Motor Learning:
What Is It and How to Integrate into Swallowing Management

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Lori Quinn, PT, EdD, FAPTA
Disclosures

• Michelle Troche
  Salary: Teachers College, Columbia University
  Grant support: National Institutes of Health, Michael J Fox Foundation, National Ataxia Foundation, CurePSP Foundation
  Royalties: MedBridge Inc
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• Lori Quinn
  Salary: Teachers College, Columbia University
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Overview

1. Brief introduction (Michelle)
2. Key Principles of Motor Learning and Motor Control (Lori)
3. Applying principles of motor learning and control to swallowing and cough (Michelle)
4. Promoting skill learning (Lori)
5. Application of motor skill learning to swallowing and cough training (Michelle)
6. Interactive case discussions (Lori & Michelle)
7. Questions
Motor Learning and Dysphagia Rehabilitation

Swallowing and Dysphagia Rehabilitation: Translating Principles of Neural Plasticity Into Clinically Oriented Evidence

JoAnne Robbins, Susan G. Butler, Stephanie K. Daniels, Roxann Diaz Gross, Susan Langmore, Cathy L. Lazarus, Bonnie Martin-Harris, Daniel McCabe, Nan Musson and John Rosenbek

https://doi.org/10.1044/1092-4388(2008/021)

Dysphagia (2003) 38:756-767
https://doi.org/10.1007/s00455-022-10516-3

Expanding Rehabilitation Options for Dysphagia: Skill-Based Swallowing Training

Maggie-Lee Huckabee, Ruth Flynn, Madeline Mills

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A Survey of Speech-Language Pathologists' Applications of Motor Learning Principles in Dysphagia Therapy in Adults in India

Thejaswi Dodderi, Varsha Muthukumar, Prasanna Suresh Hedge, Santosh P. V. Rai, Sheetal Raj Moolambally, Radish Kumar Balasubramanium and Mohit K J Prasanna Suresh Hedge

https://doi.org/10.1044/2023JSLHR-23-00185
Key Principles of Motor Learning and Motor Control
Active physiological mechanisms that support recovery and limit future disability.

Physical and cognitive mechanisms, including musculoskeletal linkages, control of basic movement types, ability to plan, etc.

Ability to achieve meaningful goals with consistency, flexibility, and efficiency.

Participation in necessary and desired roles including self-care, social, occupational, and recreational.

Active physiological mechanisms that support recovery and limit future disability.

Health condition (disease/disorder)

Body Structures & Functions

Activities (skills)

Participation

Disability

Participation Restriction

Activity Limitation

Impairments

Rehabilitation

Participation

Quinn & Gordon 2016
What is Skill?

- Skill is the ability to achieve a desired outcome, with
  - consistency
  - flexibility
  - efficiency
  (physical and mental)
What is Motor Skill Learning?

• The acquisition or reacquisition of motor skills
• Patients learn motor skills in order to most effectively achieve goals that are meaningful to them
• Therefore, *single most important factor* that shapes the overall process of skill acquisition is what specific TASKS the learner is challenged with

_Gentile 1985_
Stages of Motor Skill Learning

**Cognitive**
- Conveyance & Acquisition of New Information
- Trial and Error
- Verbal, Visual, Motor
- Learning Skill Objectives
- Organizing Information
- Processing Environmental Variables
- Understanding Skill

**Associative**
- Translation of Declarative Knowledge into Procedural Knowledge
- Difficult & Awkward
- Proportioceptive / Motor
- Practice Phase
- Chunking
- Eliminating Mistakes
- Improving Selective Attention Focus

**Autonomous**
- Performance
- Cognitive Demands are Minimal
- Attention Focus Can Be External
- State of Flow
- Habitual
- Ability to Self Correct
- Unconscious

Fitts & Posner 1967
Measuring Functional Outcomes Using a Skill-Based Framework

Was the goal achieved?

Consistency

- Rate of Goal Achievement (# successes/# of attempts)
- Accuracy (spatial errors, temporal errors)

Efficiency

- Time required
- Speed
- Duration
- Distance

Flexibility

- Task performance under different conditions or in different environments (open vs closed)
- Predictable vs. unpredictable conditions

Quinn & Gordon 2016
Performance vs. Learning

- **Performance**
  - Simply the acquisition of skill as indicated by initial acquisition trials

- **Learning**
  - Relatively permanent improvement in skilled behavior as indicated by the retention and transfer tests that follow a period of no practice

*Lee et al., 1991*
What are the foundations of task-specific training?

