# 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

  Registration Waiver, ASHA

- Lori Quinn

  Salary: Teachers College, Columbia University

  Grant support: Michael J Fox Foundation, Parkinson’s Foundation, Teva Pharmaceuticals

  Royalties: Elsevier Publishers

  Registration Waiver, ASHA

# 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

YOU HAVE ACCESS | Journal of Speech, Language, and Hearing Research | Supplement Article | 1 Feb 2008

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

JoAnne Robbins, Susan G. Butler, Stephanie K. Daniels, Roxann Diez 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)

AJSLP

Review Article

## Motor Learning, Neuroplasticity, and Strength and Skill Training: Moving From Compensation to Retraining in Behavioral Management of Dysphagia

Emily Zimmerman,[a] Giselle Carnaby,[b] Cathy L. Lazarus,[c] and Georgia A. Malandraki[d]

Dysphagia (2023) 38:756–767
https://doi.org/10.1007/s00455-022-10516-3

REVIEW

## Expanding Rehabilitation Options for Dysphagia: Skill-Based Swallowing Training

Maggie-Lee Huckabee[1] · Ruth Flynn[1] · Madeline Mills[1]

Received: 19 July 2022 / Accepted: 17 August 2022 / Published online: 12 September 2022


NO ACCESS | Journal of Speech, Language, and Hearing Research | Research Article | 4 Oct 2023

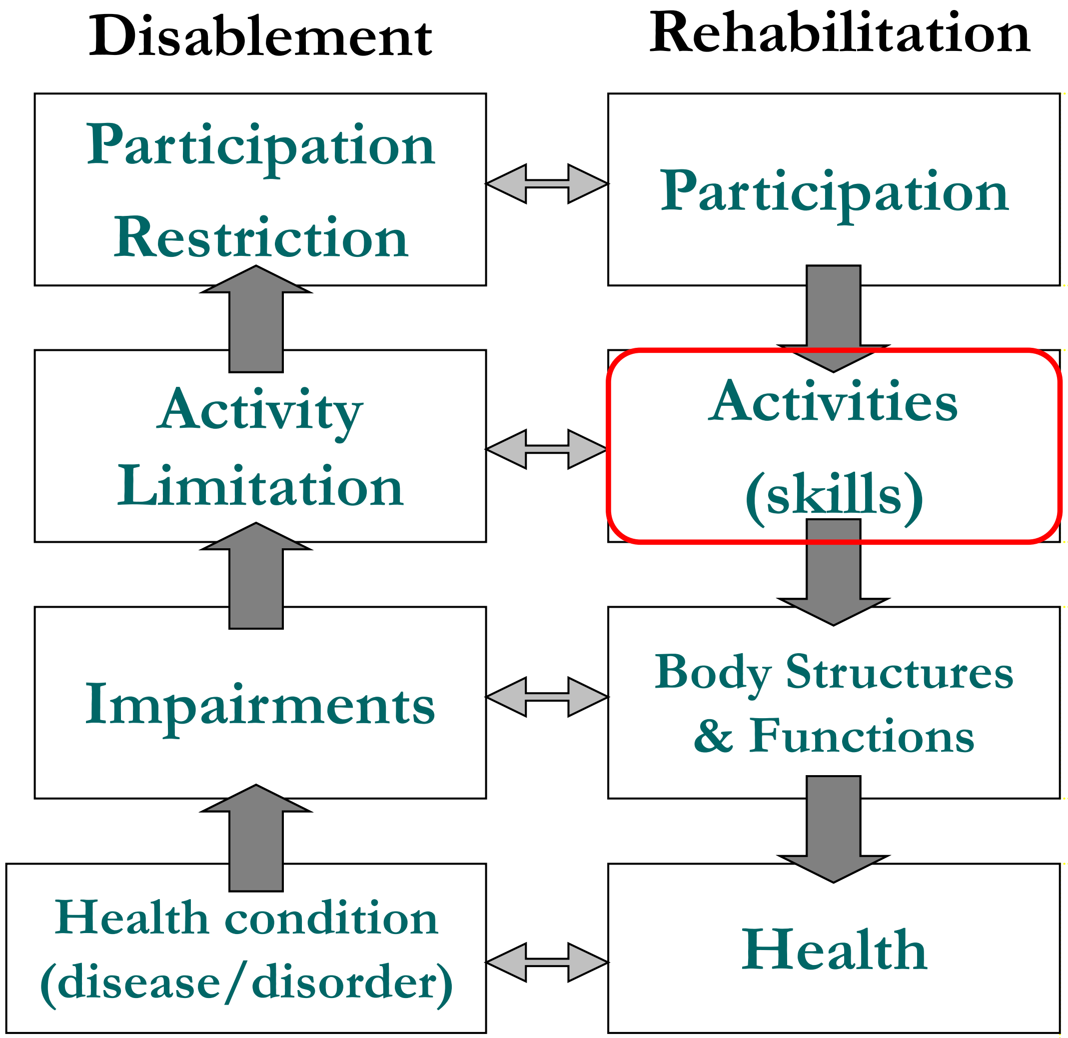
## A Survey of Speech-Language Pathologists' Applications of Motor Learning Principles in Dysphagia Therapy in Adults in India

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

https://doi.org/10.1044/2023_JSLHR-23-00185

# Key Principles of Motor Learning and Motor Control

# Top-Down Model of Rehabilitation (vs Bottom up)




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

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

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

Active *physiological mechanisms* that support recovery and limit future disability.

*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 — "WHAT TO DO"

• Conveyance & Aquisition of New Information •Trial and Error
• Verbal, Visual, Motor • Learning Skill Objectives • Organizing Information
• Processing Environmental Variables • Understanding Skill

### ♦ ASSOCIATIVE — "HOW TO DO IT"

• Translation of Declarative Knowledge into Procedural Knowledge
• Difficult & Awkward • Proprioceptive / Motor • Practice Phase
• Chunking • Eliminating Mistakes • Improving Selective Attention Focus

### ♦ AUTONOMOUS — "DO IT"

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

Aaron Swanson | @ASwansonPT

*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

| | Regression | Progression |
|---|---|---|
| **Base of Support** | • Increase base of support to improve stability (e.g. widen feet (sitting or standing) | • Narrow base of support (e.g. Place feet closer together (standing); tandem walk (walking) |
| **Speed** | • Allow slower completion of task | • Encourage faster completion of task if safe |
| **Perturbation** | --- | • Add internal perturbation (e.g. head turns while walking, marching in place) |
| **Cognitive Demand** | --- | • 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) |
| **Availability of vision** | --- | • Reduce use of vision (e.g. close eyes) |

# ENVIRONMENTAL VARIATIONS

| | Regression | Progression |
| --- | --- | --- |
| **Surface type or height** | • Alter surface height  (e.g. lower step height (step up); raise seat height (sit to stand) | • Alter surface height (e.g. raise step height (step up); lower seat height (sit to stand)<br>• Alter surface type (e.g. Standing on foam or incline (standing); walking on grass (walking) |
| **Cueing** | • Verbal cueing or physical prompts | --- |
| **Physical assistance** | • Provide physical assistance (therapist or other person) to enable completion of the task. | --- |
| **External support** | • Provide external support (e.g. orthotics or assistive device (standing, walking) | --- |
| **Environmental inputs** | • Alter auditory and visual environment (e.g. quiet environment; brighten lights (all tasks) | • Alter auditory and visual environment (e.g. louder environment; motion in environment such as walking in crowds<br>• Add external perturbations (e.g. Nudge/push during standing |

# Use-dependent neuroplasticity

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

**SUPPLEMENT**

*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.*

Kleim & Jones, J of Speech, Language & Hearing Research, 2008

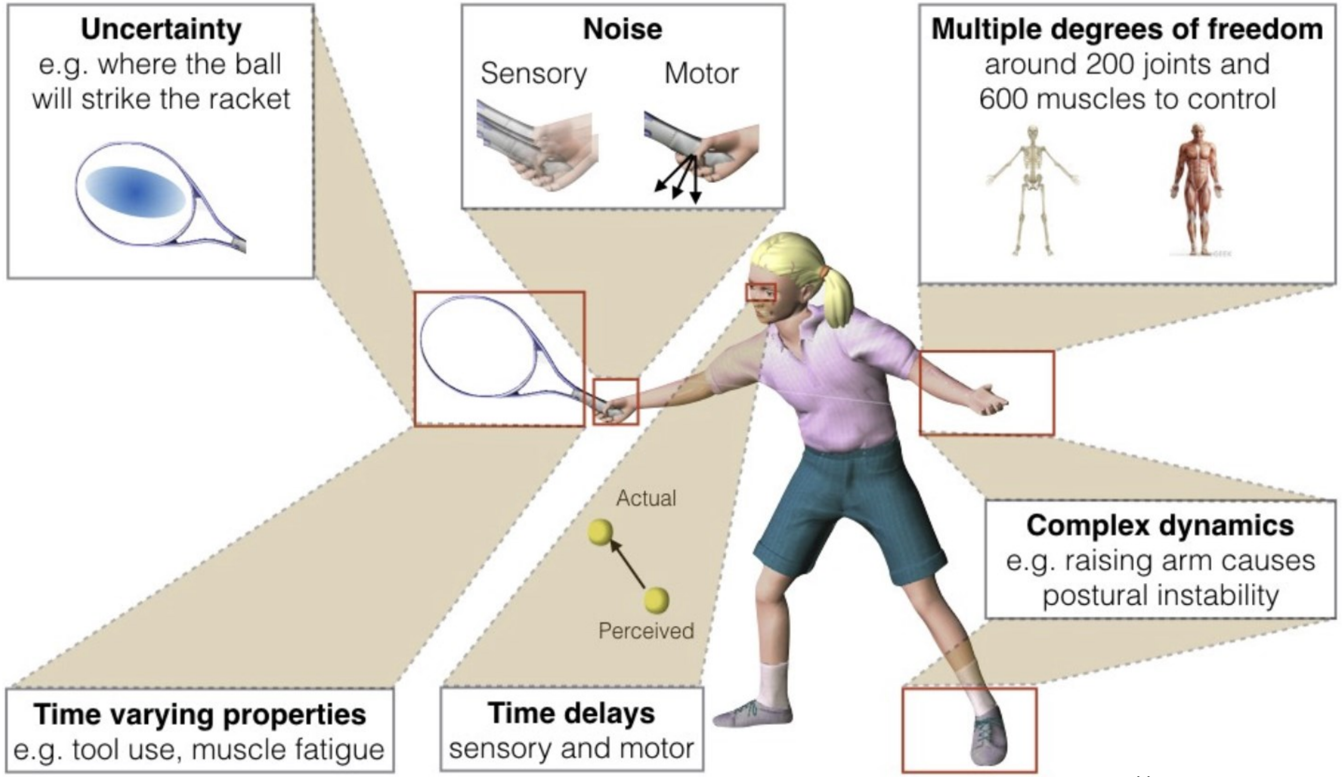
# Use-dependent neuroplasticity: key concepts

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

*Kleim & Jones, J of Speech, Language & Hearing Research, 2008*

# What is Motor Control?

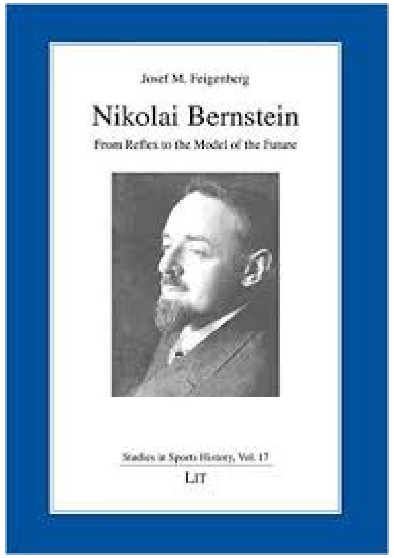
- The mechanisms by which individuals execute movements to achieve a task goal




https://wolpertlab.neuroscience.columbia.edu/research-projects/overview

# Nikolai Bernstein

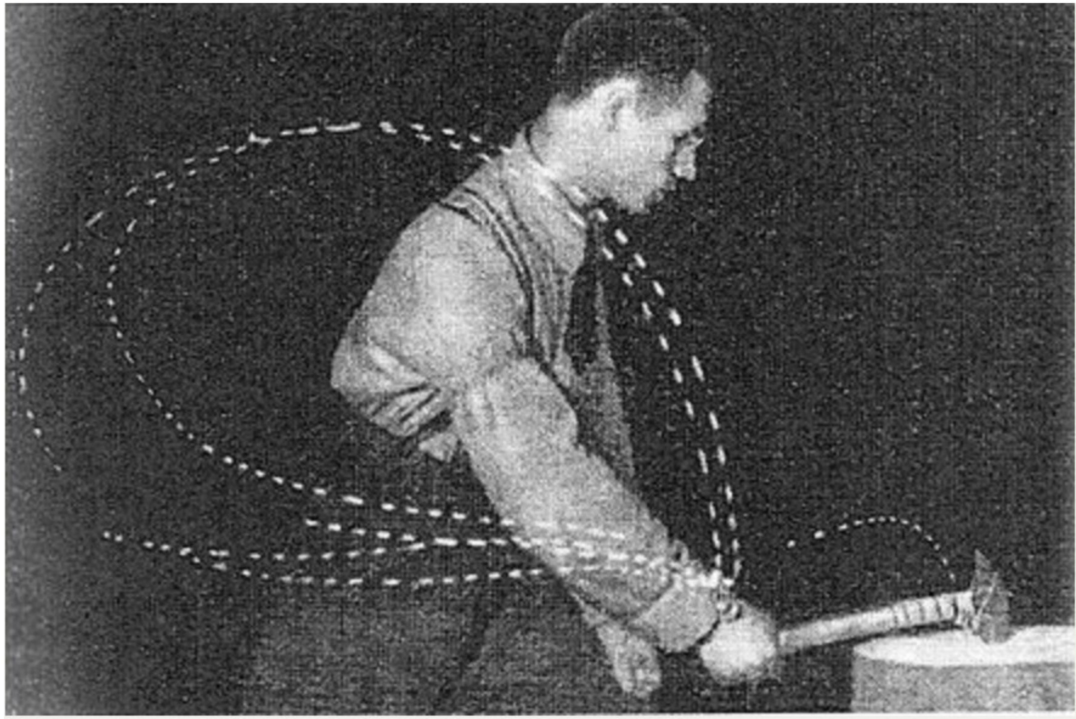
- Russian neurophysiologist
- His first research work was the study of movement during manual labour in Moscow’s Central Institute of Labour.
- The purpose of the study was to optimize productivity.
- Bernstein coined the term biomechanics, the study of movement through the application of mechanical principles




