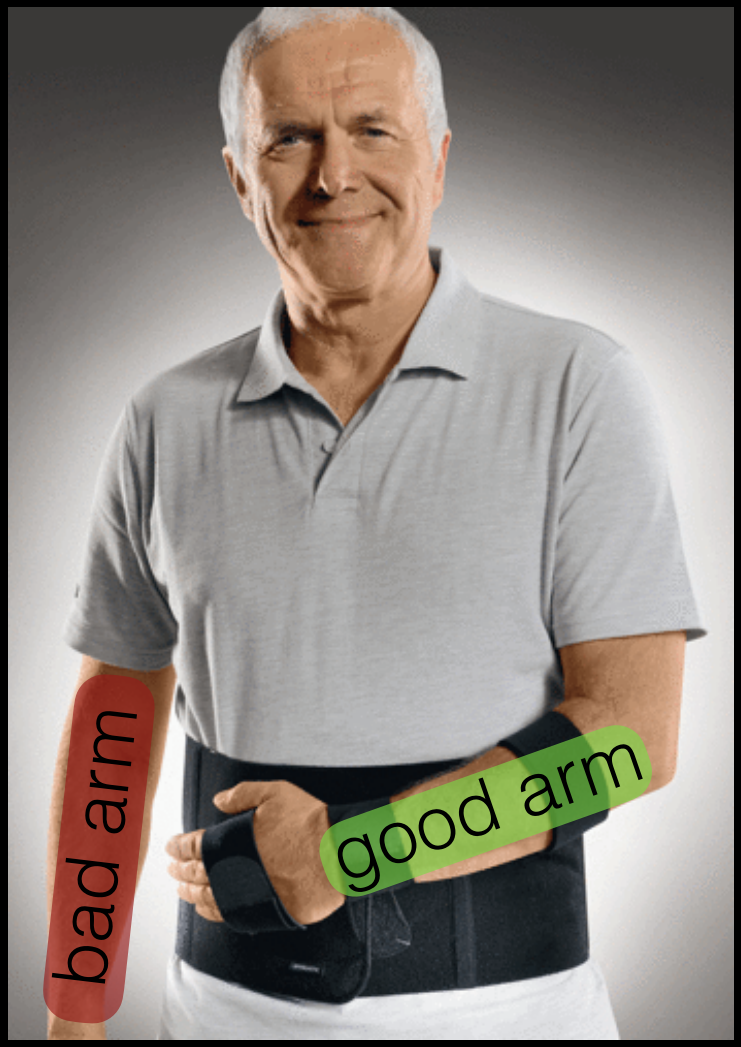
Stay in Your Lane!

Do compensatory strategies rehabilitation potential?

Compensatory Strategies	Rehabilitative Techniques
Short term	Long term
Reduce impairment	Restore function
Effects only when in use	Effects after use
i.e. “Crutch”	Improved strength or skill

Occupational Therapy



Constraint induced movement therapy

Constrain the good arm

Challenge bad arm to work

Form of rehabilitation

Challenge

Demand

Trial

Effort

Difficulty

Strenuous

Arduous

Typical Table of Compensatory Strategies

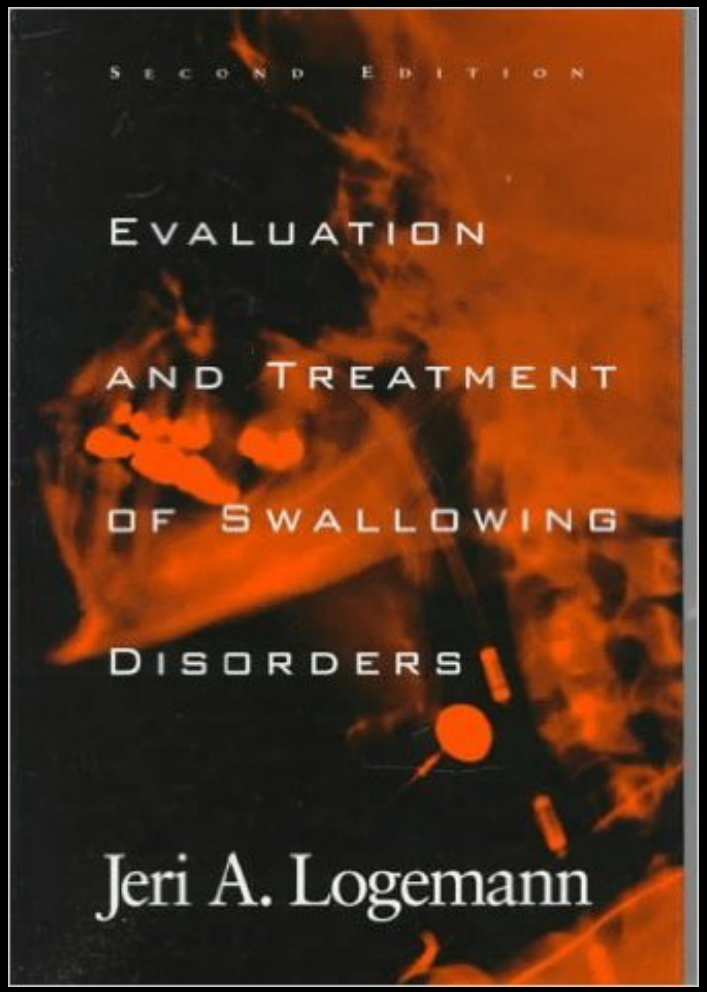
Table 6.1
Postural Techniques Successful in Eliminating Aspiration or Residue Resulting from Various Swallowing Disorders and the Rationale for Their Effectiveness

Disorder Observed on Fluoroscopy	Posture Applied	Rationale
Inefficient oral transit (Reduced posterior propulsion of bolus by tongue)	Head back	Utilizes gravity to clear oral cavity
Delay in triggering the pharyngeal swallow (Bolus past ramus of mandible, but pharyngeal swallow not triggered)	Chin down	Widens valleculae to prevent bolus entering airway; narrows airway entrance; pushes epiglottis posteriorly
Reduced posterior motion of tongue base (Residue in valleculae)	Chin down	Pushes tongue base backward toward pharyngeal wall
Unilateral laryngeal dysfunction (Aspiration during swallow)	Head rotated to damaged side; chin down	Places extrinsic pressure on thyroid cartilage, increasing adduction
Reduced laryngeal closure (Aspiration during swallow)	Chin down; head rotated to damaged side	Puts epiglottis in more protective position; narrows laryngeal entrance; increases vocal fold closure by applying extrinsic pressure
Reduced pharyngeal contraction (Residue spread throughout pharynx)	Lying down on one side	Eliminates gravitational effect on pharyngeal residue
Unilateral pharyngeal paresis (Residue on one side of pharynx)	Head rotated to damaged side	Eliminates damaged side from bolus path
Unilateral oral and pharyngeal weakness on the same side (Residue in mouth and pharynx on same side)	Head tilt to stronger side	Directs bolus down stronger side
Cricopharyngeal dysfunction (Residue in pyriform sinuses)	Head rotated	Pulls cricoid cartilage away from posterior pharyngeal wall, reducing resting pressure in cricopharyngeal sphincter

Common postural techniques & some indications for use

Compensatory technique	Indication
Chin tuck	Reduced oral bolus control with aspiration before or during the swallow
Neck extension	Impaired oral bolus propulsion
Head turn to weak side	Unilat. Pharyngeal weakness with retention after swallowing
Head tilt to weak side	Unilat. Oral & pharyngeal weakness
Reclining position	Pharyngeal weakness with retention & overflow after swallowing
Supraglottic swallow	In adequate or delayed closure of laryngeal aditus (entrance)
Effortful swallow	Poor tongue based retraction
Mendoelsohn maneuver	Inadequate upper esophageal sphincter opening
Syringe feeding	Impaired oral bolus propulsion
Alterating solids & liquids	Retention in the pharynx after swallowing

Comes from dysphagia “bible”



Jeri Logemann,
Ph.D., CCC-SLP

Our studies

chin up and chin down
(principles of motor adaptation)

bolus modification
(principles of sensitivity shifting)

might challenge your views on the potential of compensatory strategies

chin up and chin down

Chin-Down

Reduced oral bolus control → Widens valleculae, prevents aspiration

Chin-Up

Reduced posterior propulsion of bolus by tongue → Utilizes gravity to clear oral cavity

Logemann, 1998

Motor
Adaptation

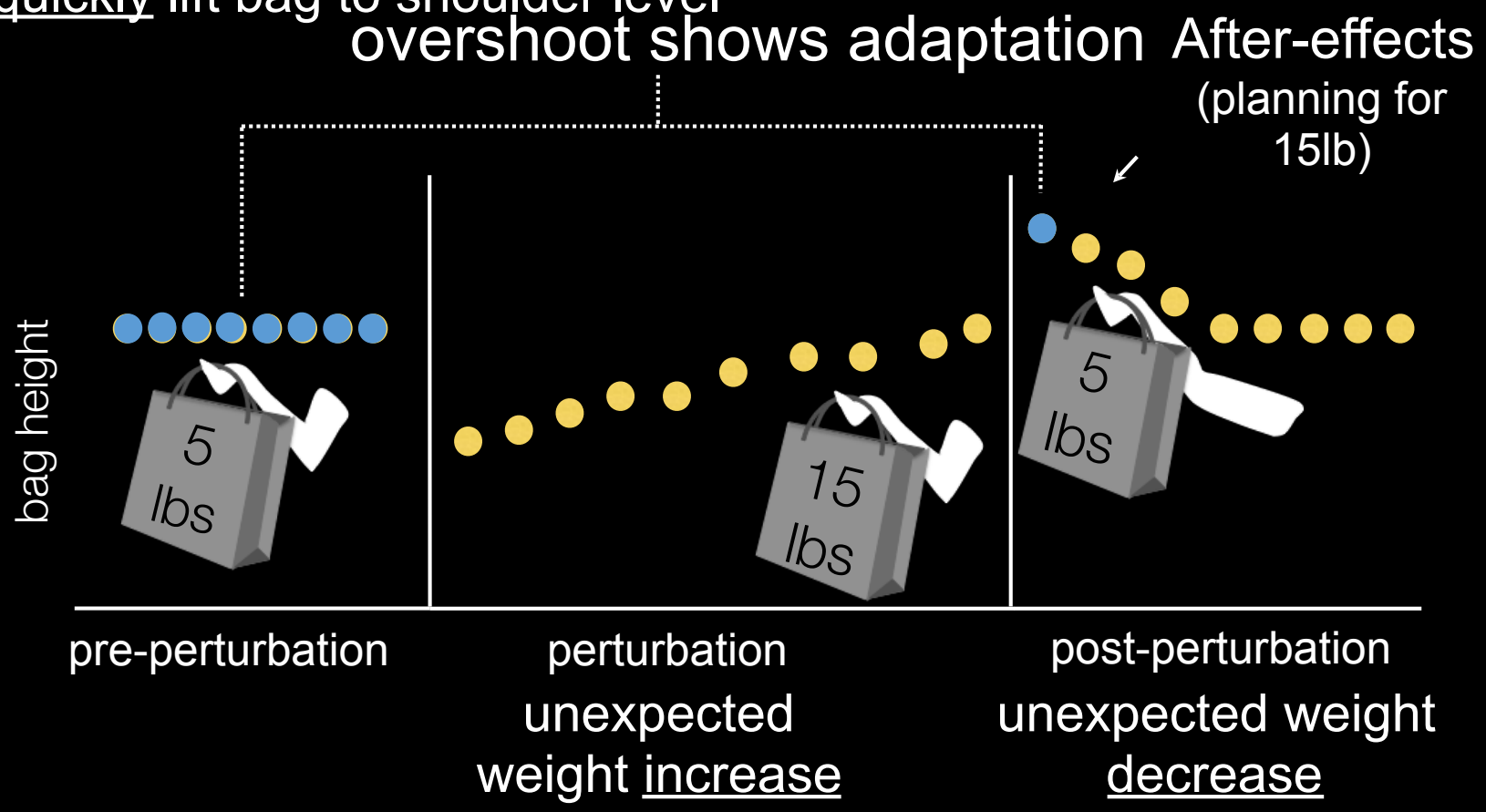
Can a swallow be challenged?

