

Applying Principles of Motor Learning to Dysphagia Management

Motor Learning Improving movements over time

note:
sensory included
movements could worsen

(Bastian 2008)

If **learning** implies that something is unknown, can there be learning in swallowing?

Arguments **against** learning in swallowing:

Hardwired function
1st swallow about 10th week of gestation to regulate amniotic fluid

The pharyngeal phase is primarily brainstem regulated and reflexive.

Most people don't know how a swallow happens

How can you objectively measure learning in swallowing?

(Ross et al 1998; Lang 2009; Humbert and German 2013)

Arguments **for** learning in swallowing:

Obligatory **volitional** and reflexive components and one can influence the other
oral - volitional; pharyngeal/laryngeal - reflexive

Reflexive components are modifiable (cortical input)
Mendelsohn, effortful, supraglottic

Initiation can be volitional, spontaneous, or reflexive

(Shaker et al 1994; Peck et al 2010; Humbert et al 2012)

Can there be learning in swallowing?

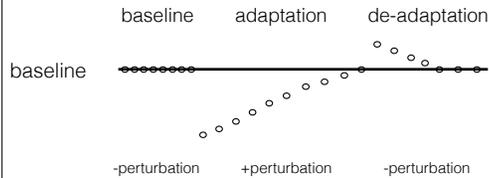
Depends on the learning parameters you set

Unique system - Unique rules!

Ways to understand learning...

typical study design

motor adaptation
error-based learning



Learn a new sequence of movements that become increasingly smooth and efficient, gradually moving away from baseline (Dayan et al 2009)



Reis et al 2009

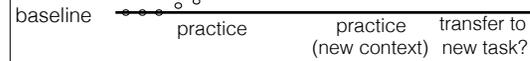


Cantarero et al 2015

skill learning

implicit

explicit



What is a skill?
new movement?
not necessarily...



What is a skill?

Skill means that you can make particular movements under certain constraints with a specified goal:

hit a small, rapidly moving ball in a particular direction, to a particular distance, at a particular speed

motor adaptation
error-based learning

skill learning

implicit

explicit

The TASK is the other differentiation between implicit and explicit learning

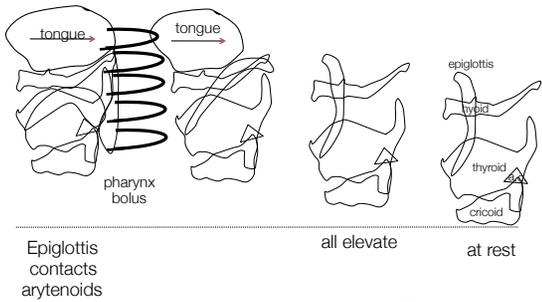
well learned task

skilled task

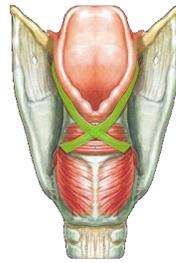


Our swallowing learning studies focus on airway protection

Laryngeal Vestibule Closure



Logemann et al 1992; Fink 1974

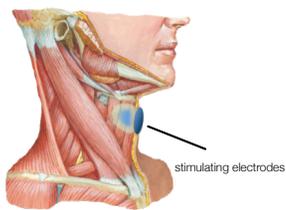


Aryepiglottic Muscle

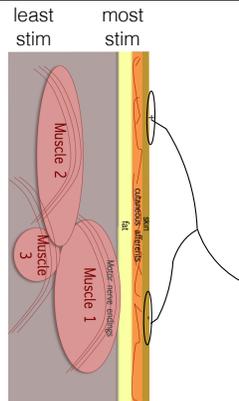
Implicit Learning - Error based learning study

Healthy young volunteers

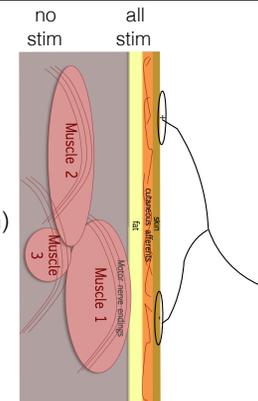
Perturbation - surface electrical stimulation