*Bernstein, 1967*

# Practice is repetition without repetition

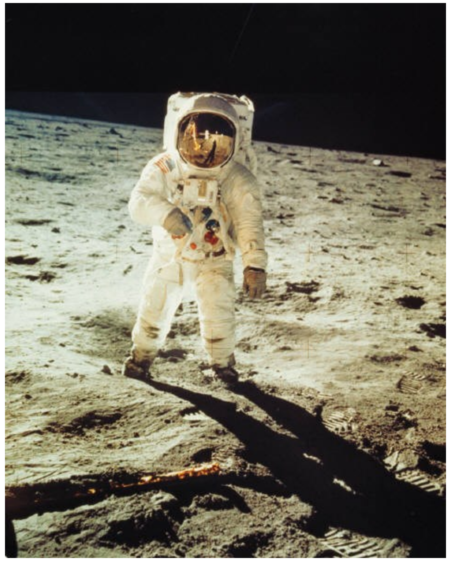
- Practice consists in the gradual success of a search for optimal motor solutions to the appropriate problems.
- Because of this, practice, when properly undertaken, does not consist in repeating the means of solution of a motor problem time after time, but in the process of solving this problem again and again by techniques which we have changed and perfected from repetition to repetition.



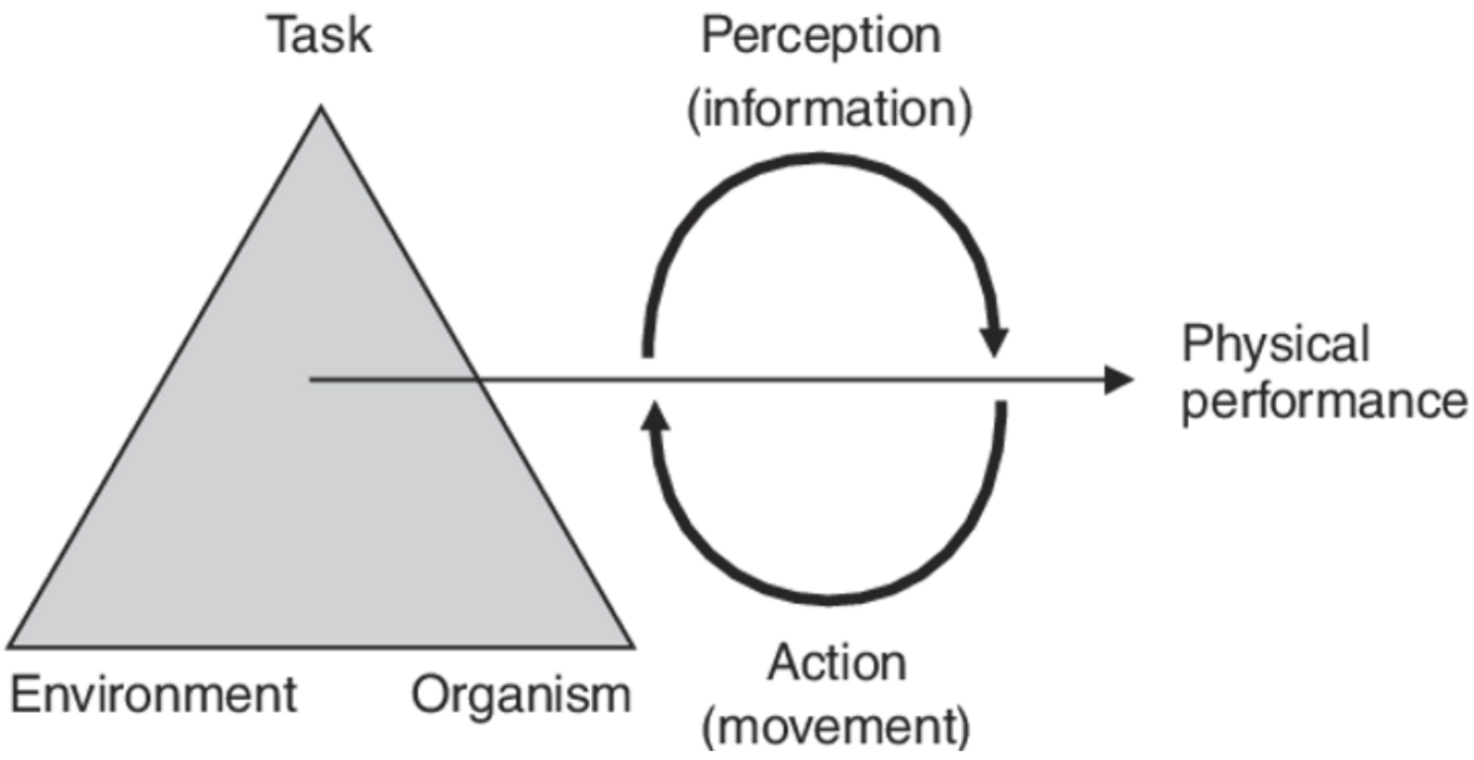
*Bernstein, 1967*

# 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

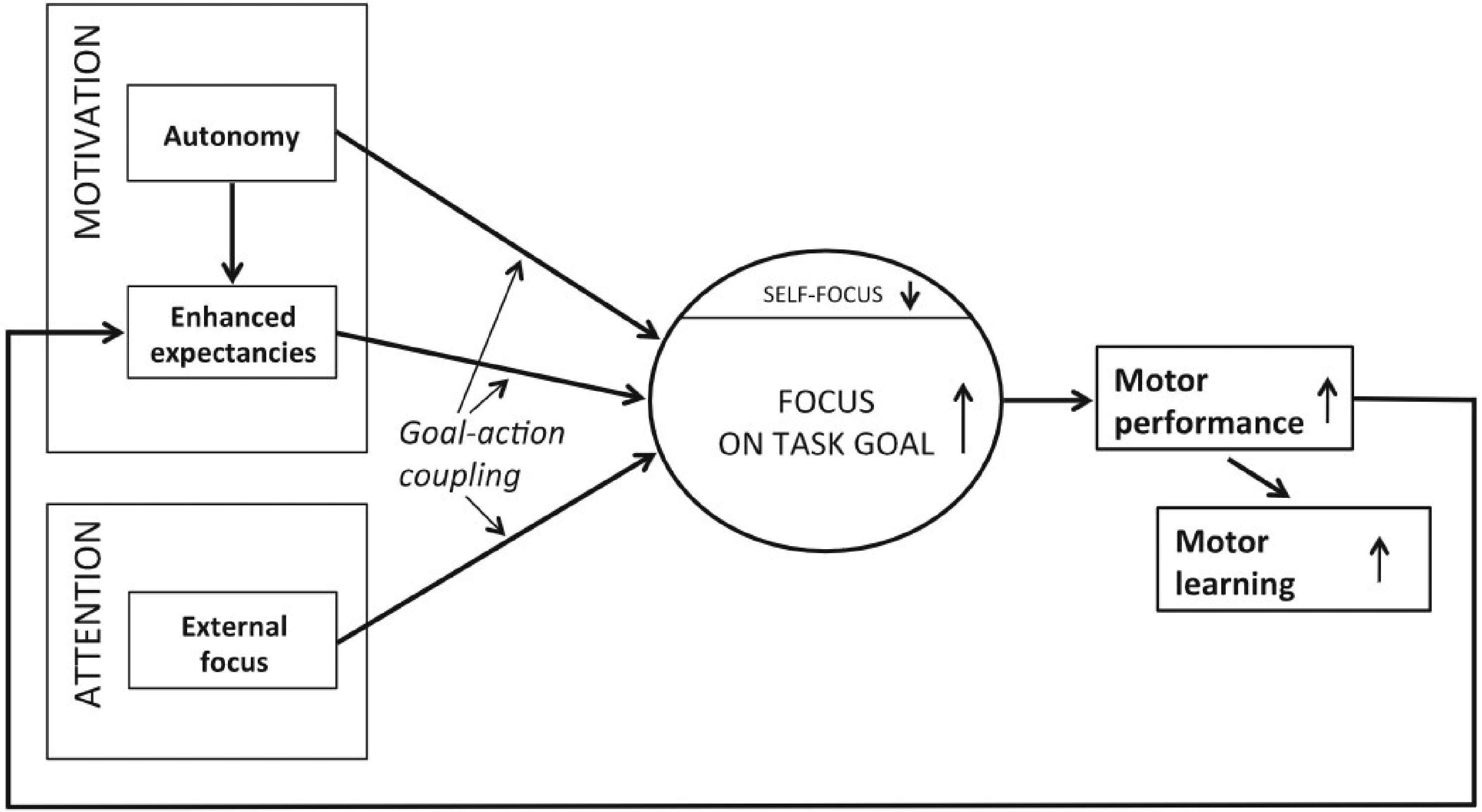


# Dynamical Systems Theory




*Davids et al. (2003). Newell's model of interacting constraints*

# OPTIMAL Theory




- Autonomy
- Enhanced Expectancies
- External focus

*Wulf & Lewthwaite 2016*

# OPTIMAL Theory

| OPTIMAL Concept | Definition | Example |
| --- | --- | --- |
| **Autonomy** | Motivation is enhanced if performer is provided with choice when learning movements | *"Would you like to start with practicing sit to stand or walking?"* |
| **Enhanced Expectancies** | Performers are wired to prefer positive information about themselves. Improving expectations of performance on a skill will improve performance. | *"You have been steadily improving in the distance you can walk"* |
| **External Focus** | Focus is on intended movement effect, versus focusing on body movements | *"Next time, try to take bigger steps" or "Try to step with an even tempo"* |

*Wulf & Lewthwaite 2016*

# 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**

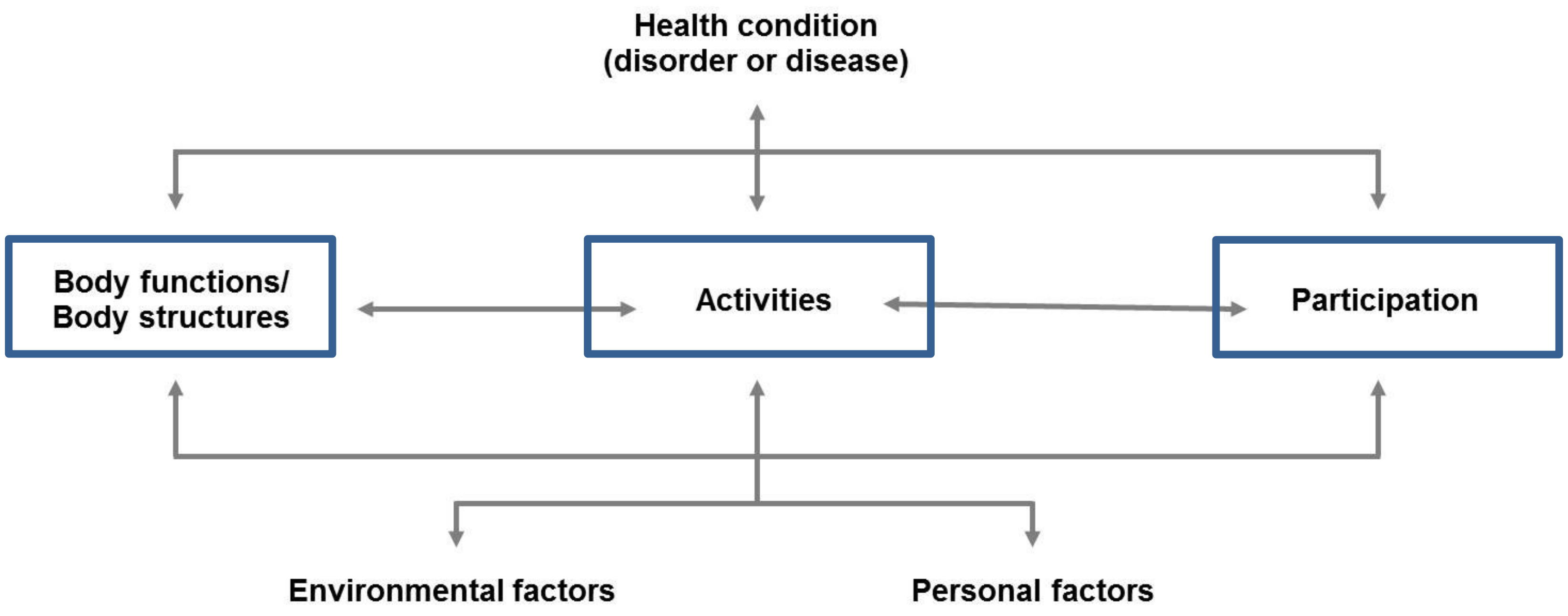
**Rehabilitation**

Participation

Activities (skills)