How?

Motor adaptation
(aka error-based learning)

Movement errors are prevented when the nervous system (primary cerebellum) *predicts* the outcome of a movement *before* the movement is made

Task: quickly lift bag to shoulder level



Chin-Down

16 healthy adults

(Macrae et al. 2014)

Chin-Up

12 healthy adults

(Sunday et al. *submitted*)

1. Are there immediate changes in swallowing kinematics during postural swallows?

2. Do swallowing kinematics change over several trials of the posture?

3. Are aftereffects present in neutral swallows after performing several postural swallows?

Chin-Down

16 healthy adults

(Macrae et al. 2014)

Chin-Up

12 healthy adults

(Sunday et al. *submitted*)

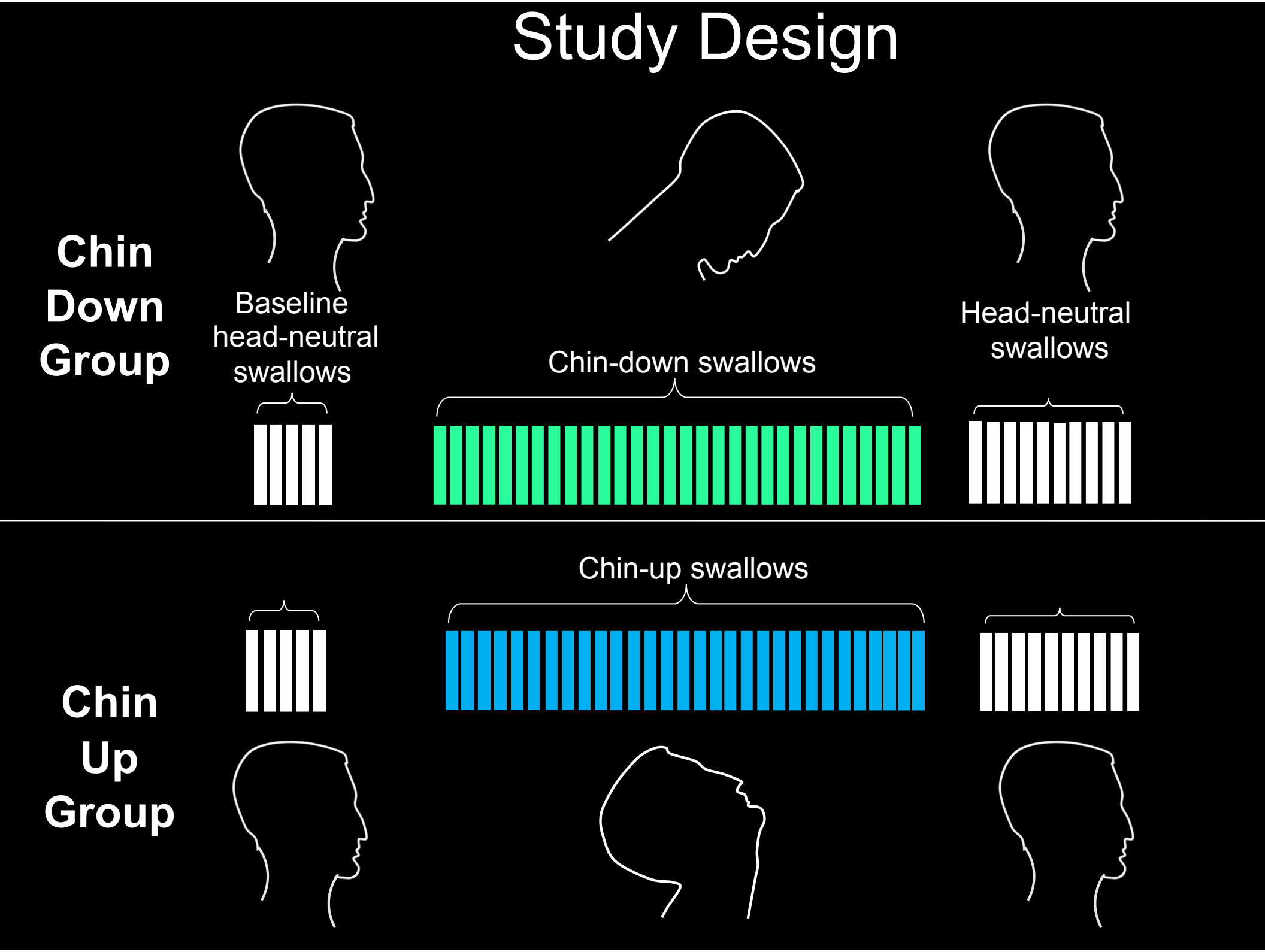
Study Design

Healthy adults

45 swallows
(5ml thin liquid barium)

