quickly, vary speed, perform at different speeds on demand

V. Cuing for appropriate movement pattern

A. Intrinsic feedback from pain will help him modify his movement pattern and contribute to retention (Kleim and Jones 2008).

i. Careful about provoking too much pain because motor learning can be hindered (Boudreau et al. 2009).

B. Hierarchy: demonstration, tactile cues, mirror, verbal cues, directive feedback to help the individual problem solve, allowing the individual to identify and then self-correct movement pattern

C. Identifying failure/success is challenging when attempting to change a movement pattern. It is more difficult for the patient to identify if his back is bending/twisting than it would be for him to know if a basketball goes through a hoop

i. Use questions to help the participant identify knowledge of results:

1. What did you notice specifically that helped you know you weren’t bending/twisting/side bending your back during that movement

D. Cuing: Grading feedback – least to most difficult

i. Visual feedback: demonstration of correct movement pattern mirror, no mirror, attending to another visual task

ii. Tactile feedback: from therapist, abdominal support/tape, no tactile feedback

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