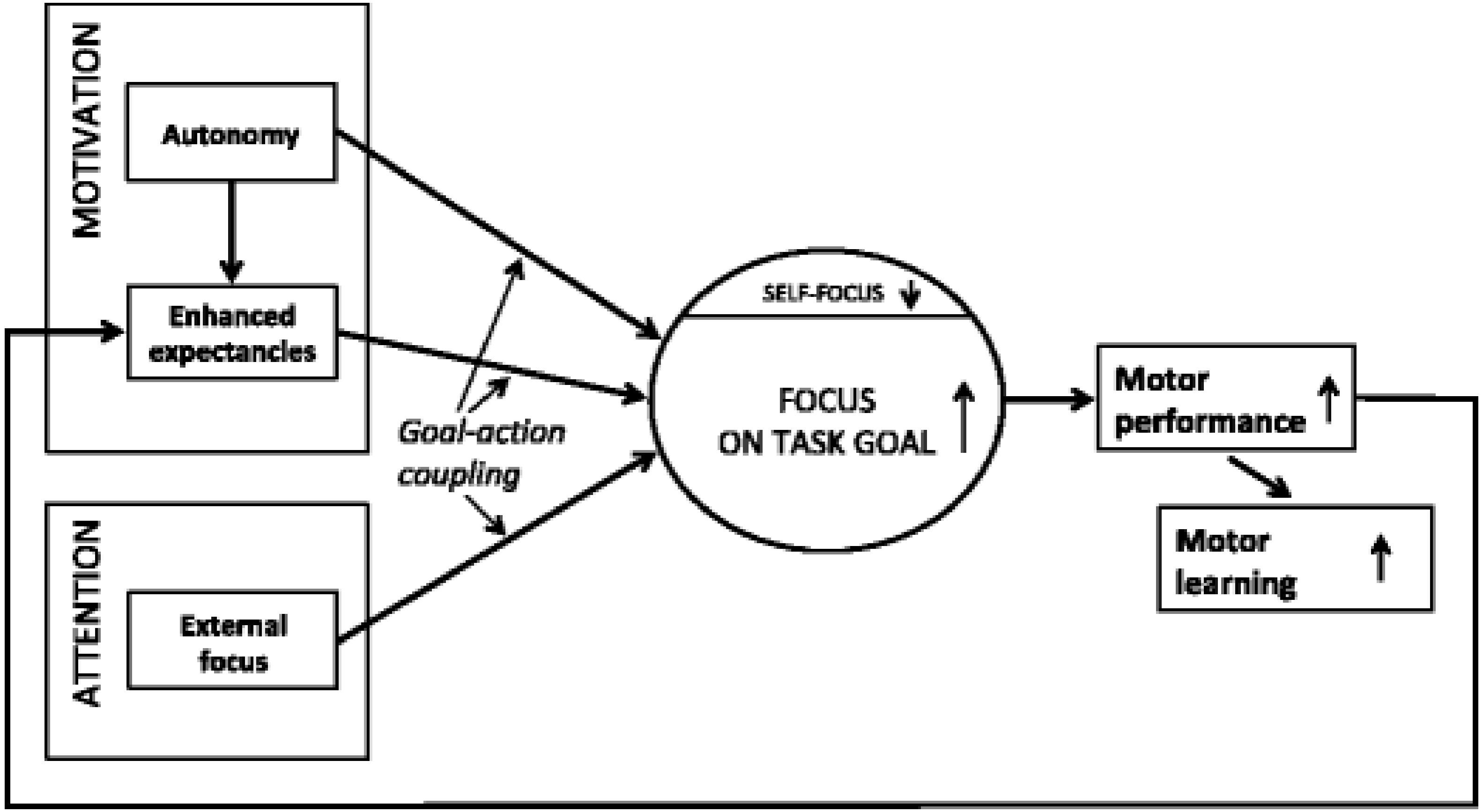
Body Structures & Functions

Health




*Quinn & Gordon 2016*

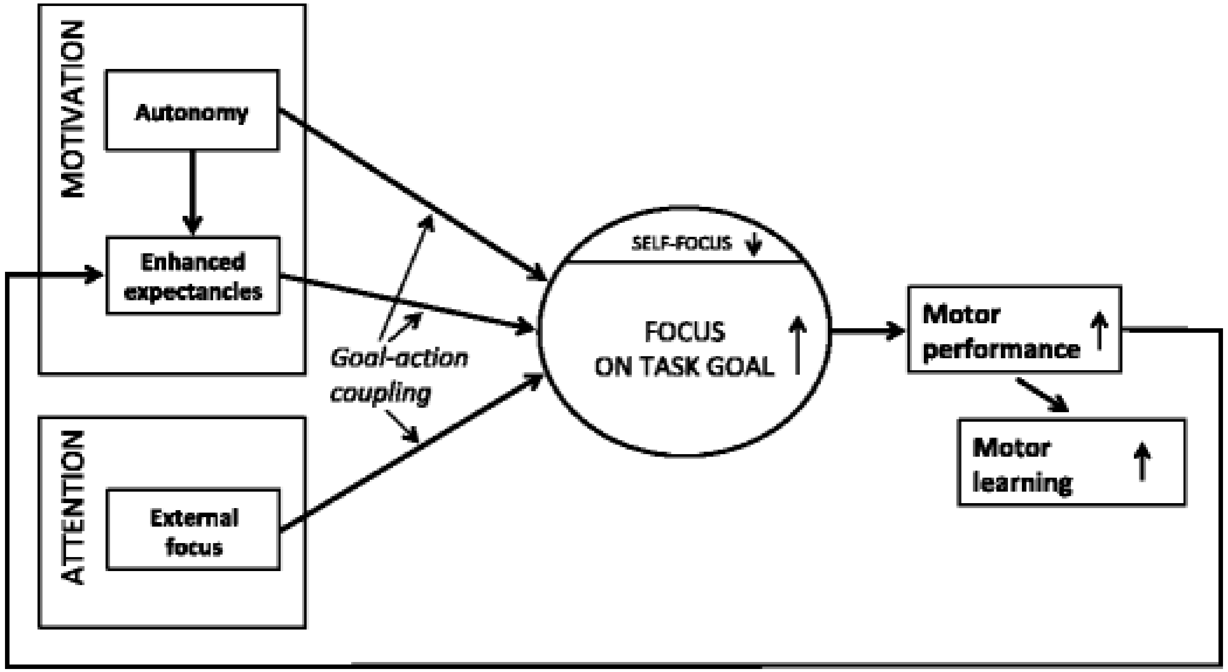
# Applying the OPTIMAL Theory to Dysphagia Rehab






(Wulf et al., 2016)

# Applying the OPTIMAL Theory to Dysphagia Rehab



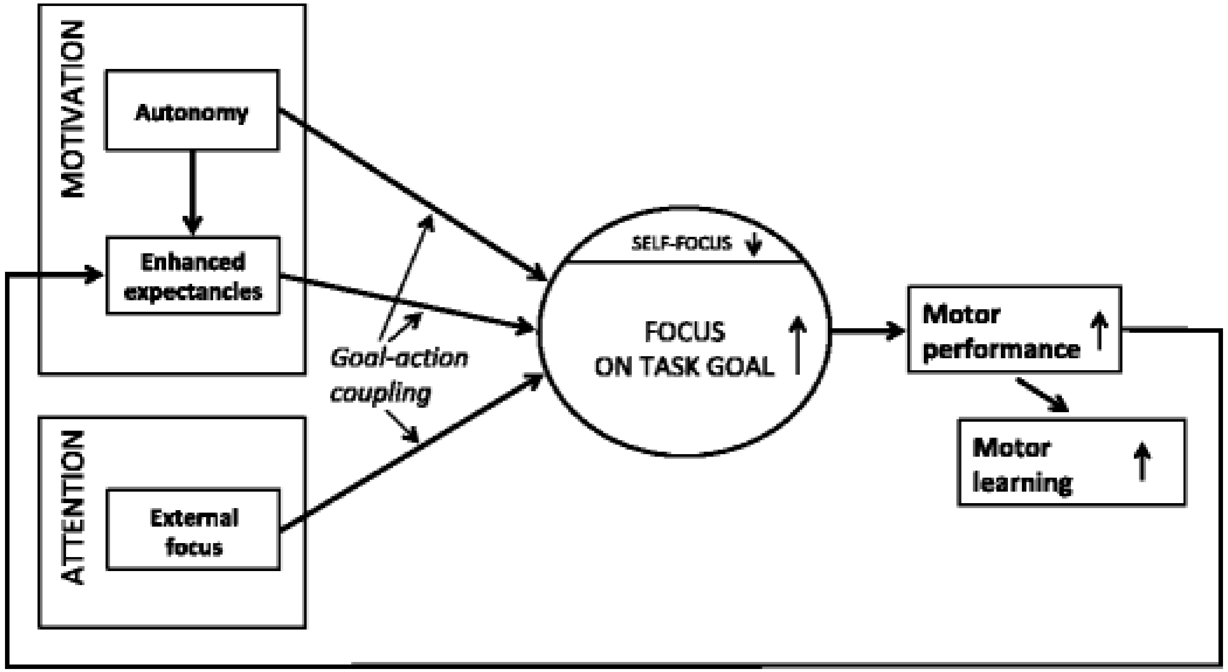

- Motor *Performance*: execution of a skill at a specific time and in a specific situation (e.g., task being performed during a therapy session)

- 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



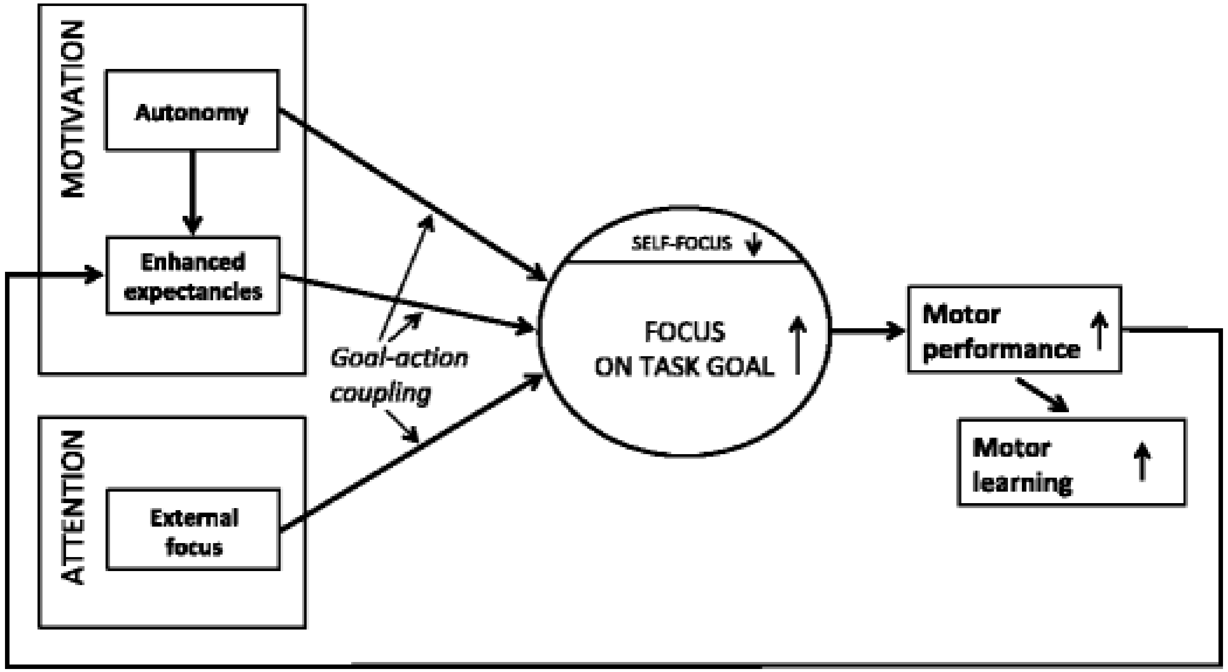

**Motivation –** "We act when future prospects provide a sense that positive outcomes will occur **(enhanced expectancies)** and perhaps particularly when we believe we will be the agents who bring these positive outcomes to fruition **(autonomy)**."