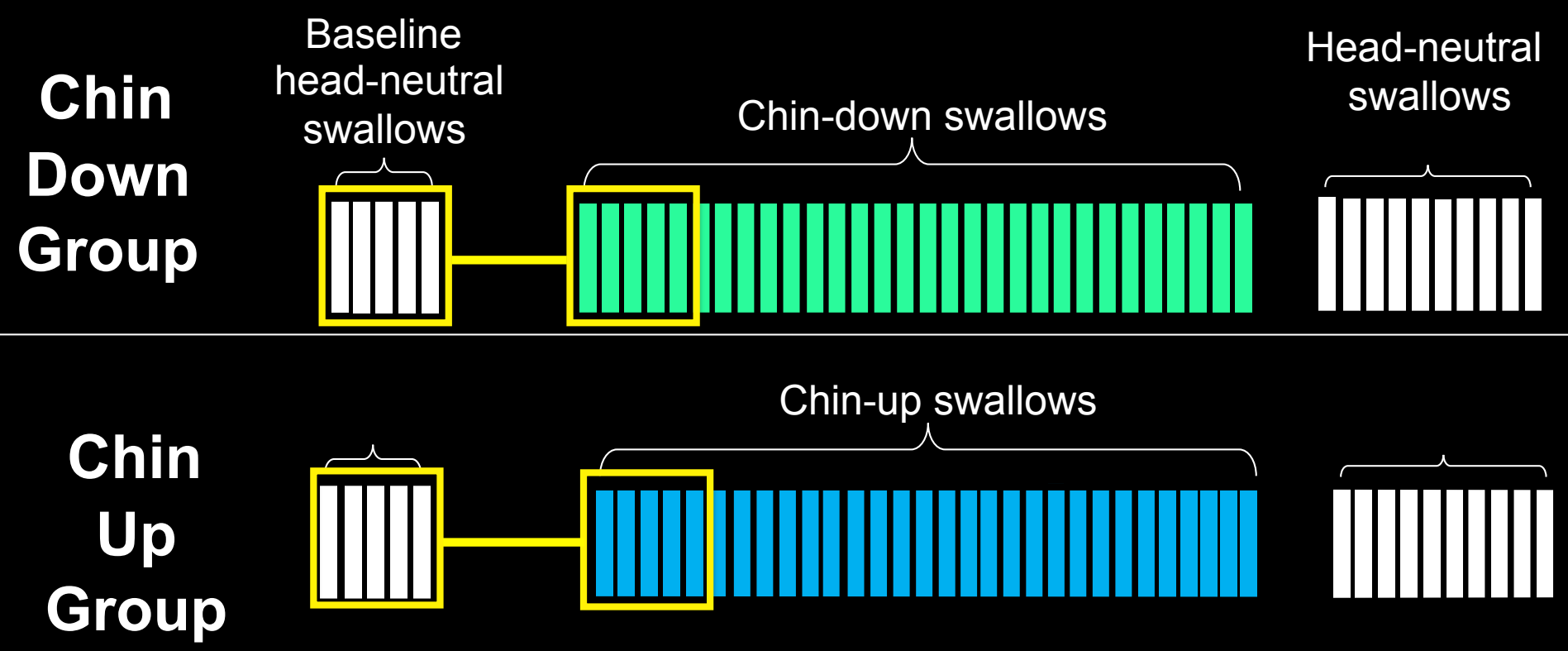
videofluoroscopy

Study Design



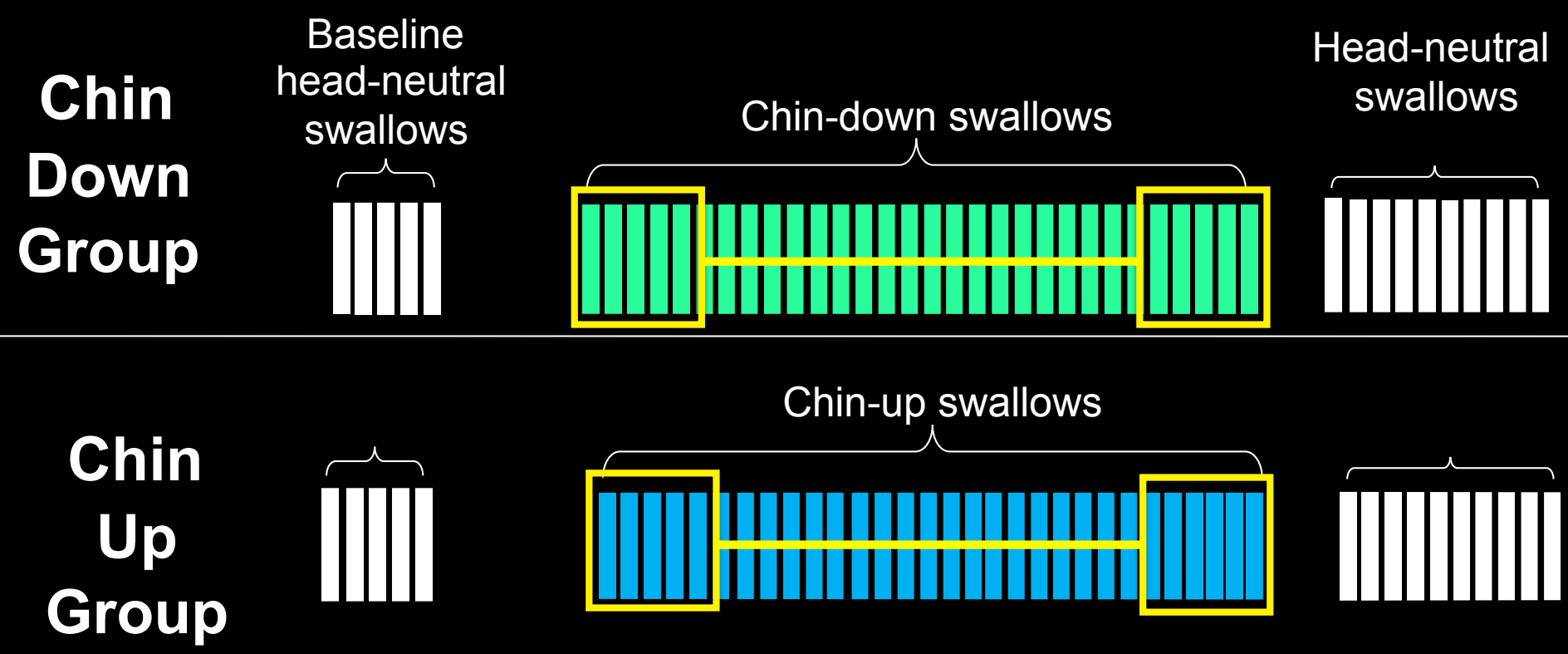
Three Research Questions

1. What are the <u>immediate</u> effects of the chin up and chin down postures?



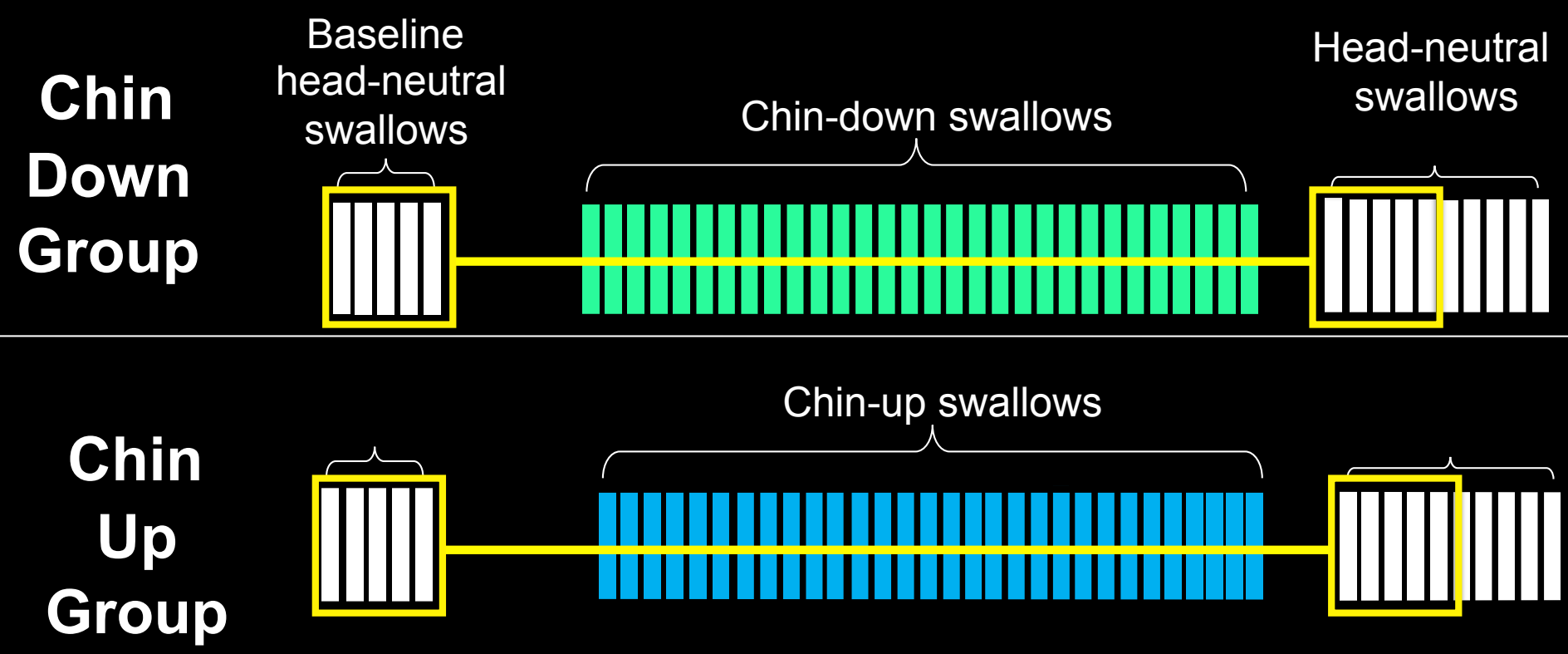
Three Research Questions

2. Do swallowing kinematics change over several trials of the posture?



Three Research Questions

3. Are aftereffects present in neutral swallows after performing several postural swallows?



Outcome Measures

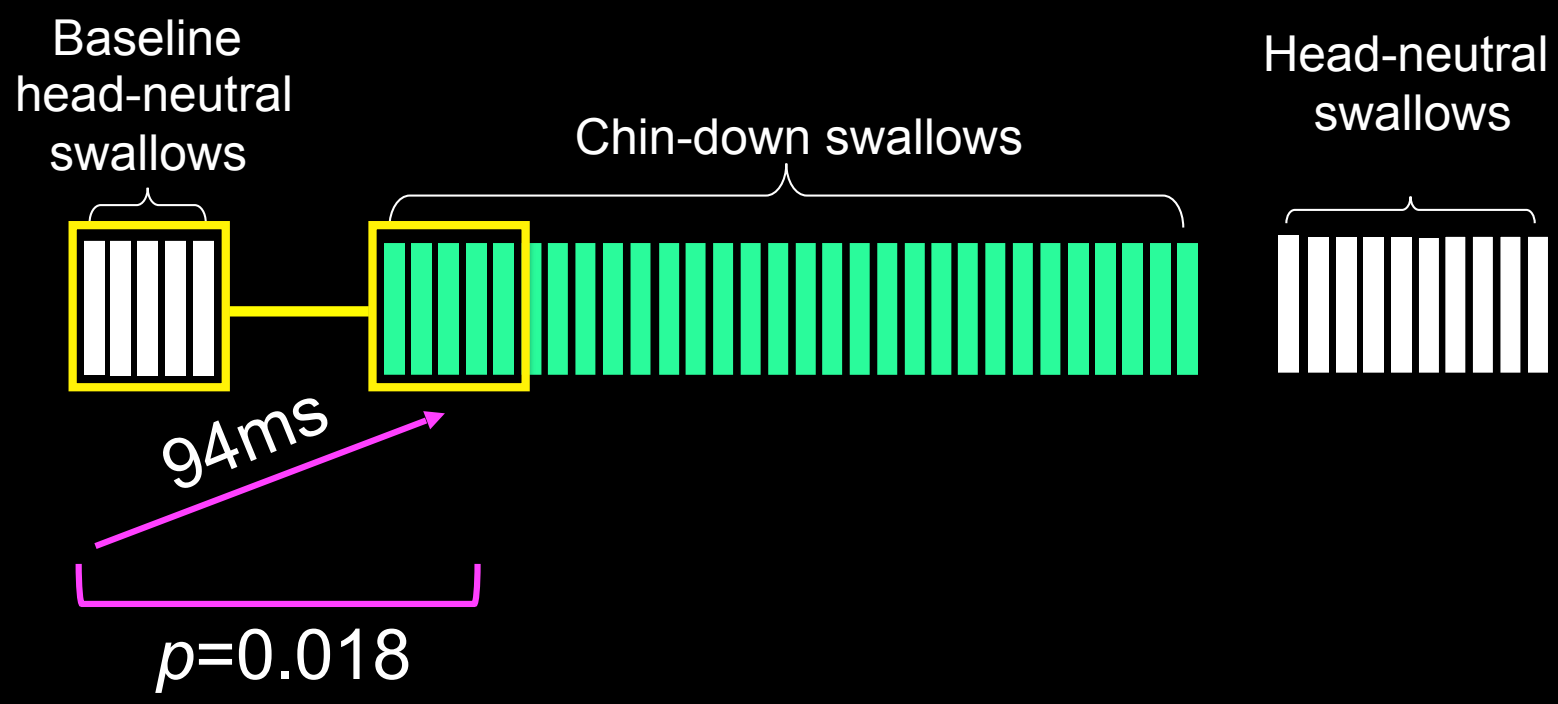
	Chin-Down	Chin-Up
Airway Protection	Laryngeal vestibule closure **duration** Laryngeal vestibule closure **reaction time**	Time to max hyoid elevation

Molfenter, S.M., Steele, C.M. (2012)