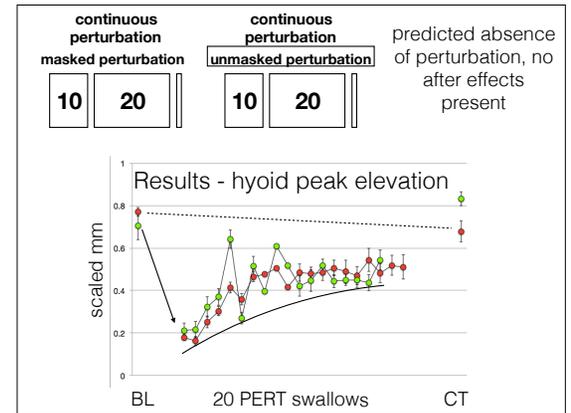
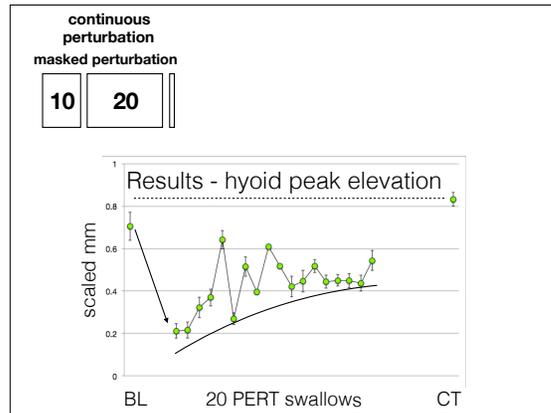
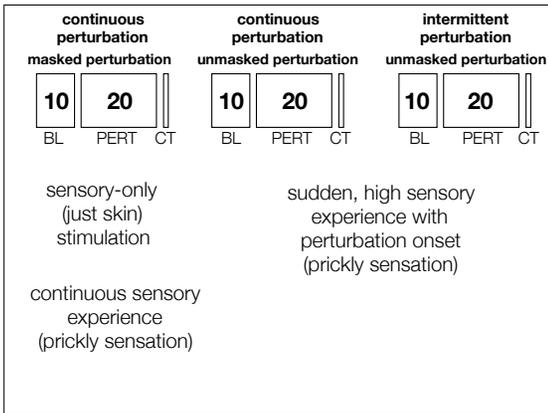
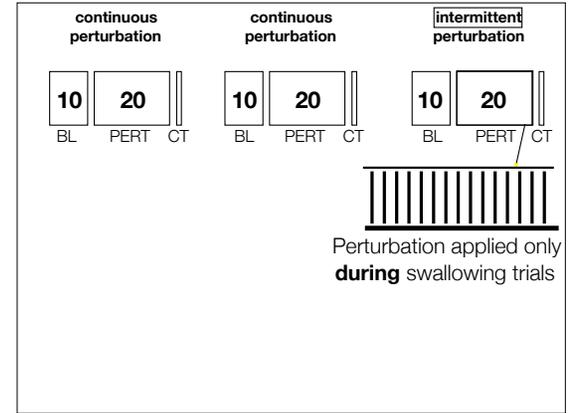
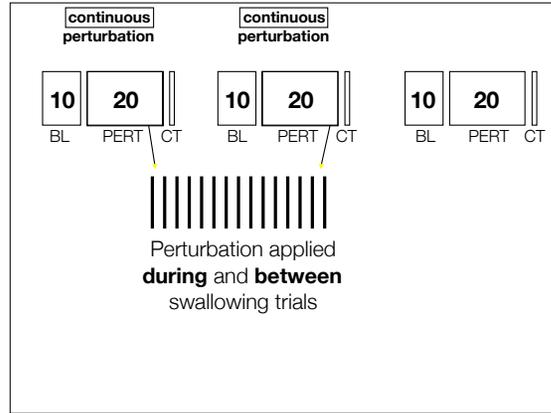
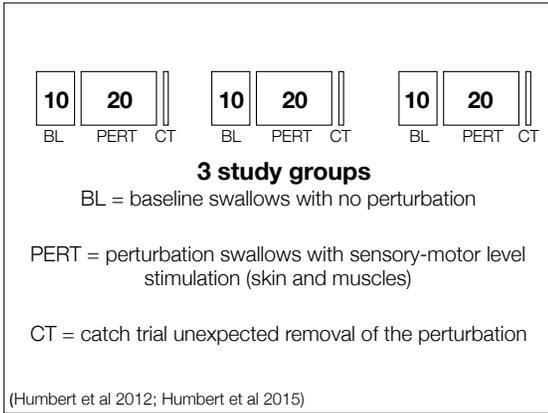