- Skill acquisition depends on active learner
- Movement is the means to an end
- Therapists are teachers of motor skills. We...
  - Select tasks for practice
  - Structure the task context and environment
  - Vary tasks
  - Progressively increase task difficulty and complexity
  - Switch to new tasks
- Primary mode of intervention is manipulation of tasks – progressions and regressions
## TASK VARIATIONS

<table>
<thead>
<tr>
<th></th>
<th>Regression</th>
<th>Progression</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base of Support</strong></td>
<td>• Increase base of support to improve stability (e.g. widen feet (sitting or standing))</td>
<td>• Narrow base of support (e.g. Place feet closer together (standing); tandem walk (walking))</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>• Allow slower completion of task</td>
<td>• Encourage faster completion of task if safe</td>
</tr>
<tr>
<td><strong>Perturbation</strong></td>
<td>---</td>
<td>• Add internal perturbation (e.g. head turns while walking, marching in place)</td>
</tr>
<tr>
<td><strong>Cognitive Demand</strong></td>
<td>---</td>
<td>• Add dual tasks (e.g. Addition/subtraction problems; reciting every other letter of alphabet (cognitive-motor); add additional motor task such as walking and carrying water (motor-motor))</td>
</tr>
<tr>
<td><strong>Availability of vision</strong></td>
<td>---</td>
<td>• Reduce use of vision (e.g. close eyes)</td>
</tr>
<tr>
<td>Surface type or height</td>
<td>Regression</td>
<td>Progression</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td></td>
<td>• Alter surface height (e.g. lower step height (step up); raise seat height (sit to stand))</td>
<td>• Alter surface height (e.g. raise step height (step up); lower seat height (sit to stand))</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Alter surface type (e.g. Standing on foam or incline (standing); walking on grass (walking))</td>
</tr>
<tr>
<td>Cueing</td>
<td>• Verbal cueing or physical prompts</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>• Provide physical assistance (therapist or other person) to enable completion of the task.</td>
<td>---</td>
</tr>
<tr>
<td>Physical assistance</td>
<td>• Provide external support (e.g. orthotics or assistive device (standing, walking))</td>
<td>---</td>
</tr>
<tr>
<td>External support</td>
<td>• Alter auditory and visual environment (e.g. quiet environment; brighten lights (all tasks))</td>
<td>• Alter auditory and visual environment (e.g. louder environment; motion in environment such as walking in crowds)</td>
</tr>
<tr>
<td>Environmental inputs</td>
<td></td>
<td>• Add external perturbations (e.g. Nudge/push during standing)</td>
</tr>
</tbody>
</table>
Use-dependent neuroplasticity

Principles of Experience-Dependent
Neural Plasticity: Implications for
Rehabilitation After Brain Damage

Neural plasticity is the mechanism by which the brain encodes experience and learns new behaviors. It is also the mechanism by which the damaged brain relearns lost behavior in response to rehabilitation.

Use-dependent neuroplasticity: key concepts

- Use it or lose it
- Specificity of practice
- Intensity matters
- Salience matters
- Repetition matters

What is Motor Control?

- The mechanisms by which individuals execute movements to achieve a task goal
Nikolai Bernstein

• Russian neurophysiologist
• His first research work was the study of movement during manual labour in Moscow’s Central Institute of Labour.
• The purpose of the study was to optimize productivity.
• Bernstein coined the term **biomechanics**, the study of movement through the application of mechanical principles.
• Practice consists in the gradual success of a search for optimal motor solutions to the appropriate problems.

• Because of this, practice, when properly undertaken, does not consist in repeating the means of solution of a motor problem time after time, but in the process of solving this problem again and again by techniques which we have changed and perfected from repetition to repetition.