Chin Down Results

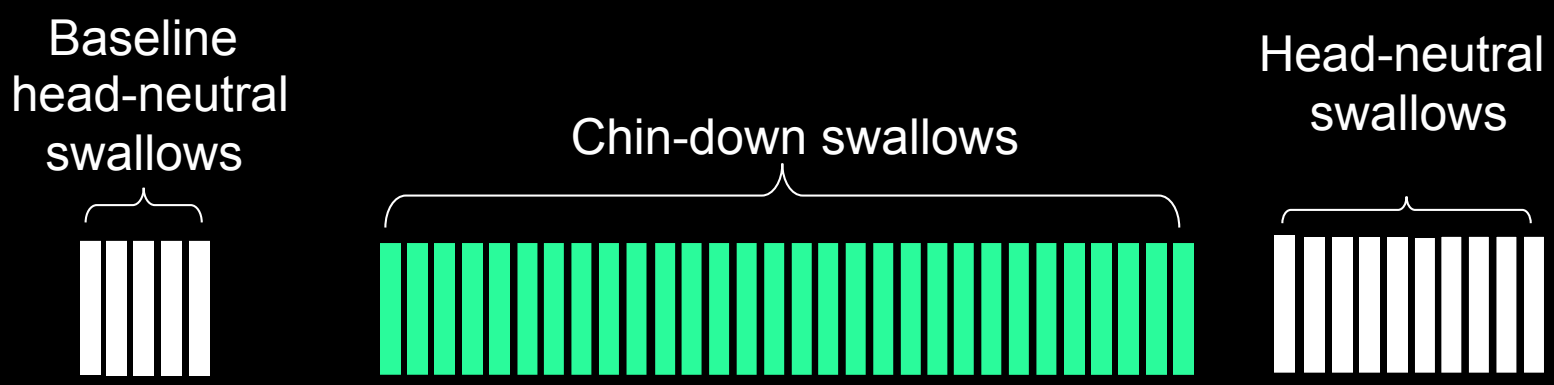
laryngeal vestibule closure duration

Chin Down Group



laryngeal vestibule closure reaction time

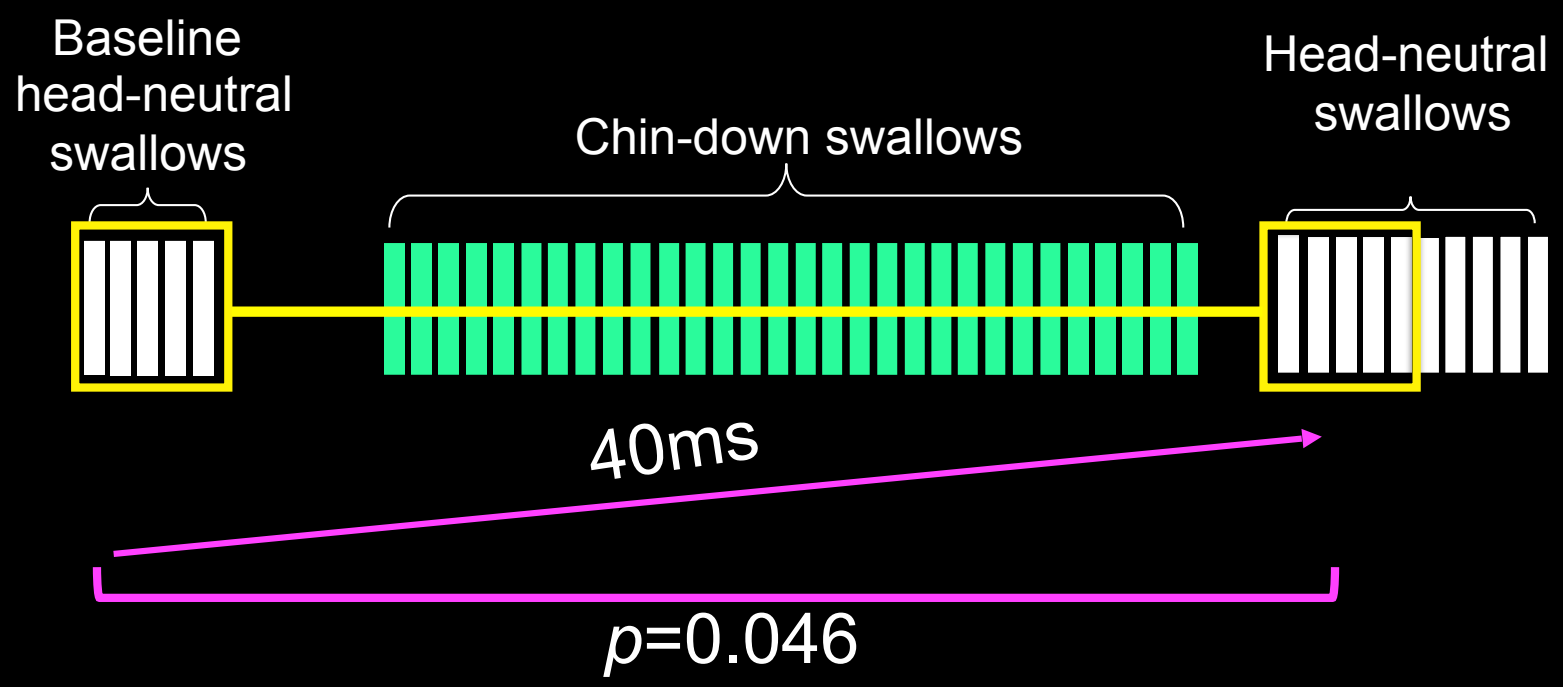
Chin Down Group



no change

pharyngeal transit time

Chin Down Group



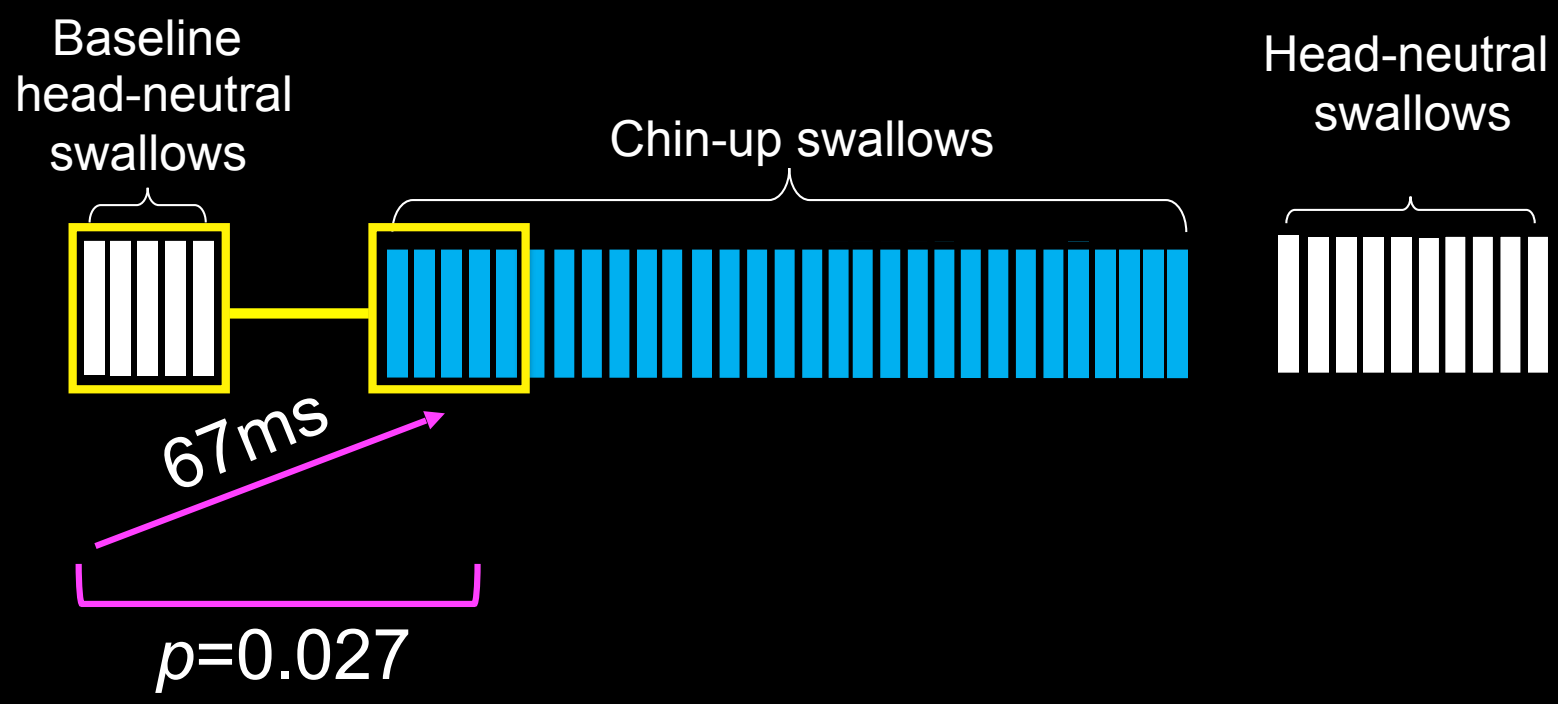
Does the chin-down swallowing strategy challenge swallowing?