- 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

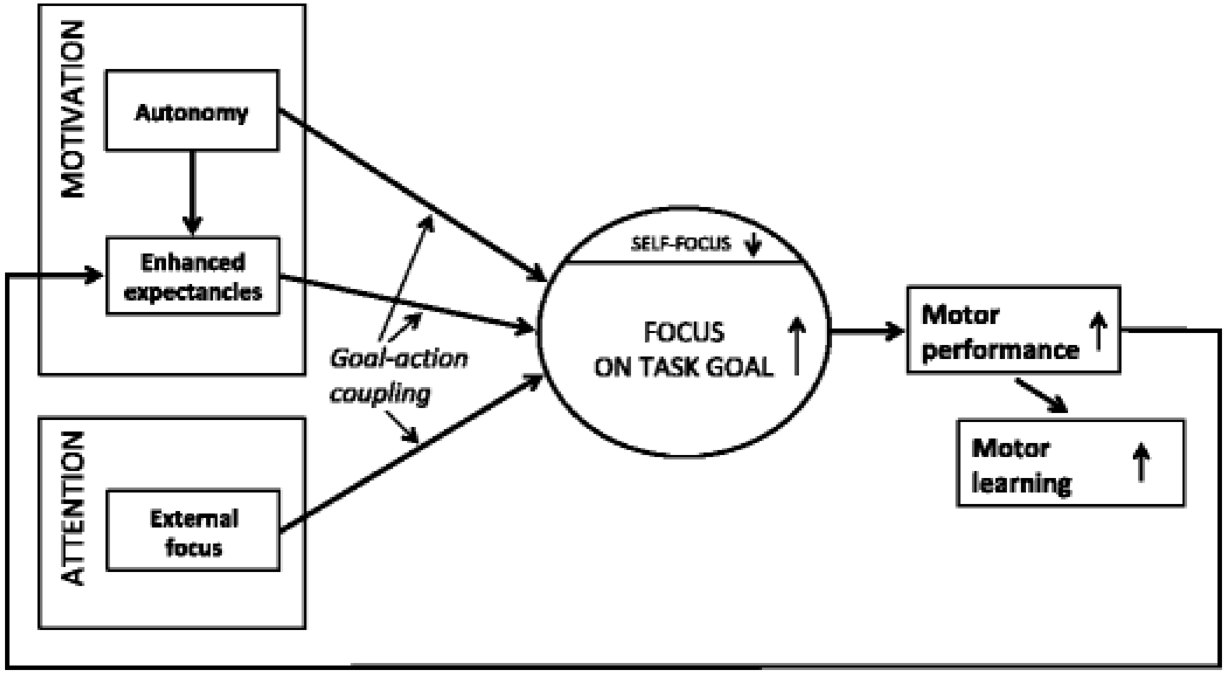
How do we do this for swallowing and cough when the consequences of "skill going wrong' are often so hidden (from the person with dysphagia and the clinician)?

(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?

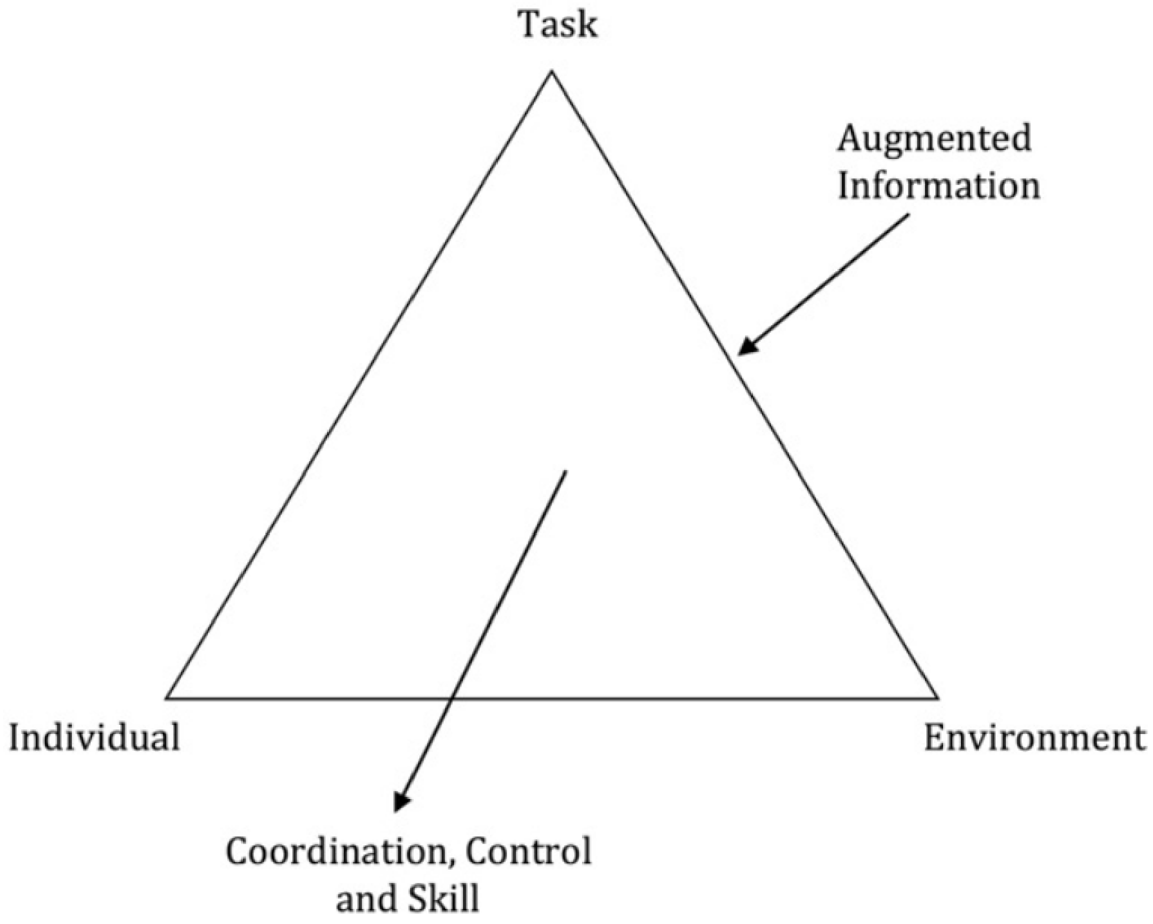
# Applying a skill-based framework for *Functional Swallowing Outcomes*

## 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...

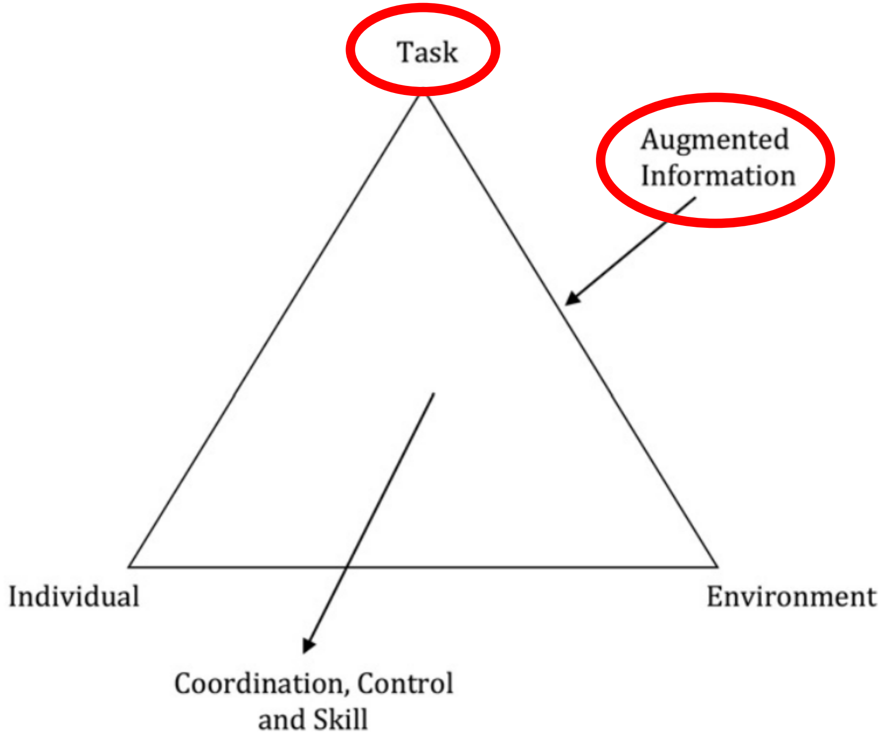
# Constraint model




*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

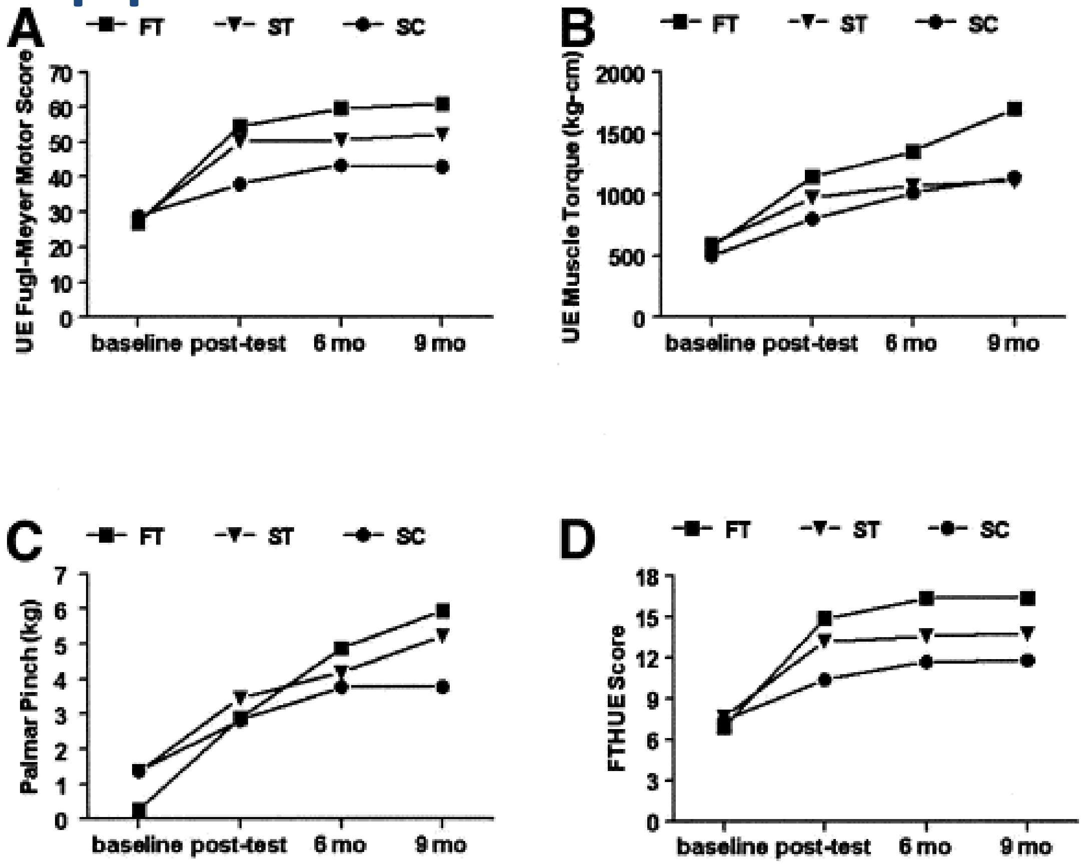


# What is task-specific training?

- 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 in early motor recovery benefit from a task-specific approach

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

AUSTRALIAN PHYSIOTHERAPY ASSOCIATION

Journal of PHYSIOTHERAPY

journal homepage: www.elsevier.com/locate/jphys

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 [e], Zheng Cao [f], Roberta Shepherd [d], Sarah Tyson [g]

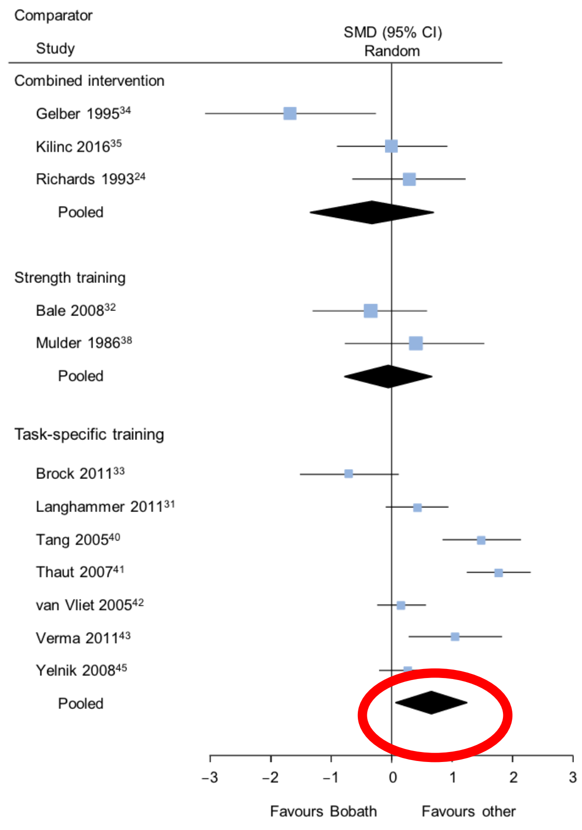



**Figure 4.** Standardised mean difference (95% CI) of the effect of Bobath therapy versus other intervention on walking.