Bernstein, 1967
Dynamical Systems Theory

- A movement pattern emerges (*self-organizes*) as a function of the ever-changing *constraints* placed upon it.
- **Environment** plays a large role
Dynamical Systems Theory

Davids et al. (2003). Newell’s model of interacting constraints
OPTIMAL Theory

- Autonomy
- Enhanced Expectancies
- External focus

Wulf & Lewthwaite 2016
## OPTIMAL Theory

<table>
<thead>
<tr>
<th>OPTIMAL Concept</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Autonomy</strong></td>
<td>Motivation is enhanced if performer is provided with choice when learning movements</td>
<td>“Would you like to start with practicing sit to stand or walking?”</td>
</tr>
<tr>
<td><strong>Enhanced Expectancies</strong></td>
<td>Performers are wired to prefer positive information about themselves. Improving expectations of performance on a skill will improve performance.</td>
<td>“You have been steadily improving in the distance you can walk”</td>
</tr>
<tr>
<td><strong>External Focus</strong></td>
<td>Focus is on intended movement effect, versus focusing on body movements</td>
<td>“Next time, try to take bigger steps” or “Try to step with an even tempo”</td>
</tr>
</tbody>
</table>
Applications to **Dysphagia Rehabilitation**
Swallowing and Cough are Sensorimotor Skills

• Both are an activity/task that have a specific purpose or goal to achieve
  – Safely and efficiently swallow food/liquid
  – Cough to clear the airway of foreign material

• An effective, efficient, and safe swallow or cough requires precise coordination and flexibility to perform this behavior in a variety of contexts.

• Having the requisite muscle strength is critical – but the accuracy and efficiency of performing the motor skill is also critical.
The Stages of Motor Learning and Dysphagia Rehab

Stage 1: Cognitive Stage

Stage 2: Associative Stage

Stage 3: Autonomous Stage
Targeting skill for enhanced **Activity** and **Participation**

Rehabilitation

- Participation
- Activities (skills)
- Body Structures & Functions
- Health

Diagram:

- **Body functions/Body structures**
- **Activities**
- **Participation**
- **Environmental factors**
- **Personal factors**
- **Health condition (disorder or disease)**

Quinn & Gordon 2016
Applying the OPTIMAL Theory to Dysphagia Rehab

(Wulf et al., 2016)
Motor **Performance**: execution of a skill at a specific time and in a specific situation (e.g., task being performed during a therapy session)

Motor **Learning**: relatively permanent change in the capability of a person to perform a skill (e.g., can be inferred from a similar but untrained task)

- Coughing to clear airway invasion - if training cough peak flow
- Swallowing a meal - if working on dry swallows

*(Wulf et al., 2016)*
Applying the OPTIMAL Theory to Dysphagia Rehab

Motivation – “We act when future prospects provide a sense that positive outcomes will occur (enhanced expectancies) and perhaps particularly when we believe we will be the agents who bring these positive outcomes to fruition (autonomy).”

• Education related to impairment & impact
• Shared decision-making: goals, selection of therapy ‘stimuli’, length of treatment, etc
• Education on desired/hopes for treatment outcomes
• Engagement of care partners

(Wulf et al., 2016)
Applying the OPTIMAL Theory to Dysphagia Rehab

External Focus – directing attention away from one’s body parts or self and to the intended movement effect

How do we do this for swallowing and cough when the consequences of “skill going wrong” are often so hidden (from the person with dysphagia and the clinician)?

(More to come on this....)

(Wulf et al., 2016)
Applying the OPTIMAL Theory to Dysphagia Rehab

How about THE TASKS.....

(Wulf et al., 2016)
Skill learning and re-learning is achieved through *task-specific training*

- Task-specific training should allow for *problem solving* opportunities
- This is primarily achieved through the *manipulation of tasks*
- What is best for long-term *motor learning* is not always best for short-term *motor performance*
  - More about this later
Task-specific training for Dysphagia Rehab

• In order to understand the task specifications – we need to understand the components of the skill

• To maximize motor learning we should reframe our dysphagia management plans – we must be teaching our patients to *problem solve* with the goal of swallowing/coughing more *consistently, efficiently*, and with greater *flexibility*
Considering the *skill* of *swallowing* through a skill-based framework of functional outcomes
Applying a skill-based framework for *Functional Swallowing Outcomes*