The increase in laryngeal vestibule closure likely only occurred because the chin down position places the hyoid and larynx closer together (Bulow 1999, 2001), not because participants volitionally maintained longer closure

Chin Up Results

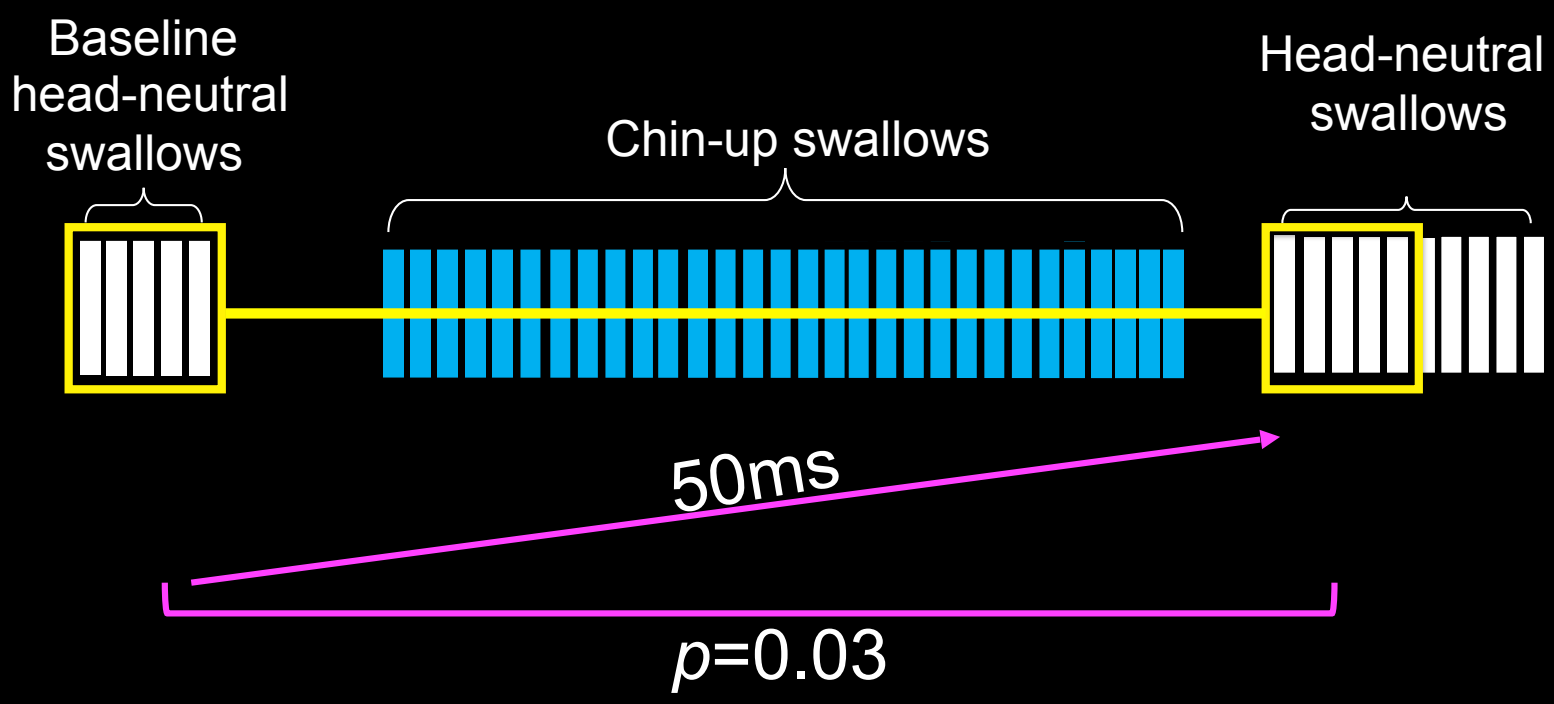
time to max hyoid elevation

Chin Up Group



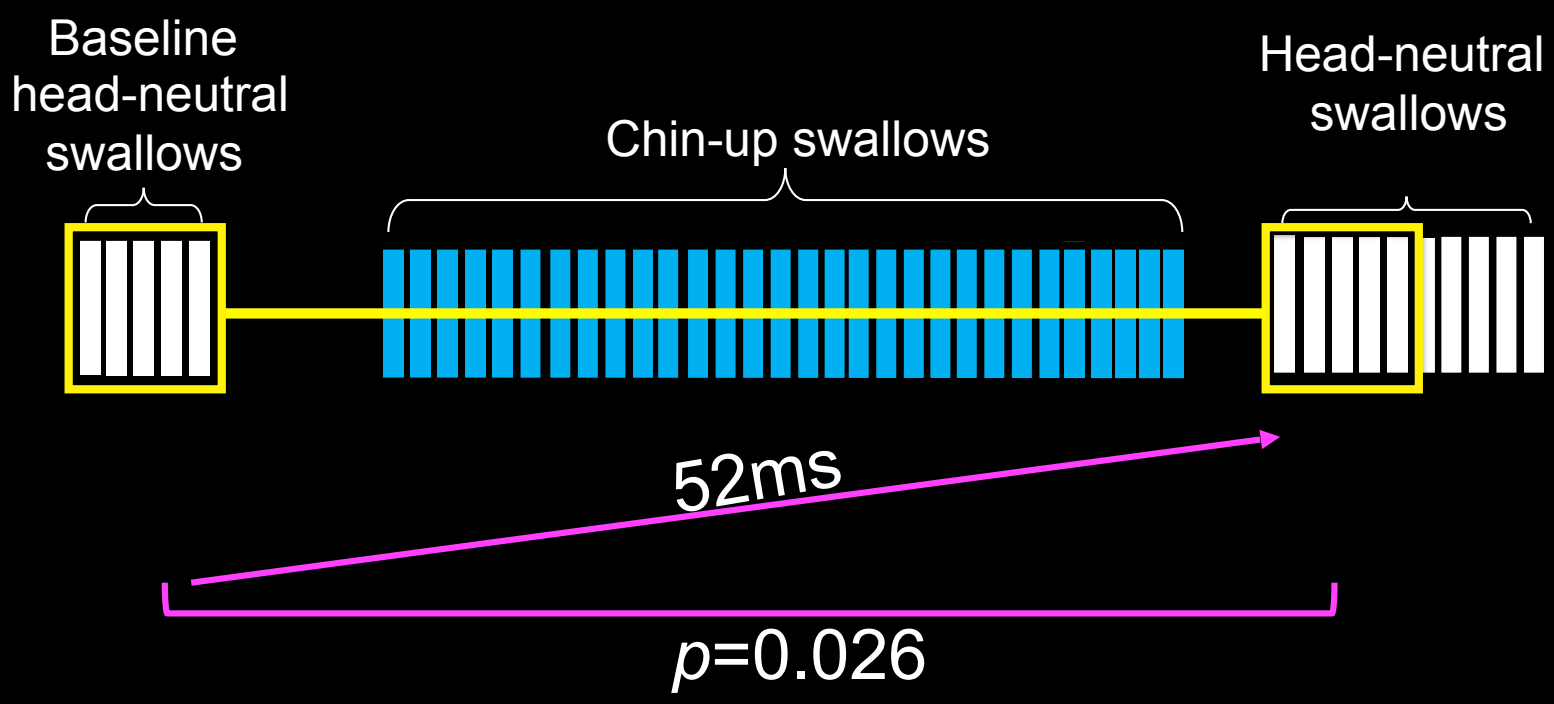
UES opening reaction time

Chin Up Group



Pharyngeal transit time

Chin Up Group



Does the chin-up swallowing strategy challenge swallowing?

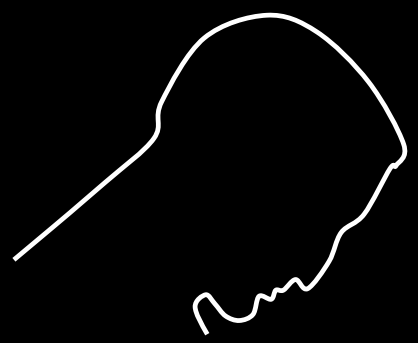
The chin-up strategy had a similar effect on limiting the time to max hyoid elevation (+67ms) as found with electrical stimulation (+73ms)

Anderson & colleagues (2015)

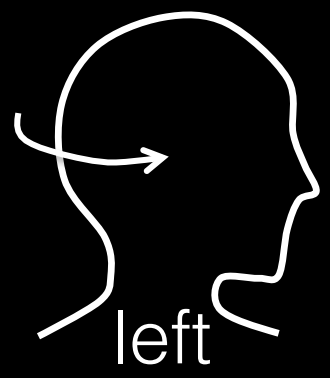
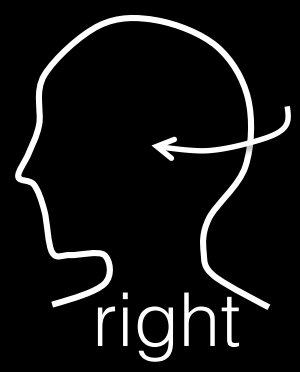
Summary

How can the impairment determine if a compensatory strategy can challenge the impairment, rather than just reduce the impairment?