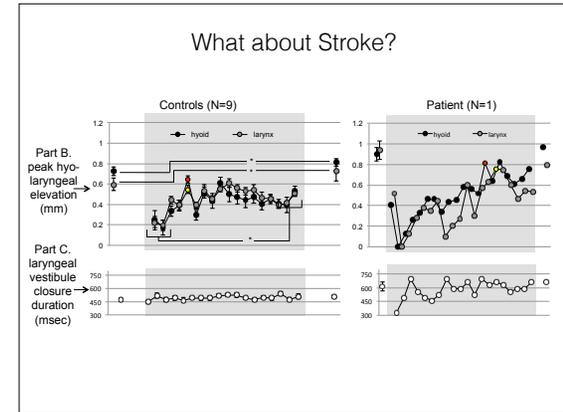
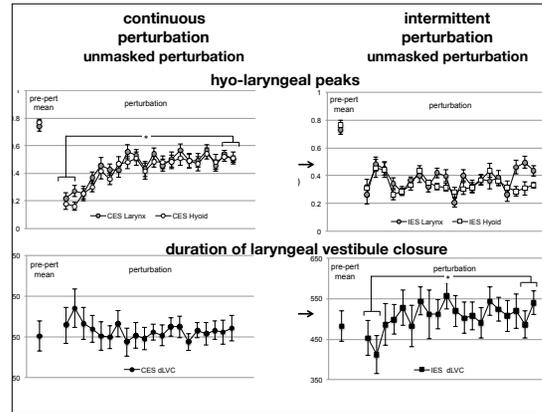
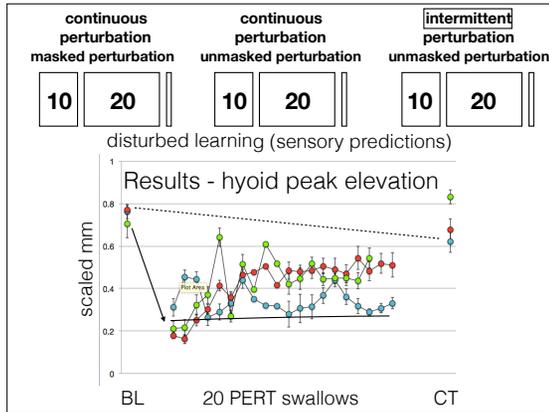
Perturbation = High stimulation (sensory-motor; skin & muscles)



Low stimulation (sensory-only; just skin)







what did we learn about implicit learning
(motor adaptation; error-based learning)

Healthy adults implicitly reduce swallowing errors

Error-reduction in swallowing airway protection is multifactorial (LVC, peak, etc)

Electrical stimulation protocol influences what component of airway protection shows learning

How to apply this into clinical practice

1. Compare abnormal **and** normal swallows
2. Establish a baseline!!!
3. Track the **same** behavior(s) overtime

1. Compare abnormal **and** normal swallows

“Why is adaptation important for human behavior and rehabilitation, given its relatively transient nature? The answer is simple: it allows the nervous system a highly flexible control that can account for temporary, but predictable, changes in the demands of the task. Thus, a finite number of ‘learned’ motor patterns can be adapted to account for many different situations

Bastian 2008

Does swallowing have
“many different situations”?

taste	upright	cup
texture	reclined	spoon
viscosity	supine	straw
temperature	prone	fork
carbonation	...any combination of these	

Your diagnostic process should determine if these are diminished or absent in patients “Why is adaptation important for human behavior and rehabilitation, given its relatively transient nature? The answer is simple: it allows the nervous system a highly flexible control that can account for temporary, but predictable, changes in the demands of the task. Thus, a finite number of ‘learned’ motor patterns can be adapted to account for many different situations

How?

Is a particular swallowing event normal under one swallowing circumstance, but abnormal in another?

How do you know?

How frequently do you analyze the NORMAL swallows in your patients?

1. Establish a baseline

Do you do the following:

Determine % intelligibility at only the phoneme level?

Determine severity of dysphonia with only a sample of /a/?

Diagnose aphasia only after overhearing the patient communicate with the nurse?

2. Establish a baseline

Then how can you establish a solid baseline swallowing profile with only 1-2 swallows of 3-4 consistencies?

2. Establish a baseline

Power et al 2009: Table 2 - The aspiration scores for each of the swallow trails (1-6) for the 511 swallows included in this study are shown.

Aspiration score	Trial						Total							
	1	2	3	4	5	6								
	%		%		%		%							
1	48	53	33	37	32	36	32	43	32	36	31	39	208	41
2	18	20	21	23	17	19	11	15	15	17	8	10	90	18
3	10	11	15	17	18	20	12	16	16	18	21	27	92	18
4	1	1	1	1	1	1	1	1	1	1	1	1	6	1
5	4	4	6	7	10	11	6	8	2	2	7	9	35	17
6	-	-	1	1	-	-	1	1	1	1	1	1	4	1
7	1	1	4	4	2	2	3	4	3	3	1	1	14	3
8	8	9	9	10	9	10	9	12	19	22	8	10	62	12
% >3:		26	40	44	43	46	50							

3. Track the **same** behavior(s) overtime

Analogy: Your friend's doctor indicated that her diet is unhealthy, leading to significant weight gain and high cholesterol. You check in with your friend a month after her first doctor's visit and she reports 100% adherence to the recommended diet and exercise plan!