Goal – swallow the food/liquid safely with little-to-no residue

- **Consistency**
  - Rate of achievement
    - How frequently is there airway invasion
    - How frequently is there residue
    - How frequently is the food regurgitated
  - **Accuracy - spatial/temporal errors**
    - Physiologic measures, temporal-kinematic measures
Applying a skill-based framework for *Functional Swallowing Outcomes*

**Goal** – swallow the food/liquid safely with little-to-no residue

- **Efficiency**
  - Time required/Duration
    - How long did it take for the person to finish their meal? Or a given swallow?
  - Speed
    - What was their swallowing or eating rate?
  - ‘Distance’
    - How much of the meal or the bolus was eaten/ingested?
Applying a skill-based framework for *Functional Swallowing Outcomes*

Goal – swallow the food/liquid safely with little-to-no residue

- **Flexibility**
  - Task performance under different conditions/environments
    - Drinking select boluses during a therapy session vs home vs restaurant
    - Eating soft foods vs harder foods vs liquids
  - Predictable vs. unpredictable conditions
    - Eating a meal while self feeding vs being fed
    - Eating a meal while experiencing dyspnea/fatigue/dual-tasking
What we know about promoting skill learning...
Constraint model

Newell & Verhoeven 2017
How can we apply motor learning principles to optimize motor skill acquisition and recovery of function in individuals with neurological conditions?

• Task Considerations
• Augmented Information/Feedback
What is task-specific training?

• Involves practicing real-life tasks with the intention of acquiring or reacquiring a skill
• The tasks should be **challenging** and progressively adapted and should involve **active participation**.
• Research has demonstrated that rehabilitation maybe more successful if the tasks and stimuli are important or **meaningful** to the person.
Patients with acute stroke benefited most from a functional task approach compared to strength training or standard care.

Winstein et al. 2004
Task-specific training is more beneficial for recovery of function in stroke and other neurological disorders

Research

Bobath therapy is inferior to task-specific training and not superior to other interventions in improving lower limb activities after stroke: a systematic review

Katharine Scrivener a, Simone Dorsch b,c, Annie McCluskey c,d, Karl Schurr c, Petra L Graham c, Zheng Cao c, Roberta Shepherd d, Sarah Tyson e

Figure 4. Standardised mean difference (95% CI) of the effect of Bobath therapy versus other intervention on walking.
Task Considerations

• Amount of practice
• Practice schedule
  – Massed vs. distributed
  – Random vs. blocked
• Transfer of training
  – Whole vs. part
Task Considerations

- Amount of practice
- Practice schedule
  - Massed vs. distributed
  - Random vs. blocked
- Transfer of training
  - Whole vs. part
Task practice – random vs. blocked

**Blocked**: repetition of same task variations

**Random**: repetition of different task variations

*Lage et al. 2015*
**Task practice – random vs. blocked**

Random practice may have similar or better retention of motor skills

*Figure 4–4*

Effect of blocked versus random practice on acquisition and retention of a motor skill. Although blocked practice led to better performance during acquisition, random practice led to greater learning as measured by retention tests. (Adapted with permission from Shea JB, Morgan RL. Contextual interference effects on the acquisition, retention, and transfer of a motor skill. *J Exp Psychol* 5(2):183, 1979.)
Task practice – random vs. blocked

• Blocked practice may be beneficial or necessary in individuals with poor cognitive functioning
• Intermittent blocked practice may be beneficial to focus on specific motor skills within a larger repertoire
• Ultimately depends on task goal
  – If variability is low then blocked practice may be beneficial
Augmented information – timing and type

• **Before task performance**
  – Demonstrations and modeling
  – Mental practice and imagery
  – Verbal information/cueing
    • Internal vs. external focus of attention

• **During task performance (concurrent feedback)**
  – Manual assistance and guidance

• **After task performance (terminal feedback)**
  – Knowledge of results
  – Knowledge of performance
Augmented information – timing and type

• Before task performance
  – Demonstrations and modeling
  – Mental practice and imagery
  – Verbal information/cueing
    • Internal vs. external focus of attention
• During task performance (concurrent feedback)
  – Manual assistance and guidance
• After task performance (terminal feedback)
  – Knowledge of results
  – Knowledge of performance
**Mental practice plus physical practice improves functional performance in individuals post stroke**