# Task Considerations

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

# Task Considerations

- Amount of practice
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  - **Random vs. blocked**
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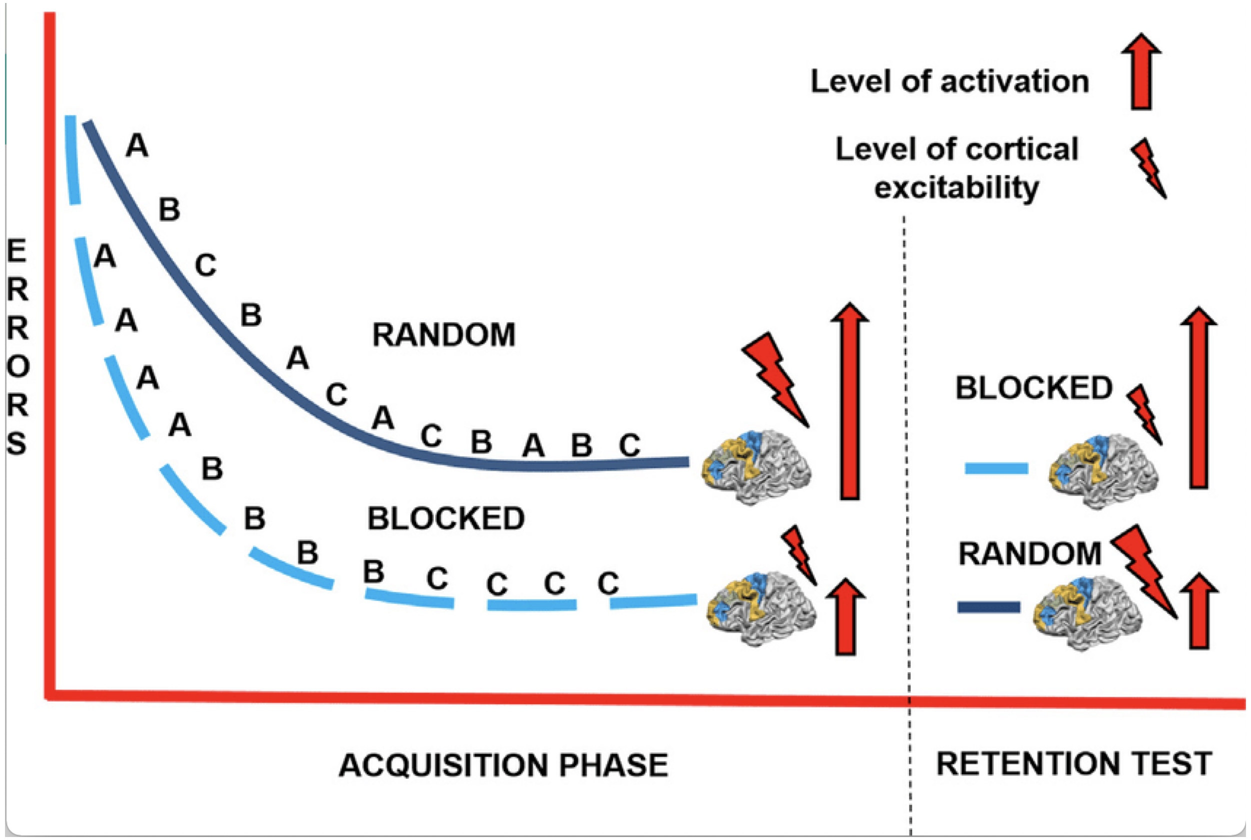
# *Task practice – random vs. blocked*




**Blocked**: repetition of same task variations

**Random**: repetition of different task variations

*Lage et al. 2015*

# Task practice – random vs. blocked

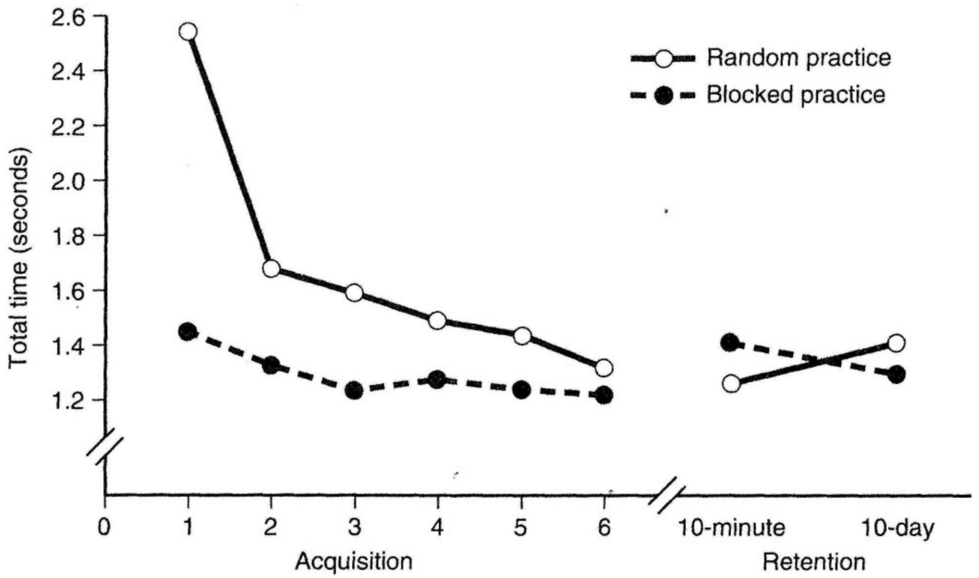
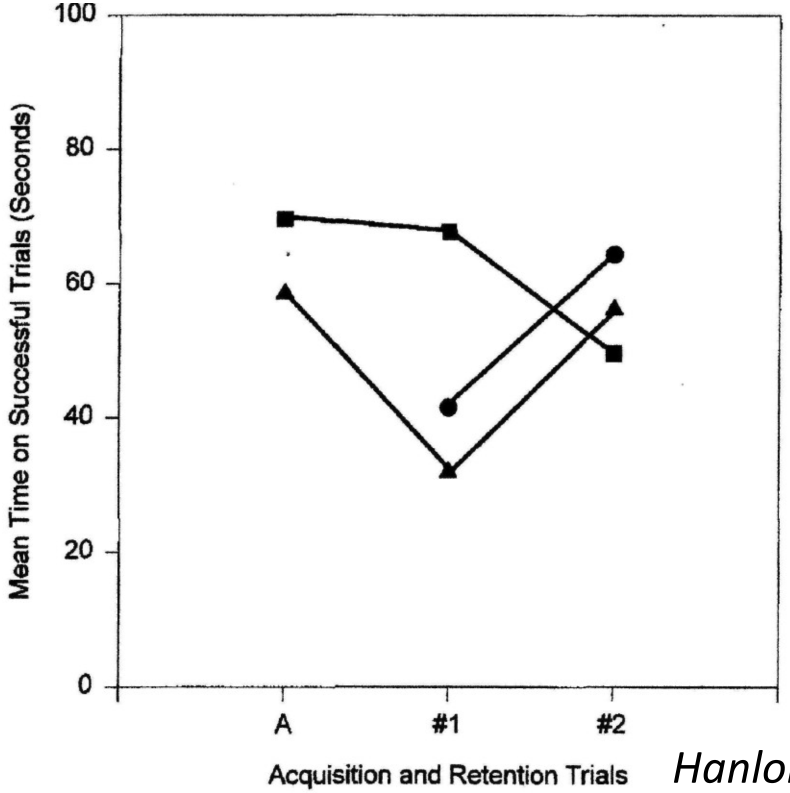



**Figure 4–4**

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.)




*Hanlon 1996*

**Fig 3. Time to complete successful trials (■, random; ▲, block; ●, control).**

Random practice may have similar or better retention of motor skills

# *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

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- **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**

| | FM | | | ARA | | |
|---|---|---|---|---|---|---|
| | PRE Mean (SD) | POST Mean (SD) | Change Mean (SD) | PRE Mean (SD) | POST Mean (SD) | Change Mean (SD) |
| MP (n=16) | 33.03 (8.37) | 39.75 (6.86) | +6.72** (3.68) | 18.00 (10.99) | 25.81 (11.29) | +7.81** (5.14) |
| PP (n=16) | 35.75 (9.51) | 36.75 (10.74) | +1.0 (3.68) | 17.25 (14.29) | 17.69 (13.75) | +0.44 (2.03) |

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*

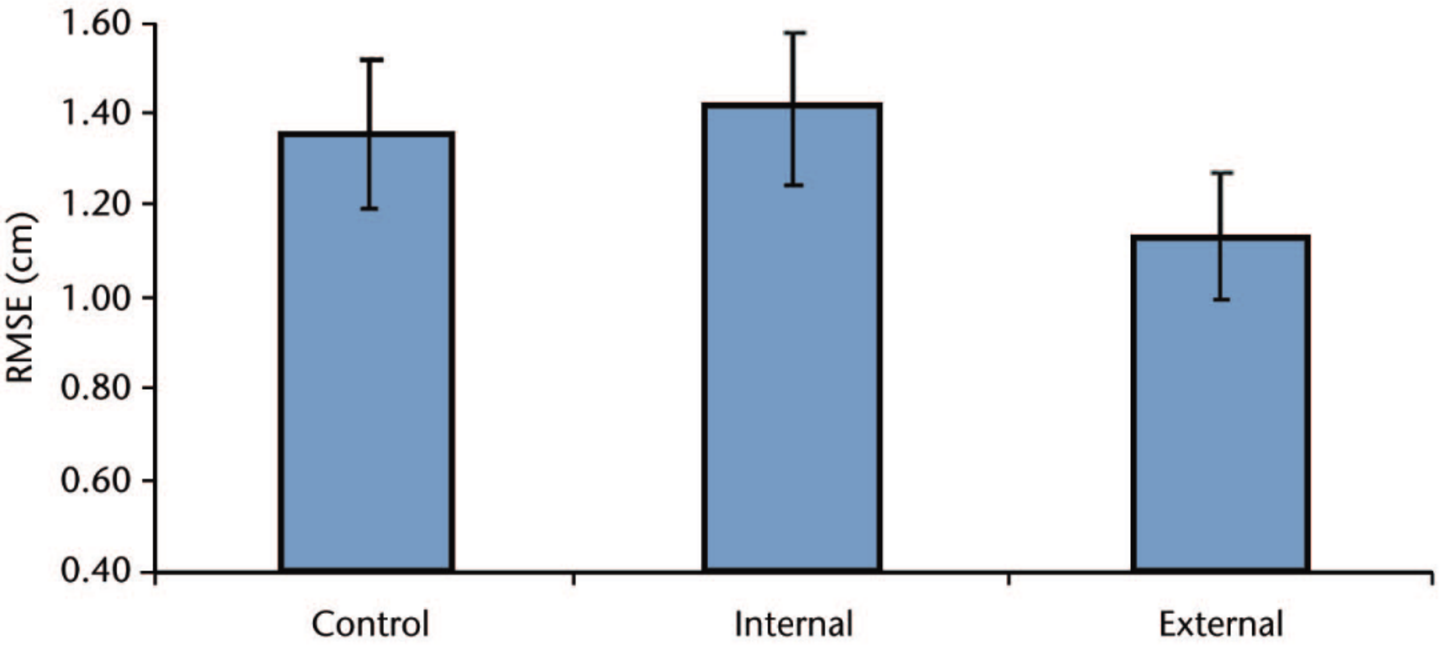



**Figure 2.**
Magnitude of sway (root-mean-square error [RMSE]) for participants with Parkinson disease as a function of the type of attentional focus (control, internal, or external). Error bars indicate 95% confidence intervals.

*Wulf et al. 200*

# Knowledge of results vs. Knowledge of performance

| Knowledge of Results | Knowledge of Performance |
| --- | --- |
| *Outcome of success or failure* | *Task execution* |
| Feedback about time to complete task such as walking or eating a meal | Feedback about position of limbs during walk or position of head/posture during eating |
| Feedback about number of successful trials during reaching for an object or swallowing | Feedback about coordination or timing of reach to grasp movements or breathing/swallowing. |

# Less feedback may result in better skill retention

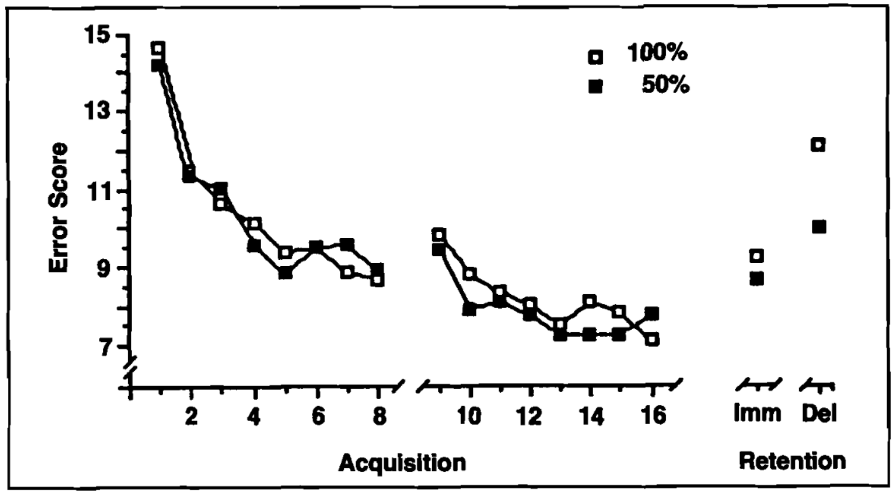
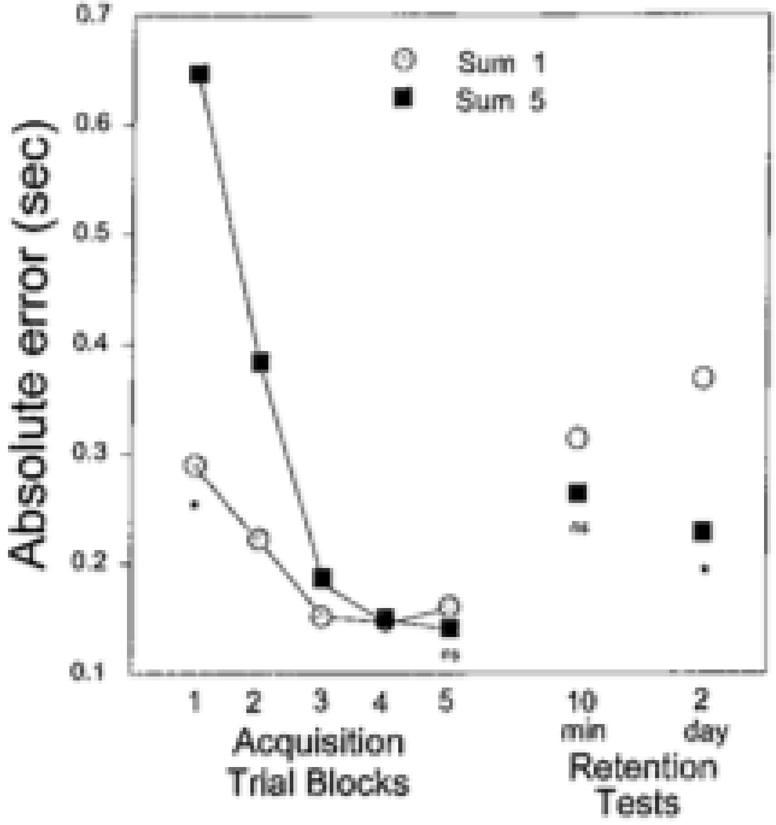