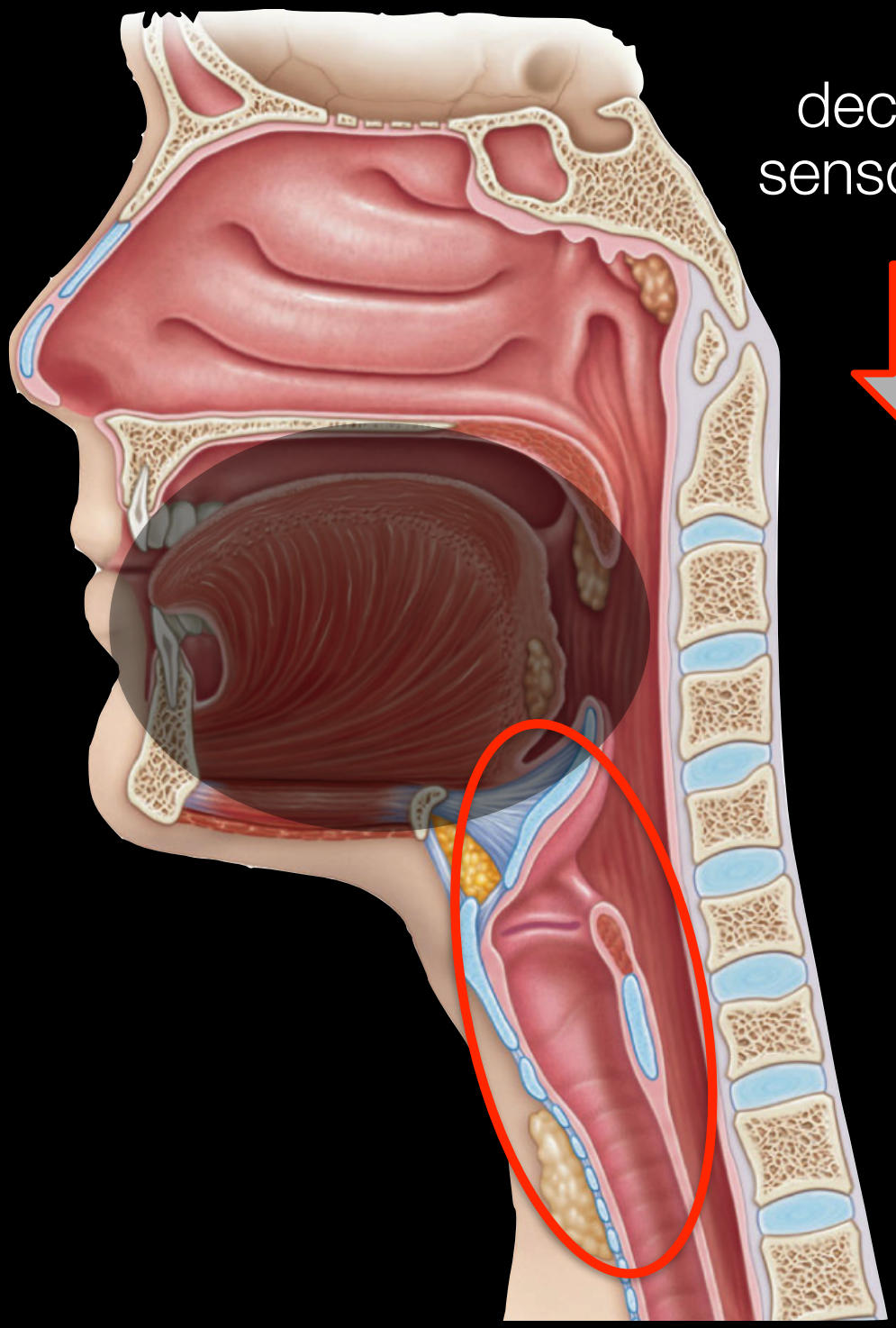
Proposed Theory

Strategy	Reduce Impairment	Challenge Impairment?
	↓ Swallow onset delay	↓ Posterior oral bolus movement
	↓ Posterior oral bolus movement	↓ Swallow onset delay

Proposed Theory

Strategy	Reduce Impairment	Challenge Impairment?
	weak left, close left	close right, open left
	weak right, close right	close left, open right

bolus modification



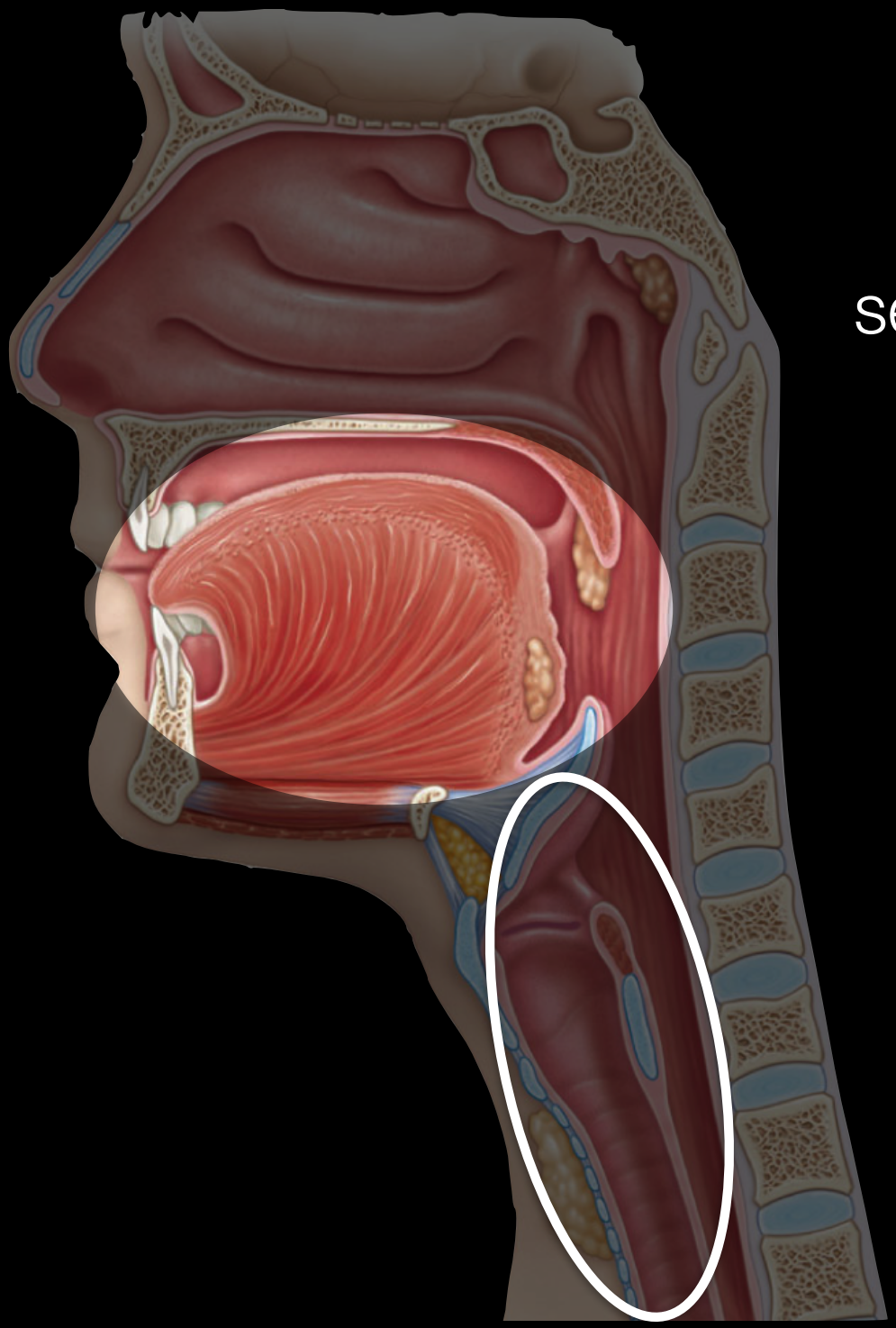
decreased
sensory input

Anesthesia
Multiple saliva swallows

=

Absent, late, reduced
swallow response

Mansonn 1975a, 1975b; Teismann 2007



sensory input

Large bolus

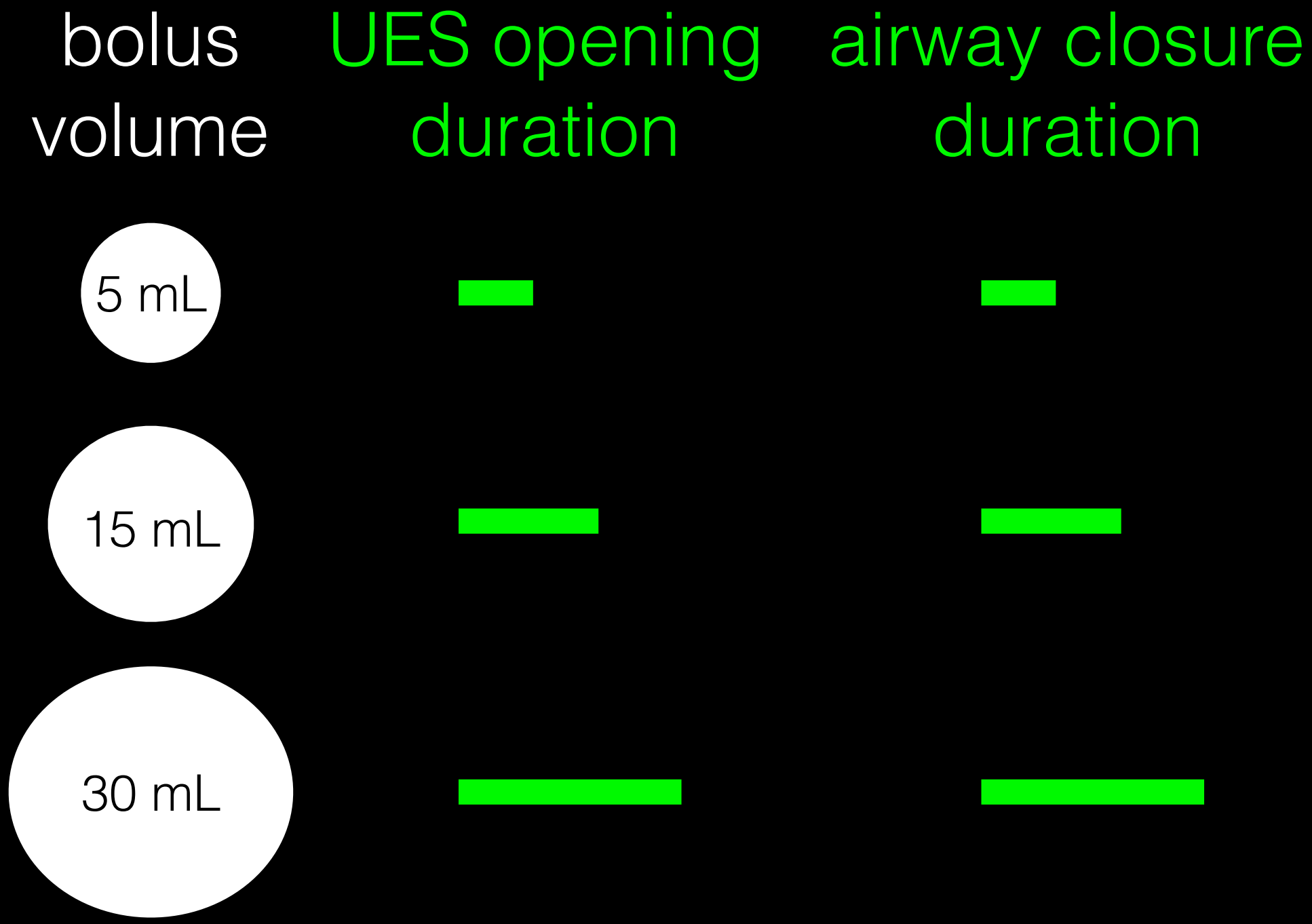
=

robust swallow response

(Dantas 1990; Kahrilas 1998; Lazarus 1993)