**TABLE 3. Patient Scores on the FM and ARA Before and After Intervention**

<table>
<thead>
<tr>
<th></th>
<th>FM</th>
<th>ARA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PRE Mean (SD)</td>
<td>POST Mean (SD)</td>
</tr>
<tr>
<td>MP (n=16)</td>
<td>33.03 (8.37)</td>
<td>39.75 (6.86)</td>
</tr>
<tr>
<td>PP (n=16)</td>
<td>35.75 (9.51)</td>
<td>36.75 (10.74)</td>
</tr>
</tbody>
</table>

Note: PRE indicates mean score obtained during pretesting period; POST, mean score obtained during posttest; Change, Post−[(Pre1+Pre2)/2]. Exact $P$ values for the Wilcoxon 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 "***".

*Page et al. 2001*
Verbal information or cueing

• **Internal focus of attention**: focus on body part or movement
  – e.g. how a person is moving their legs during walking, or moving their jaw during chewing

• **External focus of attention**: focus on the outcome
  – e.g. success or outcome of walking task, or how well food was chewed
External focus of attention reduces postural sway during a balance task in people with PD

Figure 2.
Magnitude of sway (root-mean-square error [RMSE]) for participants with Parkinson disease as a function of the type of attentional focus (control, internal, or external). Error bars indicate 95% confidence intervals.
# Knowledge of results vs. Knowledge of performance

<table>
<thead>
<tr>
<th>Knowledge of Results</th>
<th>Knowledge of Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome of success or failure</strong></td>
<td><strong>Task execution</strong></td>
</tr>
<tr>
<td>Feedback about time to complete task such as walking or eating a meal</td>
<td>Feedback about position of limbs during walk or position of head/posture during eating</td>
</tr>
<tr>
<td>Feedback about number of successful trials during reaching for an object or swallowing</td>
<td>Feedback about coordination or timing of reach to grasp movements or breathing/swallowing.</td>
</tr>
</tbody>
</table>
Less feedback may result in better skill retention

Figure 1. Average error score for the 50%-KR and 100%-KR relative-frequency groups during the 2-day acquisition phase (blocks 1-16) and the immediate (Imm) and 1-day delayed (Del) no-KR retention phases. Each block is the average of 12 trials. (Adapted from Winstein and Schmidt.21)

Winstein 1991
Adams et al. 2002
Application of motor skill learning to the rehabilitation of swallowing and cough function
What is task specific training for dysphagia rehab?

• Involves practicing real-life tasks *eating and drinking* with the intention of acquiring or reacquiring the skill *the skills of swallowing and coughing during a meal*.

• The tasks should be *challenging* and progressively adapted and should involve *active participation*.

• Research has demonstrated that rehabilitation maybe more successful if the tasks and stimuli are important or *meaningful* to the person.
What is task specific training for dysphagia rehab?

• Any approach that includes active swallowing or coughing can be considered task-specific training in the context of dysphagia rehabilitation.
To review: Promoting Motor Learning

• Task Considerations
  —Random vs. Blocked practice
  —Whole Practice vs. Part Practice

• Augmented Information
  —External vs. Internal Focus
  —Delayed vs. Concurrent Feedback
  —Less frequent vs. More Frequent Feedback
    • Knowledge of Performance vs. Knowledge of Results

• Motivation and Autonomy

(e.g., Magill & Anderson, 2016; Schmidt & Lee, 2005; Sheppard, 2008; Zimmerman et al., 2020)
Let’s delve into the Dysphagia Rehab Literature
Task Considerations
Task Considerations: Amount of Practice

The Intensive Dysphagia Rehabilitation Approach Applied to Patients With Neurogenic Dysphagia: A Case Series Design Study

Presented in part to the American Speech Language and Hearing Association, November 20, 2014, Orlando, FL.

Georgio A. Melandradi PhD, Akila Rajoppa MS, Cogla Kantarjian MS, Elise Wegner MS, Chandra Ivey MD, Kathleen Youse PhD

McNeill Dysphagia Therapy Program: A Case-Control Study

Presented to the Dysphagia Research Society, March 5, 2009, New Orleans, LA.