**Figure 1.** *Average error score for the 50%-KR and 100%-KR relative-frequency groups during the 2-day acquisition phase (blocks 1-16) and the immediate (Imm) and 1-day delayed (Del) no-KR retention phases. Each block is the average of 12 trials. (Adapted from Winstein and Schmidt.[37])*




*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 ~~a 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

Archives of Physical Medicine and Rehabilitation
Volume 97, Issue 4, April 2016, Pages 567-574

Original research

## 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.

Georgia A. Malandraki PhD [a b c], Akila Rajappa MS [b], Cagla Kantarcigil MS [a b], Elise Wagner MS [b], Chandra Ivey MD [d], Kathleen Youse PhD [b]

Archives of Physical Medicine and Rehabilitation
Volume 91, Issue 5, May 2010, Pages 743-749

Original article

## McNeill Dysphagia Therapy Program: A Case-Control Study

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

Giselle D. Carnaby-Mann MPH, PhD [a], Michael A. Crary PhD [b]

# 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

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation
journal homepage: www.archives-pmr.org
Archives of Physical Medicine and Rehabilitation 2014;95:1374-82

ORIGINAL ARTICLE

## Skill Training for Swallowing Rehabilitation in Patients With Parkinson's Disease

CrossMark

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

Movement Disorders
CLINICAL PRACTICE
LETTERS: NEW OBSERVATIONS

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

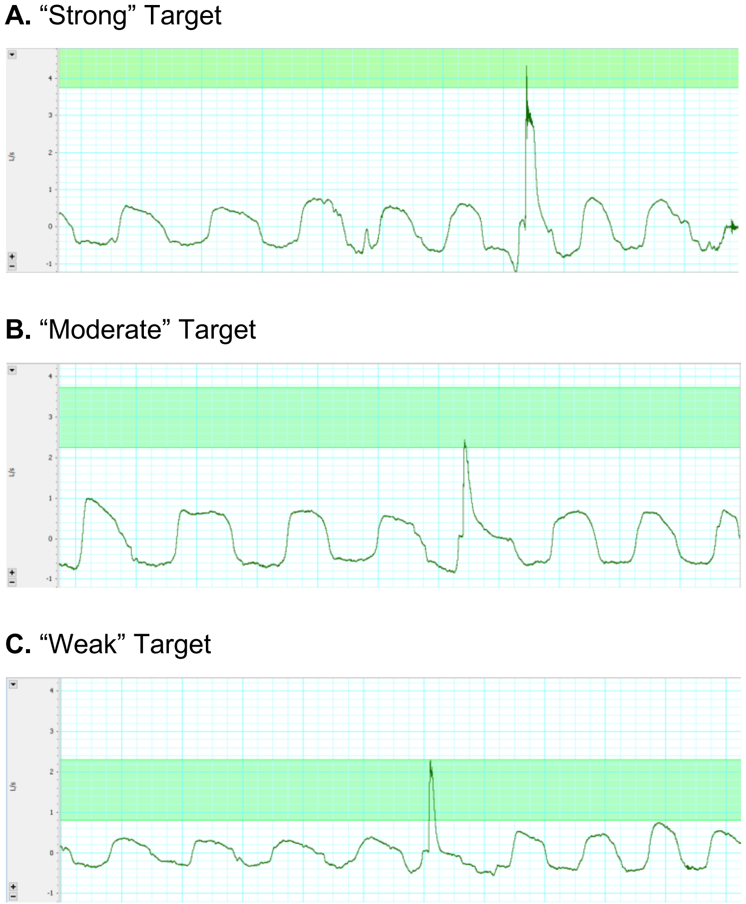
*Sarah E. Perry, PhD,[1,*] Jordanna S. Sevitz, MS,[1] James A. Curtis, MS,[1] Sheng-Han Kuo, MD,[2] and Michelle S. Troche, PhD[1,2]*

# Task Considerations: Random Practice

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

| | | | |
|---|---|---|---|
| Block 1 | Moderate (3 trials) | Strong (3 trials) | Weak (3 trials) |
| Block 2 | Strong | Moderate | Weak |
| Block 3 | Weak | Strong | Moderate |






(Borders et al., in prep, dissertation)

# Task Considerations: Random Practice

## Generalization to trained and untrained tasks

| Time | Task | Result |
|---|---|---|
| Visit 1 | Voluntary Single | Improved 0.31 L/s |
| | Voluntary Sequential | Improved 0.24 L/s |
| | Reflex | No change |
| Visit 2 | Voluntary Single | Improved 0.20 L/s |
| | Voluntary Sequential | Improved 0.15 L/s |
| | Reflex | No change |
| Change from Pre to Post-Treatment | Voluntary Single | Improved 0.35 L/s |
| | Voluntary Sequential | Improved 0.22 L/s |
| | Reflex | No change |



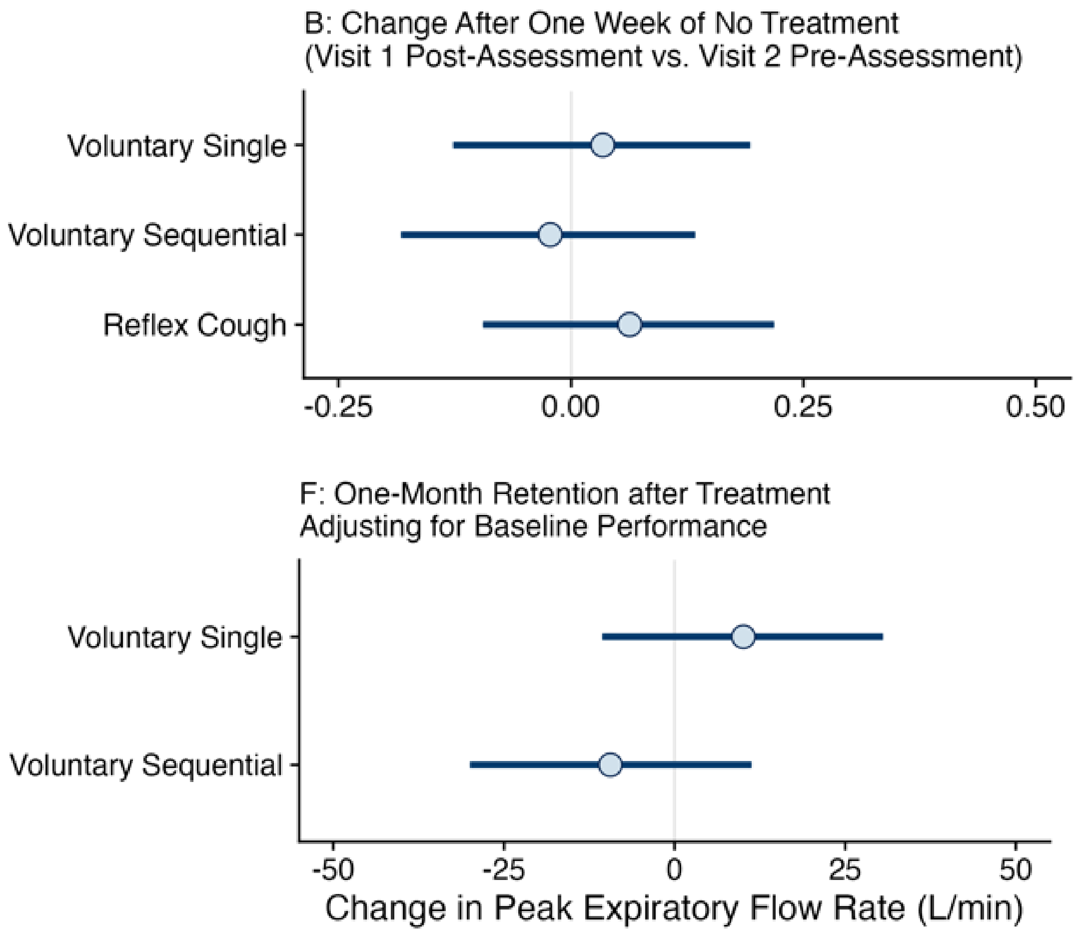
(Borders et al., in prep, dissertation)

# Task Considerations: Variability of Practice

Retention of Treatment Gains

- Short-term retention
- Long-term retention

- Indicating maintenance of treatment gains *(motor learning)*





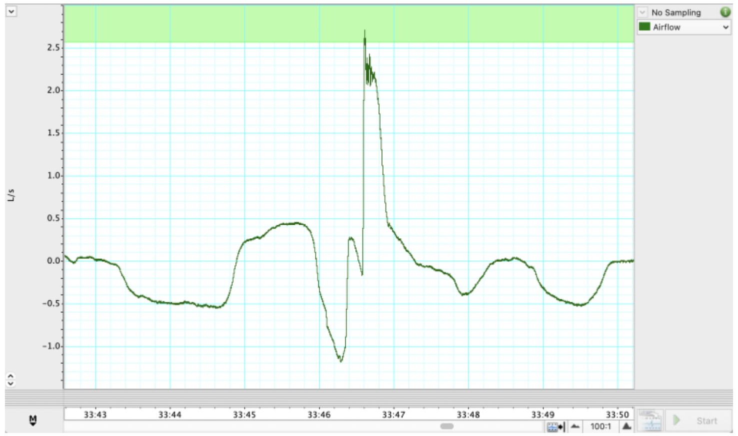

(Borders et al., in prep, dissertation)

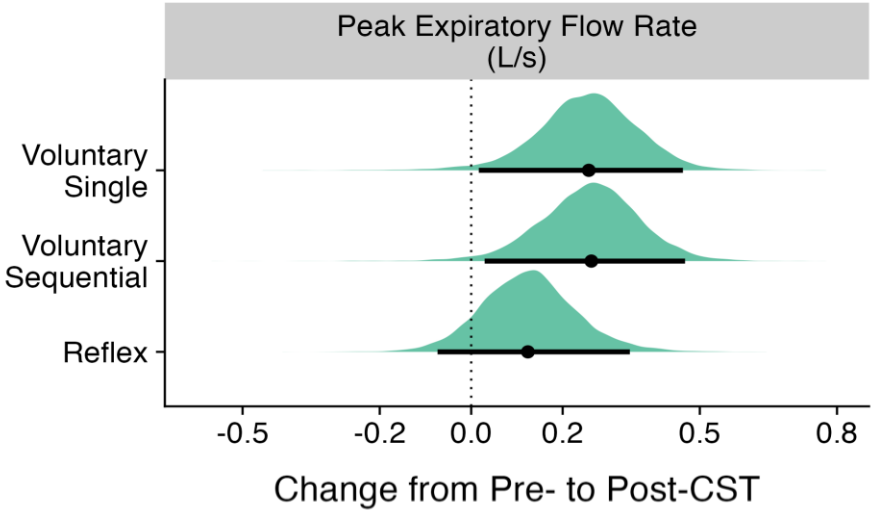
# Task Considerations: Blocked Practice

- 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





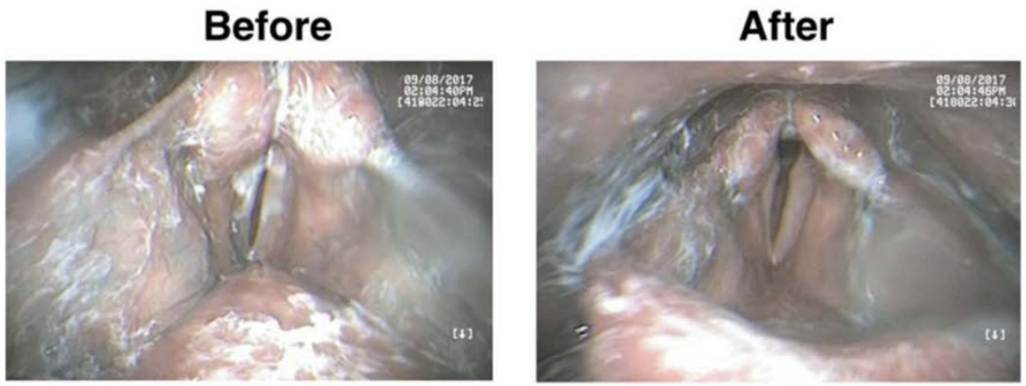



(Borders et al., in prep, dissertation)