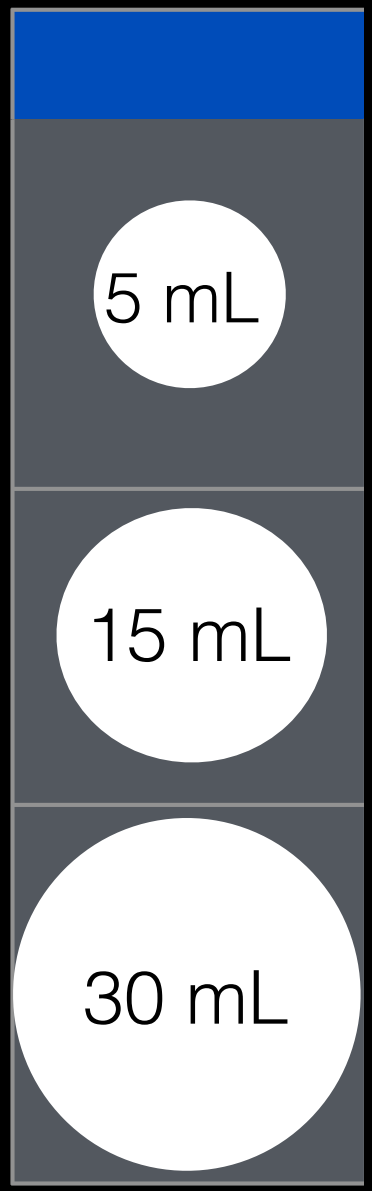
Oral sensation modulates the swallow response to accommodate the properties of the bolus

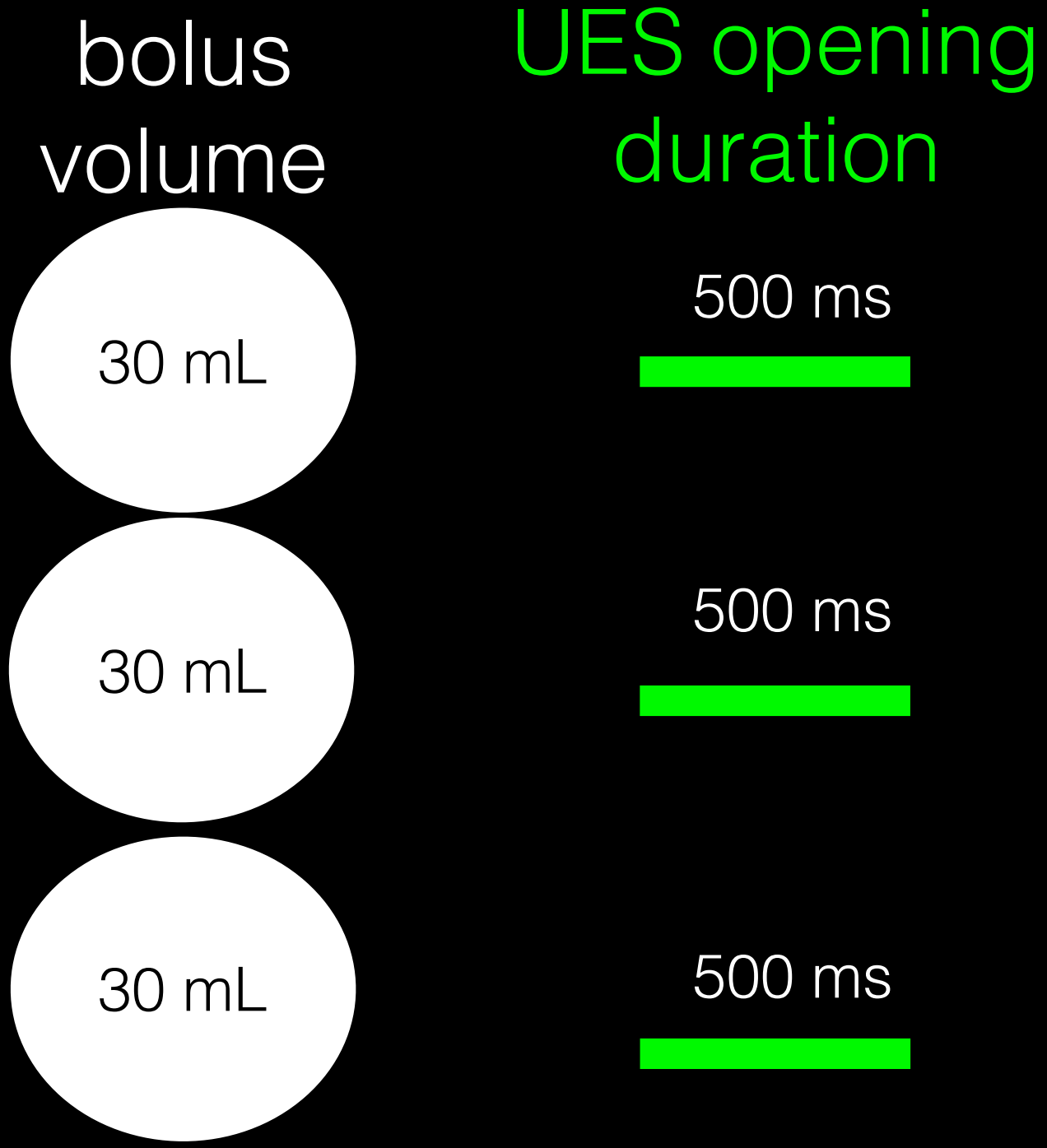
Steele & Miller 2010



Molfenter et al, 2012

But are these relationships fixed?




bolus volume
UES opening duration
30 mL
500 ms
30 mL
500 ms
30 mL
500 ms

Sensitivity Shifting

Allows us to determine whether or not the same stimulus induces various sensory-motor responses

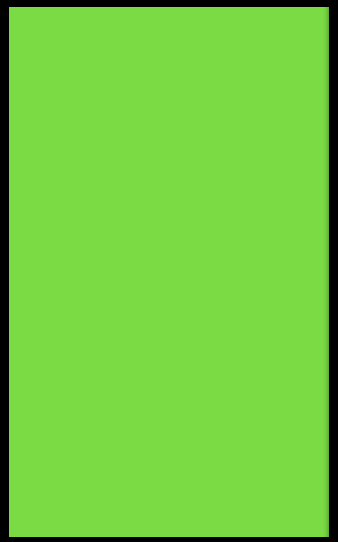
These modifications are based on <u>prior</u> sensory experiences

Sensitivity Shifting

50°

outdoors

70°



indoors

warm cool

90°

outdoors

Sensitivity Shifting

70°

indoors

same: indoor condition

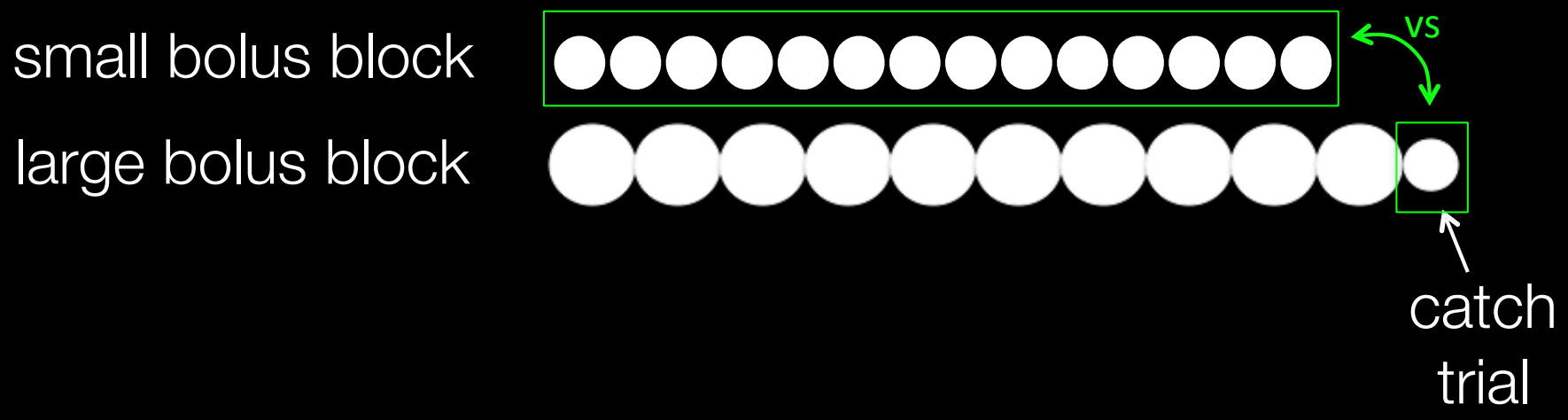
different: sensory experience

Sensitivity Shifting

Is the response to one bolus modified based on the sensory experiences that immediately preceded it?

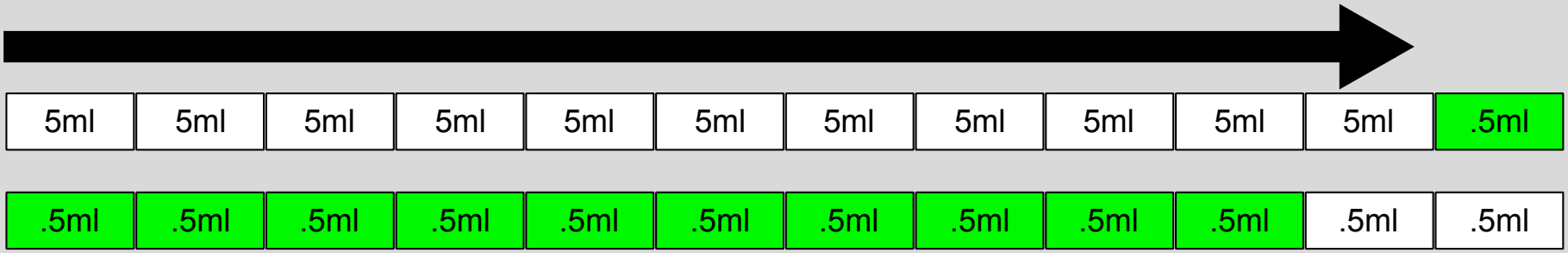
Humbert et al, 2012

swallowing example



Our Study Design

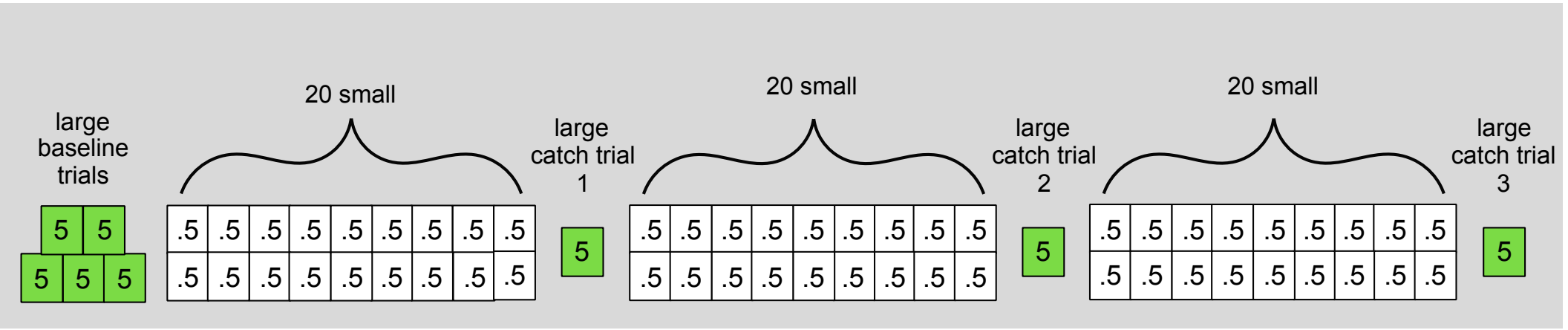
Humbert et al, 2012



Results - no difference

10 swallows too few?
Perhaps a large catch trial?