Giselle D. Cornaby-Mann MPH, PhD, Michael A. Crary PhD
Task Considerations: Amount of Practice

• Important to increase number of swallowing/coughing trials
  — NPO - - -> PO trials (++oral care, ++cough effectiveness)
  — Intensive approaches with increased swallowing/coughing trials
  — Translating practice to the home setting
Task Considerations: Random Practice

Skill Training for Swallowing Rehabilitation in Patients With Parkinson’s Disease

Ruvini P. Athukorala, MSc, a, b Richard D. Jones, PhD, a, b, c Oshrat Sella, PhD, a, b
Maggie-Lee Huckabee, PhD, a, b

Skill Training Resulted in Improved Swallowing in a Person with Multiple System Atrophy: An Endoscopy Study

Sarah E. Perry, PhD, a, b Jordanna S. Sevitz, MS, c James A. Curtis, MS, c Sheng-Han Kuo, MD, c and Michelle S. Troche, PhD, c
3 types of treatment targets

- **Strong**: 25% above max peak flow without an upper bound
- **Moderate**: 25% below to 25% above max peak flow
- **Weak**: 75% below to 25% below max peak flow

**Task Considerations:** Random Practice

- **Block 1**
  - Moderate (3 trials)
  - Strong (3 trials)
  - Weak (3 trials)

- **Block 2**
  - Strong
  - Moderate
  - Weak

- **Block 3**
  - Weak
  - Strong
  - Moderate
## Task Considerations: Random Practice

Generalization to trained and untrained tasks

<table>
<thead>
<tr>
<th>Time</th>
<th>Task</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visit 1</strong></td>
<td>Voluntary Single</td>
<td>Improved 0.31 L/s</td>
</tr>
<tr>
<td></td>
<td>Voluntary Sequential</td>
<td>Improved 0.24 L/s</td>
</tr>
<tr>
<td></td>
<td>Reflex</td>
<td>No change</td>
</tr>
<tr>
<td><strong>Visit 2</strong></td>
<td>Voluntary Single</td>
<td>Improved 0.20 L/s</td>
</tr>
<tr>
<td></td>
<td>Voluntary Sequential</td>
<td>Improved 0.15 L/s</td>
</tr>
<tr>
<td></td>
<td>Reflex</td>
<td>No change</td>
</tr>
<tr>
<td><strong>Change from Pre to Post-Treatment</strong></td>
<td>Voluntary Single</td>
<td>Improved 0.35 L/s</td>
</tr>
<tr>
<td></td>
<td>Voluntary Sequential</td>
<td>Improved 0.22 L/s</td>
</tr>
<tr>
<td></td>
<td>Reflex</td>
<td>No change</td>
</tr>
</tbody>
</table>

(Borders et al., in prep, dissertation)
Task Considerations: Variability of Practice

Retention of Treatment Gains
- Short-term retention
- Long-term retention
- Indicating maintenance of treatment gains (motor learning)

(Borders et al., in prep, dissertation)
Task Considerations: Blocked Practice

- Completed 25 practice trials
  - Target set 25% above baseline peak flow
  - Single voluntary coughs
- Randomized to biofeedback and no biofeedback groups
- No clinician feedback on performance

- After one treatment session, cough strength improved by 0.25 L/s
- Similar improvement for those who did not receive biofeedback

(Borders et al., in prep, dissertation)
Task Considerations: Blocked vs Random Practice

• Compared to blocked practice study, random practice resulted in larger improvements in cough strength after both first (0.31 L/s) and second (0.35 L/s) sessions

• Improved ability to clear the airway of penetrated material after cough skill training
  – Less improvement for clearance of aspiration

(Borders et al., in prep, dissertation)
Task Considerations: Random Practice

Research Article

Motor Performance During Sensorimotor Training for Airway Protection in Parkinson’s Disease

James C. Borders, a, D Karen W. Hegland, b, D Nora Vanegas-Arroyave, c, D and Michelle S. Troche a, D

a Laboratory for the Study of Upper Airway Dysfunction, Department of Biobehavioral Sciences, Teachers College, Columbia University, New York b Laboratory for the Study of Upper Airway Dysfunction, College of Public Health and Health Professions, University of Florida, Gainesville c Department of Neurology, Baylor College of Medicine, Houston, TX