# 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

ASHA American Speech-Language-Hearing Association

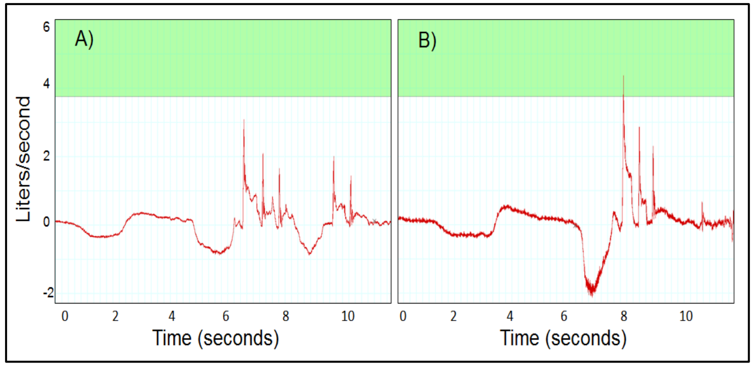
AJSLP

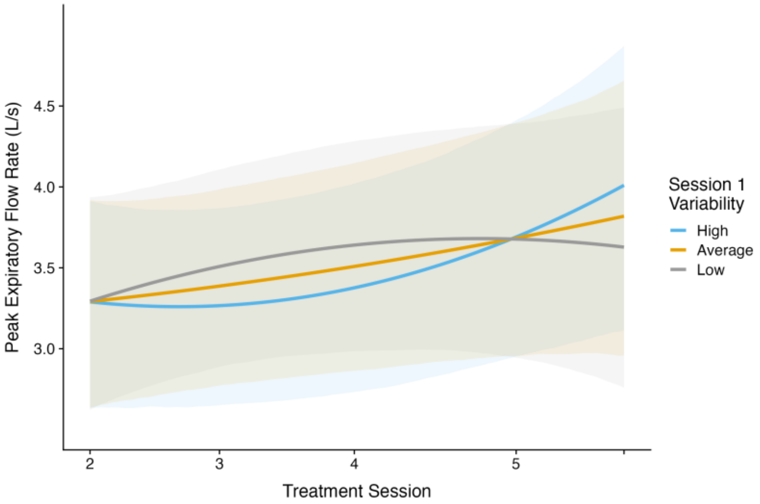
Research Article

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

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

[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



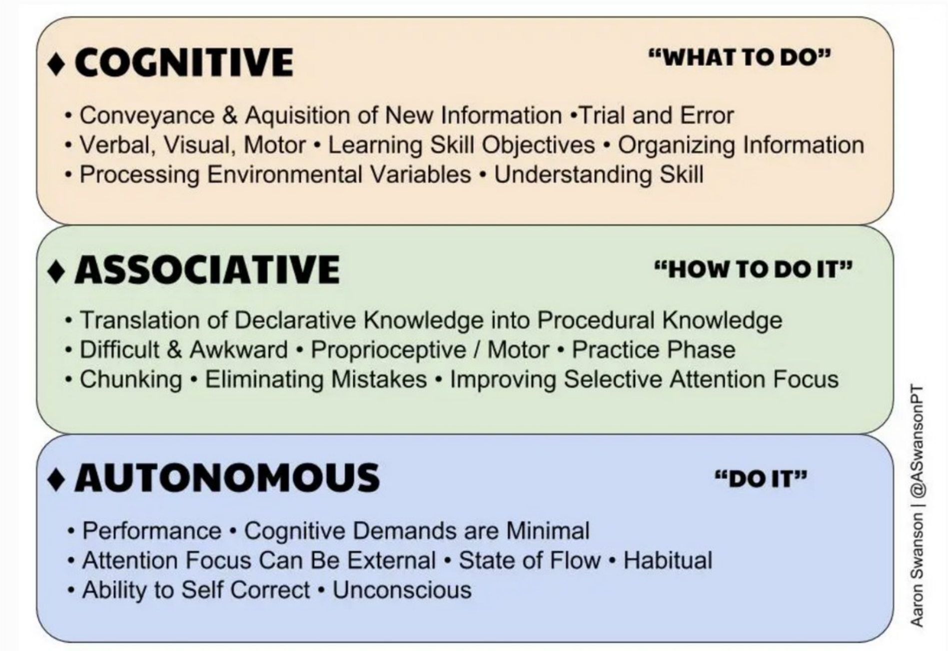

- Early variability during cough skill training may predict treatment response
- Variability may indicate exploring different strategies to improve cough



(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



# Augmented Information: Motor Imagery

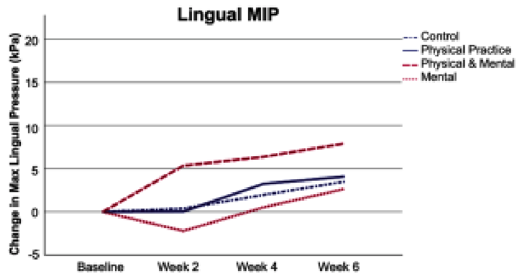



**Fig. 1** Descriptive data showing a trend for maximum isometric lingual pressure in kilopascals (kPa) to increase when physical and mental exercise components are combined


Dysphagia (2021) 36:474–482
https://doi.org/10.1007/s00455-020-10164-5


ORIGINAL ARTICLE

Check for updates

## A Randomized Controlled Trial Comparing Physical and Mental Lingual Exercise for Healthy Older Adults


Sarah H. Szynkiewicz[1,2] · Erin Kamarunas[3] · Teresa Drulia[5] · Christina V. Nobriga[6] · Lindsay Griffin[3,4] · Cynthia R. O'Donoghue[3]



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




JSLHR


Research Article

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


Sarah H. Szynkiewicz,[a] Christina V. Nobriga,[b] Cynthia R. O'Donoghue,[c] Benjamin J. Becerra,[d] and Garret LaForge[a]



International Journal of Orofacial Myology and Myofunctional Therapy

Official Journal of the International Association of Orofacial Myology

Volume 48 | Number 1 | pp. 1-16 2022


Research Article

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


Erin Kamarunas (*James Madison University*)
Sarah Szynkiewicz (*Samford University*)
Lindsay Griffin (*Emerson College and James Madison University*)
Teresa Drulia (*Texas Christian University*)
Kelsey Murray (*James Madison University*)

# Augmented Information: Verbal Cueing and Concurrent Feedback

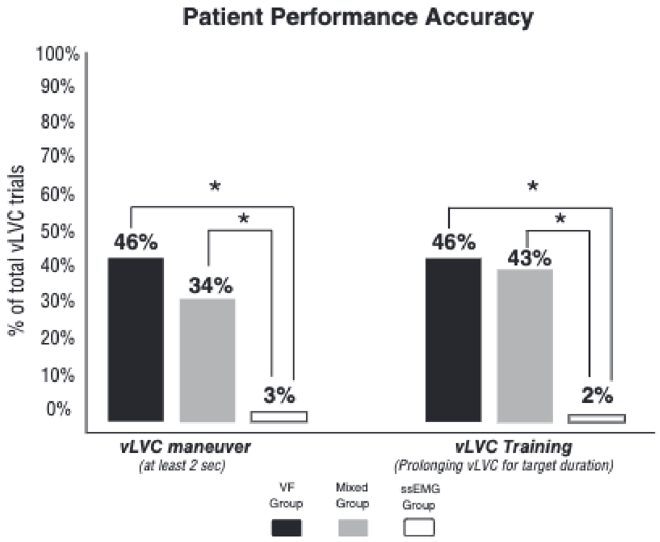
PM R 11 (2019) 1159-1169

www.pmrjournal.org

Original Research—CME

**Kinematic Visual Biofeedback Improves Accuracy of Swallowing Maneuver Training and Accuracy of Clinician Cues During Training in Stroke Patients with Dysphagia**

Alicia K. Vose, MA, Arielle Marcus, BA, Ianessa Humbert, PhD



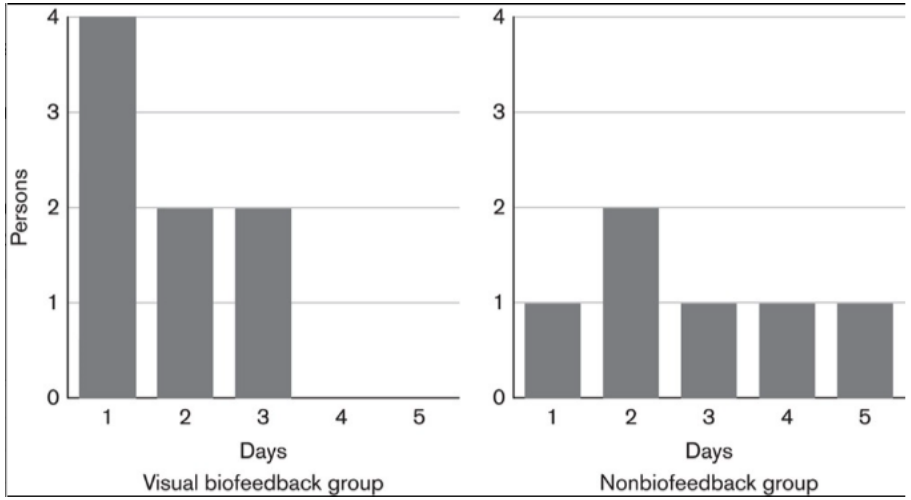

BRIEF RESEARCH REPORTS

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

Imada, Miho[a]; Kagaya, Hitoshi[b]; Ishiguro, Yuriko[a]; Kato, Miho[a]; Inamoto, Yoko[c]; Tanaka, Takashi[b]; Shibata, Seiko[b]; Saitoh, Eiichi[b]

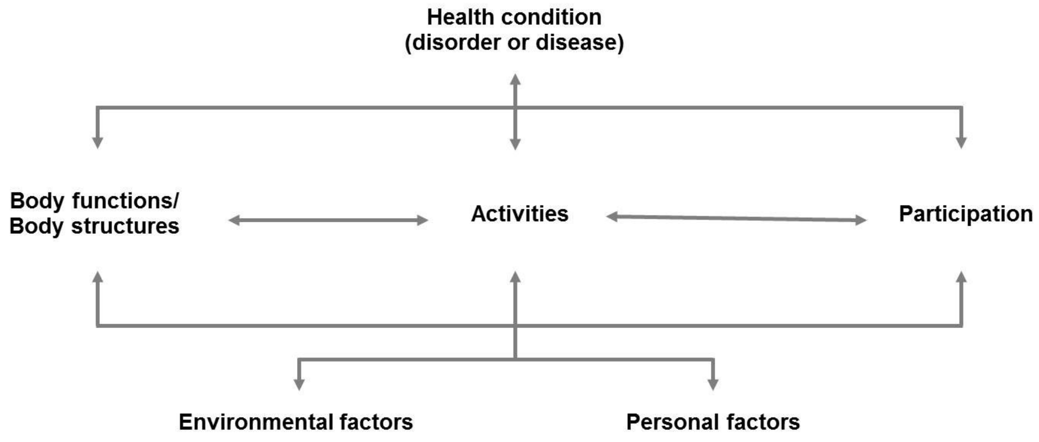
Author Information

*International Journal of Rehabilitation Research* 39(2):p 181-184, June 2016. | *DOI:* 10.1097/MRR.0000000000000154



# 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

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation
journal homepage: www.archives-pmr.org
Archives of Physical Medicine and Rehabilitation 2015;96:885-93

ORIGINAL RESEARCH

## Respiratory-Swallow Training in Patients With Head and Neck Cancer

CrossMark

Bonnie Martin-Harris, PhD, CCC-SLP,[a,b,c] David McFarland, PhD, CCC-SLP,[d,e] Elizabeth G. Hill, PhD,[f] Charlton B. Strange, MD,[g] Kendrea L. Focht, PhD, CScD, CCC-SLP,[a,b,c] Zhuang Wan, MS,[f] Julie Blair, MA, CCC-SLP,[b,c] Katlyn McGrattan, PhD, CCC-SLP[a,b]

**Table 1** Description of goals for each training module

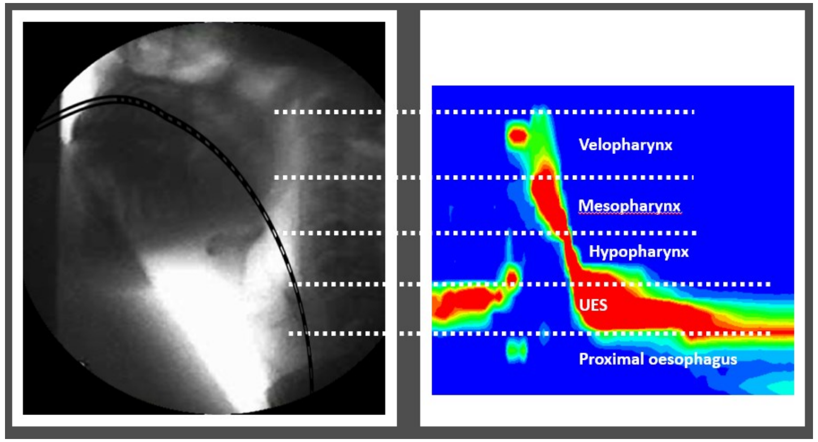
| Module | Goal Description | Criteria Level (%) |
|---|---|---|
| Identification | Identification of target respiratory phase (expiration) (goal 1) and swallow event (goal 2) using simulated tracings. | 80 |
| | Identification of target respiratory phase (expiration) (goal 3) and swallow event (goal 4) using visually guided feedback provided by respiratory movements during self-swallowing. | 80 |
| | 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 tracings (goal 5) and visually guided feedback during self-swallowing (goal 6). | 80 |
| Acquisition | 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. | 80 |
| | 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. | 80 |
| | 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. | 80 |
| | Target phase (expiration) after completion of a swallow event without visually guided feedback for thin (goal 16), nectar-thickened (goal 17), and honey-thickened (goal 18) liquids during self-swallowing. | 80 |
| Mastery | 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 19), nectar-thickened (goal 20), and honey-thickened (goal 21) liquids during self-swallowing. | 90 |

NOTE. Visually guided feedback provided to the patient using rib cage tracing on the KayPENTAX Digital Swallowing Workstation.