However, the "objective" measure of success, defined by her doctor, was that she went from a size 20 at Target to a size 14 at Lane Bryant. Huh? Wouldn't you be waiting to learn about actual weight (lbs or kg), HDL, LDL, etc?

3. Track the **same** behavior(s) overtime

Useless: Taking a properly conducted and analyzed MBS (objective measures of swallowing events), but reporting changes based on "tolerating a diet upgrade". What about the objective measures?

3. Track the **same** behavior(s) overtime

Without objective standards, given pressure on SLPs, of course everyone wins (SLP, patient, caregivers, MD, insurance, and administrators).



3. Track the **same** behavior(s) overtime

(Daily) News Flash - "You're not special, SLPs"

Message from Jon Stewart on "being special"



3. Track the **same** behavior(s) overtime

The same rigor is expected of you as every other clinical specialty, despite our limitations!

3. Track the **same** behavior(s) overtime

Even more useless: the SLP does not test the SAME consistencies (safe and unsafe) in follow up fluoros.

skill

explicit

Task: volitional Laryngeal Vestibule Closure (vLVC)

prolonged laryngeal vestibule closure beginning with a swallow and lasting for at least 2 seconds

Research Question

Does external feedback improve skill performance and generalization?

Feedback
(N=10)

vs

No Feedback
(N=7)

Feedback Provided

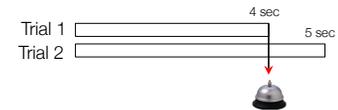
1. Movement Accuracy Cues

LVC present at start, but may not last through the task

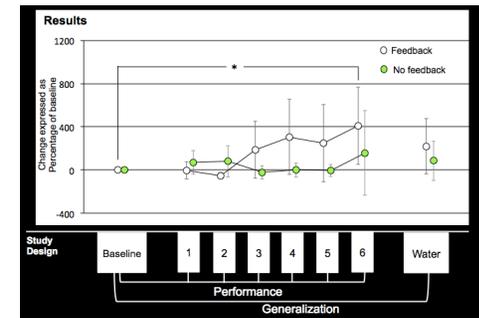
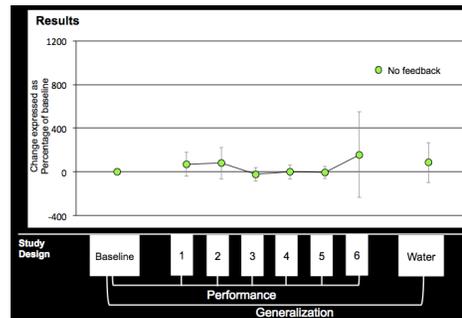
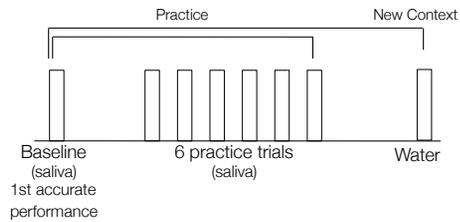
Verbal cue if laryngeal vestibule opens, ending the trial

2. Goal Attainment Cues

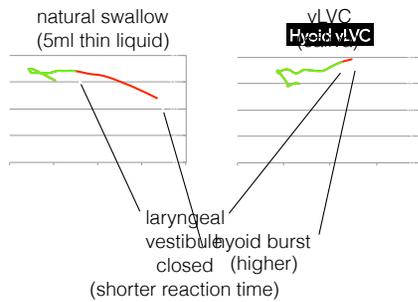
Audio cue when the hold time of the longest trial is exceeded



Study Design (vLVC swallows)



ALTERED hyoid motor pattern to achieve vLVC
mm of movement



Research patient with poor
lingual control leading to
premature spillage,
penetration, and aspiration

How to apply this into clinical practice

1. Compare abnormal **and** normal swallows
2. Establish a baseline!!!
3. Track the **same** behavior(s) overtime
4. If you can't see it (i.e. LVC), you probably can't confirm what it is doing.
"within the constraints of a clinical exam" or "without instrumental confirmation"

Conclusions

Learning happens in swallowing

Ranges between implicit and explicit learning

We have the potential to trial proper and
improper movements