- Early variability during cough skill training may predict treatment response
- Variability may indicate exploring different strategies to improve cough

(Borders et al., 2023)
Task Considerations: Practice Schedule

- We should remember there may be a trade off between motor performance and learning when using random vs blocked practice.
- We should also consider the person's stage of motor learning when making decision related to type of practice.
- Consider “changing it up” even within our established treatment paradigms:
  - Effortful and soft swallows
  - Different bolus types and consistencies
  - Single and sequential coughs
A Randomized Controlled Trial Comparing Physical and Mental Lingual Exercise for Healthy Older Adults

Sarah H. Szynkiewicz1,2, Erin Kamarunas3, Teresa Druilla3, Christina V. Nobriga4, Lindsay Griffin3,4, Cynthia R. O’Donoghue5

Received: 9 October 2019 / Accepted: 25 July 2020 / Published online: 8 August 2020
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Research Article

Motor Imagery Practice and Increased Tongue Strength: A Case Series Feasibility Report

Sarah H. Szynkiewicz1, Christina V. Nobriga2, Cynthia R. O’Donoghue3, Benjamin J. Becerra4, and Garret LaForge5

International Journal of Orofacial Myology and Myofunctional Therapy
Official Journal of the International Association of Orofacial Myology

Volume 48 | Number 1 | pp. 1-16

Mental practice of lingual resistance and cortical plasticity in older adults: An exploratory fNIRS study

Erin Kamarunas (James Madison University)
Sarah Szynkiewicz (Samford University)
Lindsey Griffen (Emerson College and James Madison University)
Teresa Druilla (Texas Christian University)
Kelsey Murray (James Madison University)
Augmented Information: Verbal Cueing and Concurrent Feedback

Brief Research Reports

Effect of visual biofeedback to acquire supraglottic swallow in healthy individuals: a randomized-controlled trial

Imada, Miho¹; Kagaya, Hitoshi²; Ishiguro, Yuriko³; Kato, Miho⁴; Inamoto, Yoko⁵; Tanaka, Takashi⁶; Shibata, Seiko⁶; Saitoh, Eichi⁷

Author Information

Augmented Information: Verbal Cueing and Concurrent Feedback

- Concurrent feedback can be important for establishing the target behavior in earlier phases of motor learning (both for clinician and patient).
- However, we should consider when, how often, for how long - we are providing the concurrent feedback.
- In order to enhance motor learning vs. motor performance we need to reduce reliance on feedback.
Augmented Information: Verbal Info/Cueing - Focus of Attention

Table 1: Description of goals for each training module

<table>
<thead>
<tr>
<th>Module</th>
<th>Goal Description</th>
<th>Criteria Level (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification</td>
<td>Identification of target respiratory phase (expiration) (goal 1) and swallow event (goal 2) using simulated tracking.</td>
<td>80</td>
</tr>
<tr>
<td>Identification</td>
<td>Identification of target respiratory phase (expiration) (goal 3) and swallow event (goal 4) using visually guided feedback provided by respiratory movements during self-swallowing.</td>
<td>80</td>
</tr>
<tr>
<td>Identification</td>
<td>Identification of target respiratory phase (expiration) and swallow event during swallowing at high, mid, and low lung volumes relative to a tidal volume cycle using simulated tracking (goal 5) and visually guided feedback during self-swallowing (goal 6).</td>
<td>80</td>
</tr>
<tr>
<td>Acquisition</td>
<td>Swallow initiation at target phase (expiration) using visually guided feedback for thin (goal 7), nectar-thickened (goal 8), and honey-thickened (goal 9) liquids during self-swallowing.</td>
<td>80</td>
</tr>
<tr>
<td>Acquisition</td>
<td>Swallow initiation at target phase (expiration) without visually guided feedback for thin (goal 10), nectar-thickened (goal 11), and honey-thickened (goal 12) liquids during self-swallowing.</td>
<td>80</td>
</tr>
<tr>
<td>Acquisition</td>
<td>Target phase (expiration) after completion of a swallow event using visually guided feedback for thin (goal 13), nectar-thickened (goal 14), and honey-thickened (goal 15) liquids during self-swallowing.</td>
<td>80</td>
</tr>
<tr>
<td>Mastery</td>
<td>Swallow initiation at target phase around mid to low lung volume followed by target phase (expiration) after completion of the swallow without visually guided feedback for thin (goal 16), nectar-thickened (goal 17), and honey-thickened (goal 18) liquids during self-swallowing.</td>
<td>90</td>
</tr>
</tbody>
</table>