ENT DYSPHAGIA CLINIC

## The use of high-resolution pharyngeal manometry as biofeedback in dysphagia therapy

Ashli O'Rourke, MD; Kate Humphries, MS



# Augmented Information: Verbal Info/Cueing - Focus of Attention

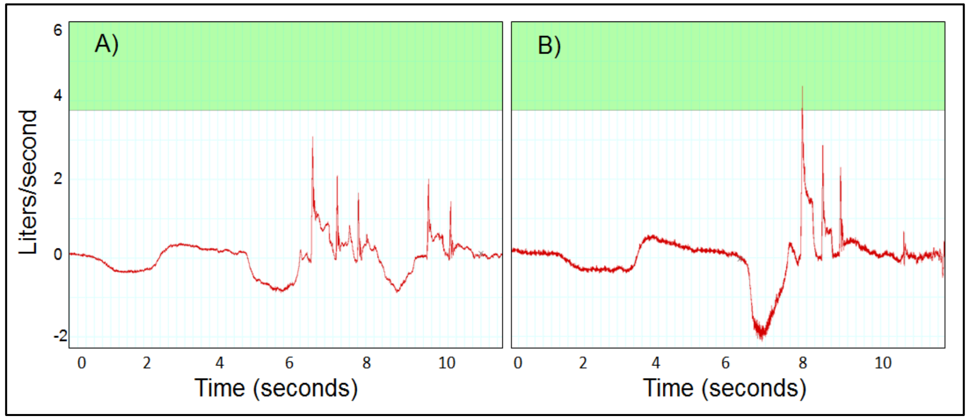
- We should try to find ways to move from internal to external focus of attention, when possible
  - Reducing reliance on biofeedback may be one way to do this
  - Focusing more on the outcome of the behavior versus the many parts that make up the behavior

# Augmented Information: Terminal Feedback – KR vs KP

RESEARCH ARTICLE

## 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,[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,[8] and Karen W. Hegland, PhD, CCC-SLP[7,9]




ORIGINAL ARTICLE

Check for updates

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

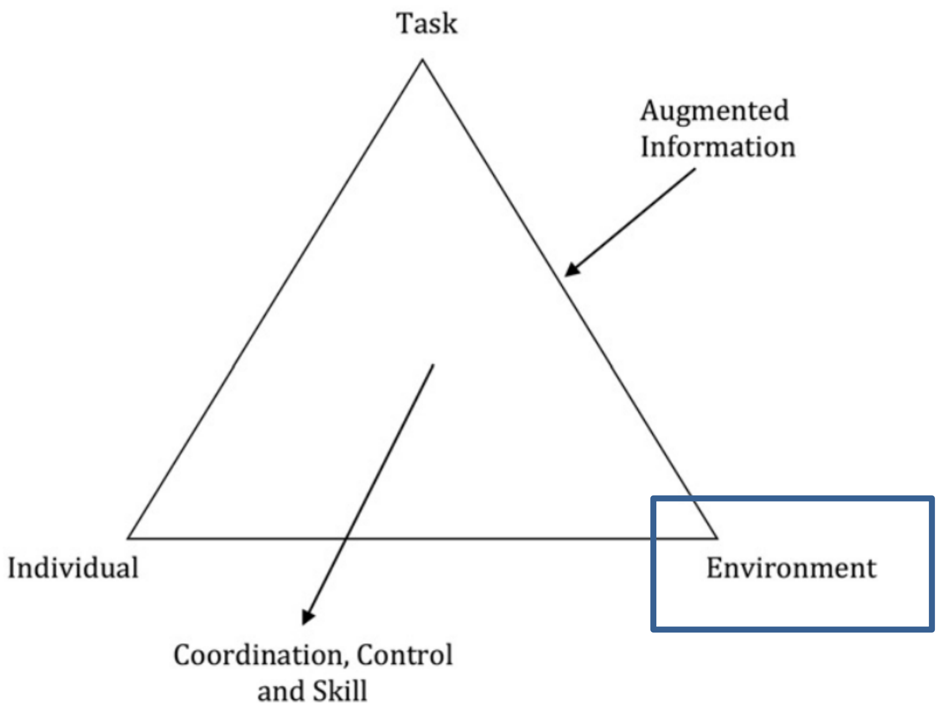
James C. Borders[1] · James A. Curtis[1] · Jordanna S. Sevitz[1] · Nora Vanegas-Arroyave[2] · Michelle S. Troche[1]

Received: 24 June 2020 / Accepted: 13 January 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

ELSEVIER
Contents lists available at ScienceDirect
Parkinsonism and Related Disorders
journal homepage: www.elsevier.com/locate/parkreldis


Attentional resource allocation and swallowing safety in Parkinson's disease: A dual task study

CrossMark

Michelle S. Troche [a,c,d,*], Michael S. Okun [b,c], John C. Rosenbek [a,c,d], Lori J. Altmann [a], Christine M. Sapienza [d,e]

Dysphagia (2021) 36:959–973
https://doi.org/10.1007/s00455-020-10223-x

ORIGINAL ARTICLE

Check for updates

Dual Tasking Influences Cough Reflex Outcomes in Adults with Parkinson's Disease: A Controlled Study

Sarah E. Perry[1,2,3] · Michelle S. Troche[1]

Received: 6 July 2020 / Accepted: 24 November 2020 / Published online: 2 January 2021

# 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

ASHA American Speech-Language-Hearing Association

AJSLP

Research Article

**Rehabilitation of Airway Protection in Individuals With Movement Disorders: A Telehealth Feasibility Study**

Jordanna S. Sevitz,[a] James C. Borders,[a] Avery E. Dakin,[a] Brianna R. Kiefer,[b] Roy N. Alcalay,[c,d] Sheng-Han Kuo,[c] and Michelle S. Troche[a,c]

[a]Laboratory for the Study of Upper Airway Dysfunction, Department of Biobehavioral Sciences, Teachers College, Columbia University, New York, NY [b]Department of Speech, Language, and Hearing Sciences, Purdue University, West Lafayette, IN [c]Department of Neurology, Columbia University Irving Medical Center, New York, NY [d]Department of Neurology, Tel Aviv Sourasky Medical Center, Israel

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

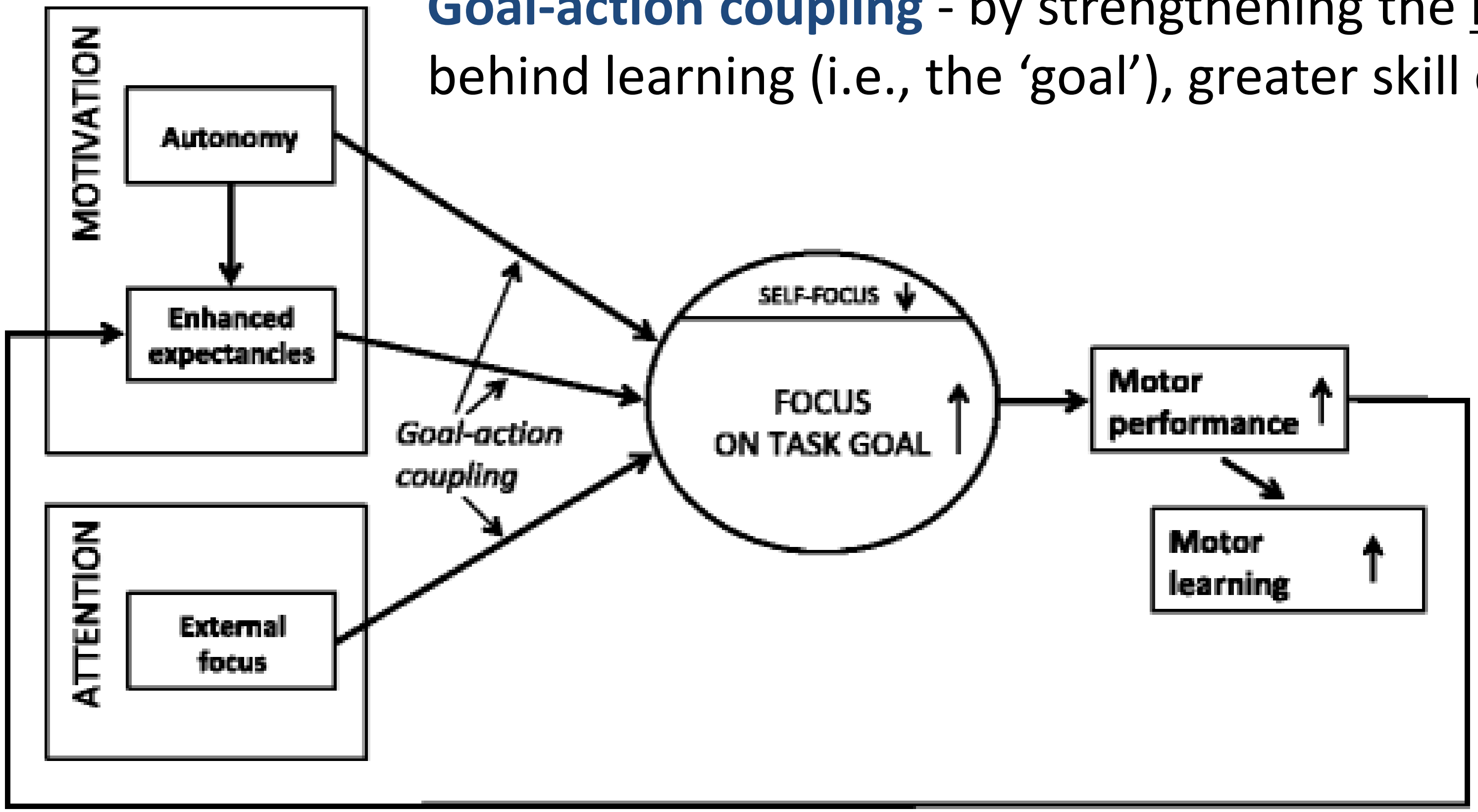
| Task Changes | Regression | Progression |
|---|---|---|
| Swallow stimuli | Simplify types of swallow stimuli | Diversity swallow stimuli to be more representative of a meal |
| Speed | Allow slower completion of task | Encourage faster completion of task |
| Perturbation | | Consider an unexpected stimulus |
| Cognitive demand | Eliminate distractions | Consider a dual task condition or engage in conversation during task performance |
| **Environmental Changes** | | |
| Physical Assistance | Hand over hand in the context of impulsivity | Increase challenge of meals |
| Environmental Inputs | Quiet environment, bright lights | Environment with more distractions and cognitive challenges |

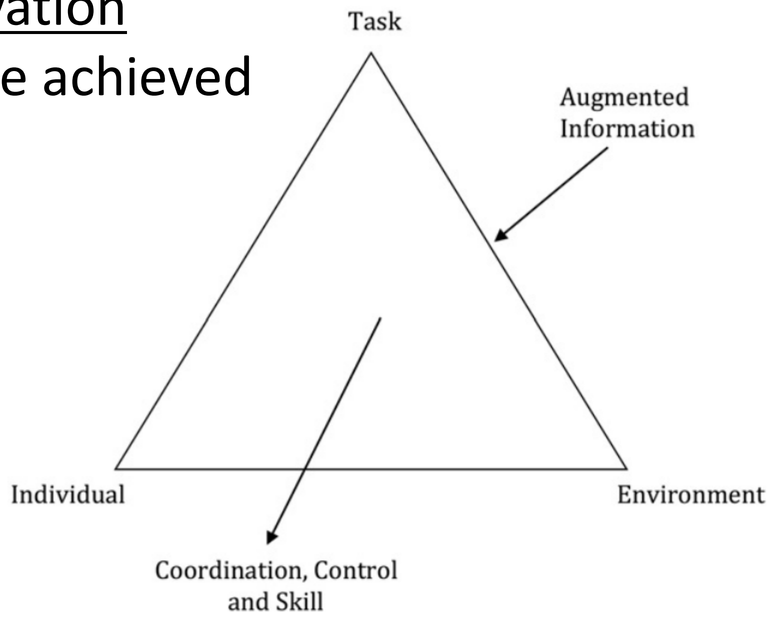


(Quinn et al., 2021)

# **Summary:** Using Principles of Motor Learning to Promote improved Swallowing and Cough

**Goal-action coupling** - by strengthening the <u>motivation</u> behind learning (i.e., the 'goal'), greater skill can be achieved






(Wulf et al., 2016; Lewthwaite 2016) )

# 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

| Task Changes | Regression | Progression |
|---|---|---|
| Swallow stimuli | Simplify types of swallow stimuli | Diversity swallow stimuli to be more representative of a meal |
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| Physical Assistance | Hand over hand in the context of impulsivity | Increase challenge of meals |
| Environmental Inputs | Quiet environment, bright lights | Environment with more distractions and cognitive challenges |



(Quinn et al., 2021)

# Thank you!


# Questions and Discussion