*Note: Visually guided feedback provided to the patient using rib cage tracing on the KayPENTAX Digital Swallowing Workstation.*
Augmented Information: Verbal Info/Cueing - Focus of Attention

• We should try to find ways to move from internal to external focus of attention, when possible
  – Reducing reliance on biofeedback may be one way to do this
  – Focusing more on the outcome of the behavior versus the many parts that make up the behavior
Rehabilitating Cough Dysfunction in Parkinson’s Disease: A Randomized Controlled Trial

Michelle S. Troche, PhD, CCC-SLP,1,2* James A. Curtis, PhD, CCC-SLP,1 Jordanna S. Sevitz, MS, CCC-SLP,1
Avery E. Dakin, MS, CCC-SLP,1 Sarah E. Perry, PhD, CCC-SLP,1,3,4,5 James C. Borders, MS, CCC-SLP,1
Alessandro A. Grande, MPhil,6 Yuhan Mou, MA, CCC-SLP,7 Nora Vanegas-Arroyave, MD,1* and
Karen W. Hegland, PhD, CCC-SLP1,2*

Immediate Effects of Sensorimotor Training in Airway Protection (smTAP) on Cough Outcomes in Progressive Supranuclear Palsy: A Feasibility Study

James C. Borders1* - James A. Curtis1* - Jordanna S. Sevitz1* - Nora Vanegas-Arroyave2* - Michelle S. Troche1*

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*The Author(s), under exclusive licence to Springer Science+Business Media, LLC part of Springer Nature 2021
Augmented Information: Terminal Feedback – KR vs KP

• This can be hard to do – we often want to jump in with our assessment of the performance (every time!)
  – Consider pausing and allowing patient to provide self-reflection first
  – Have a pre-determined bandwidth/plan for feedback – perhaps you will provide feedback every other repetition in the first set of exercise and then only at the end of the set in subsequent sets
  – Try to provide augmented information that is not necessarily available to the patient and is salient to their success – don’t just give them the solution
Considering the **Environment** and its role in Motor Learning for Dysphagia Rehab
The Environment and Swallow/Cough Motor Learning

During the training session have you considered:

• Adding distractions
• Adding demands for attention
The **Environment** and Swallow/Cough Motor Learning

During your training session are you:

- In the quiet therapy room
- The loud cafeteria
- Integrating the care taker and sharing a meal

What are you recommending for home practice?
Where are you recommend they do the home training?
The Environment and Swallow/Cough Motor Learning

How about compensations?

Could we use them to promote motor learning in our most severe patients if we promote and support their use in varying environments?
### Considering Task *Regressions and Progressions* in Dysphagia Rehab

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<tr>
<th>Task Changes</th>
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<td>Diversity swallow stimuli to be more representative of a meal</td>
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<td>Speed</td>
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<td>Consider an unexpected stimulus</td>
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<td>Environment with more distractions and cognitive challenges</td>
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Summary: Using Principles of Motor Learning to Promote improved Swallowing and Cough

**Goal-action coupling** - by strengthening the motivation behind learning (i.e., the ‘goal’), greater skill can be achieved.
The trade-offs

Patient perspectives on (cough) task-specific training:

- "I was never really able to hit into the upper one…I wanted to reach this upper green so badly but I couldn’t”
- “The visual was helpful because I could see well, I got to put a little bit more into the next one or take a little bit off...that was a help”
- “I wanted the instruction how to do, how to cough better.”
- If I was “having more difficulty swallowing or getting things stuck in my throat, that would motivate me”
- "The dangers of the pneumonia and dying of getting something, food particles, in your lung...so I definitely would engage in training for that"

(Sevitz et al., in prep – dissertation)
### Considering Task *Regressions and Progressions* in Dysphagia Rehab

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Thank you!
Questions and Discussion