Therefore, we had to challenge the system


large baseline trials
5 5
5 5 5
20 small
.5 .5 .5 .5 .5 .5 .5 .5 .5
.5 .5 .5 .5 .5 .5 .5 .5 .5
large catch trial 1
5
20 small
.5 .5 .5 .5 .5 .5 .5 .5 .5
.5 .5 .5 .5 .5 .5 .5 .5 .5
large catch trial 2
5
20 small
.5 .5 .5 .5 .5 .5 .5 .5 .5
.5 .5 .5 .5 .5 .5 .5 .5 .5
large catch trial 3
5

The MBSImP Protocol

Thin Liquid

5ml teaspoon ✗ ✗ ✗ ✗

5ml teaspoon with strategy (chin tuck, head turn, effortful swallow, etc…)

~~Single cup sip~~

~~Sequential Swallow~~

Nectar Thick Liquid

5ml teaspoon ✓

Single cup sip ✓

Sequential swallow ✓

Honey Thick Liquid

5ml teaspoon ✓

Pudding Thick

5ml teaspoon ✓

Solid

½ shortbread cookie (1”x1” x .25”) coated with 3ml pudding consistency ✓

The MBSImP Protocol

Thin Liquid

5ml teaspoon ✗ ✗ ✗ ✗

5ml teaspoon with strategy (chin tuck, head turn, effortful swallow, etc…)

~~Single cup sip~~

~~Sequential Swallow~~

What are the limits of the system?
Are we challenging the swallow?

Nectar Thick Liquid

5ml teaspoon ✓

Single cup sip ✓

Sequential swallow ✓

Honey Thick Liquid

5ml teaspoon ✓

Pudding Thick

5ml teaspoon ✓

Solid

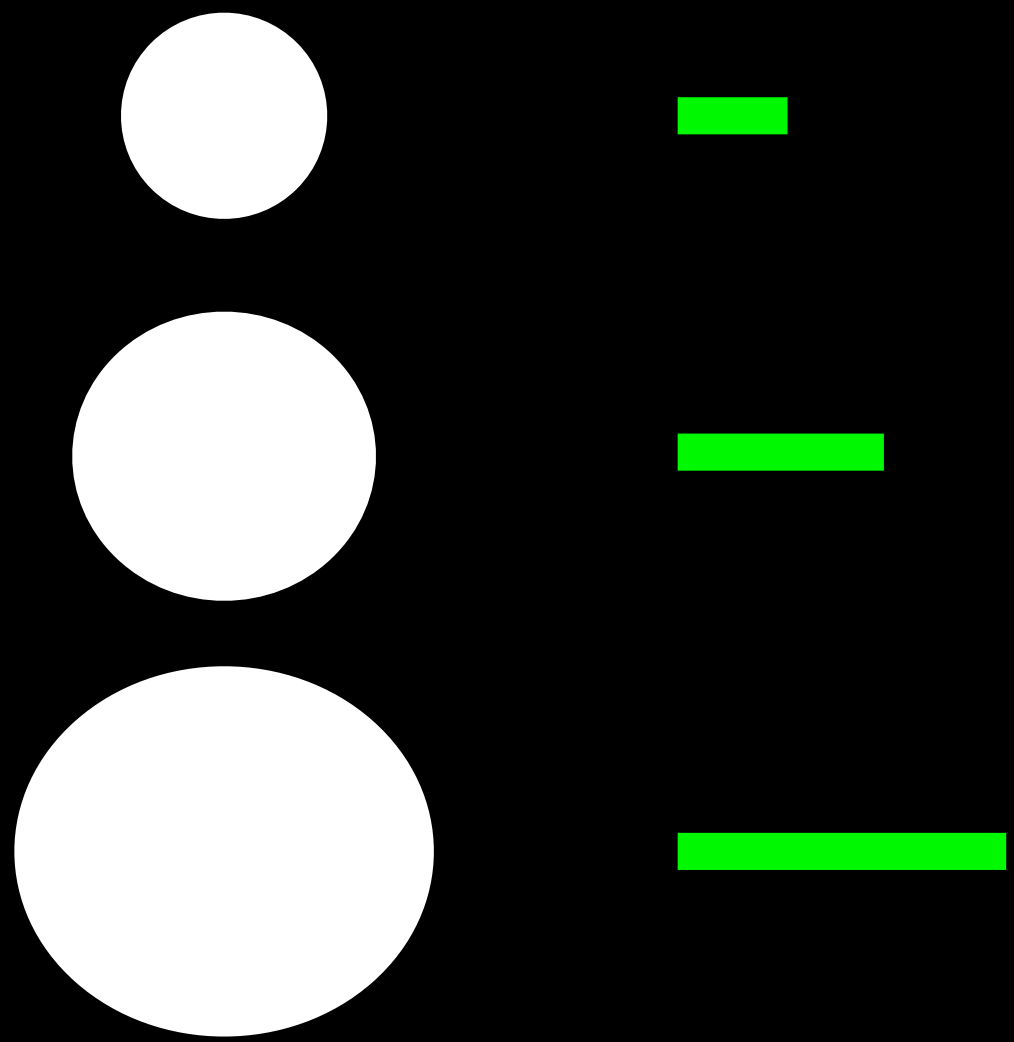
½ shortbread cookie (1”x1” x .25”) coated with 3ml pudding consistency ✓

- Compensatory strategies: limiting the system

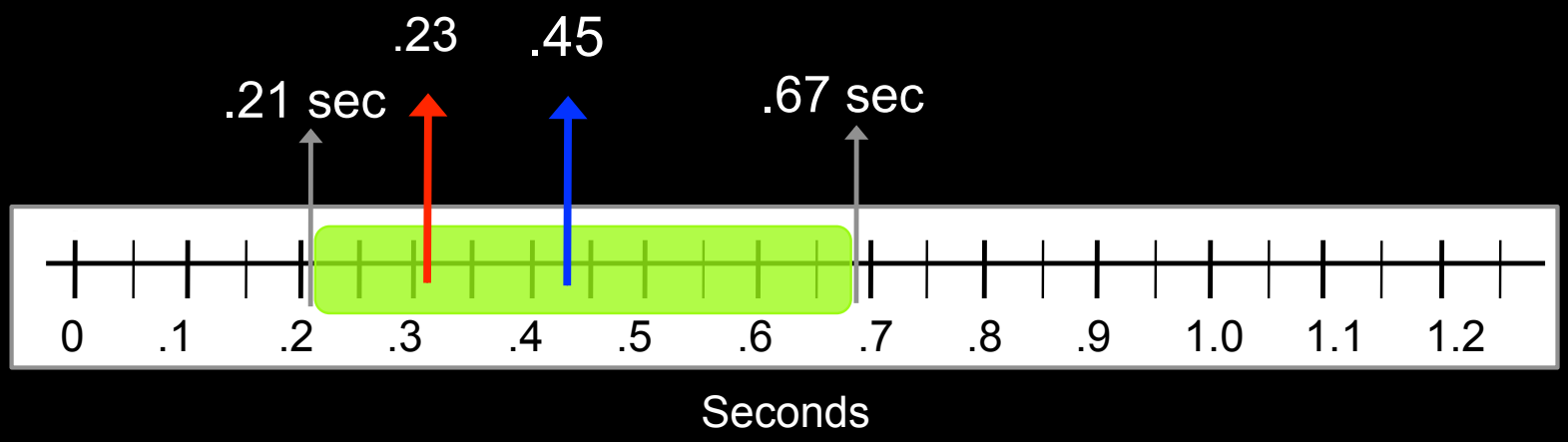
- Rehab: understanding the limits of the system

bolus volume

opening duration



(Steele & Miller, 2010; Molfenter et al, 2012)



Molfenter et al 2012

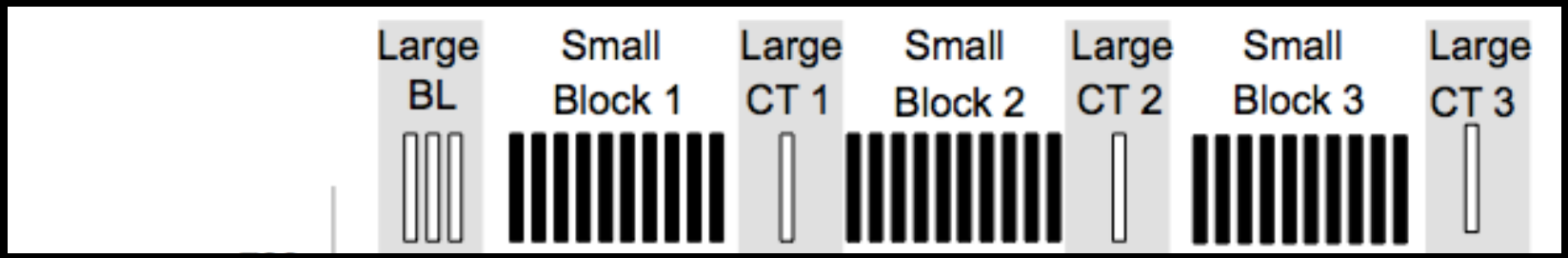
Derived from 14 studies

1. The system is responding to bolus volume as it should

2. You've identified the impairment (reduced UES duration)

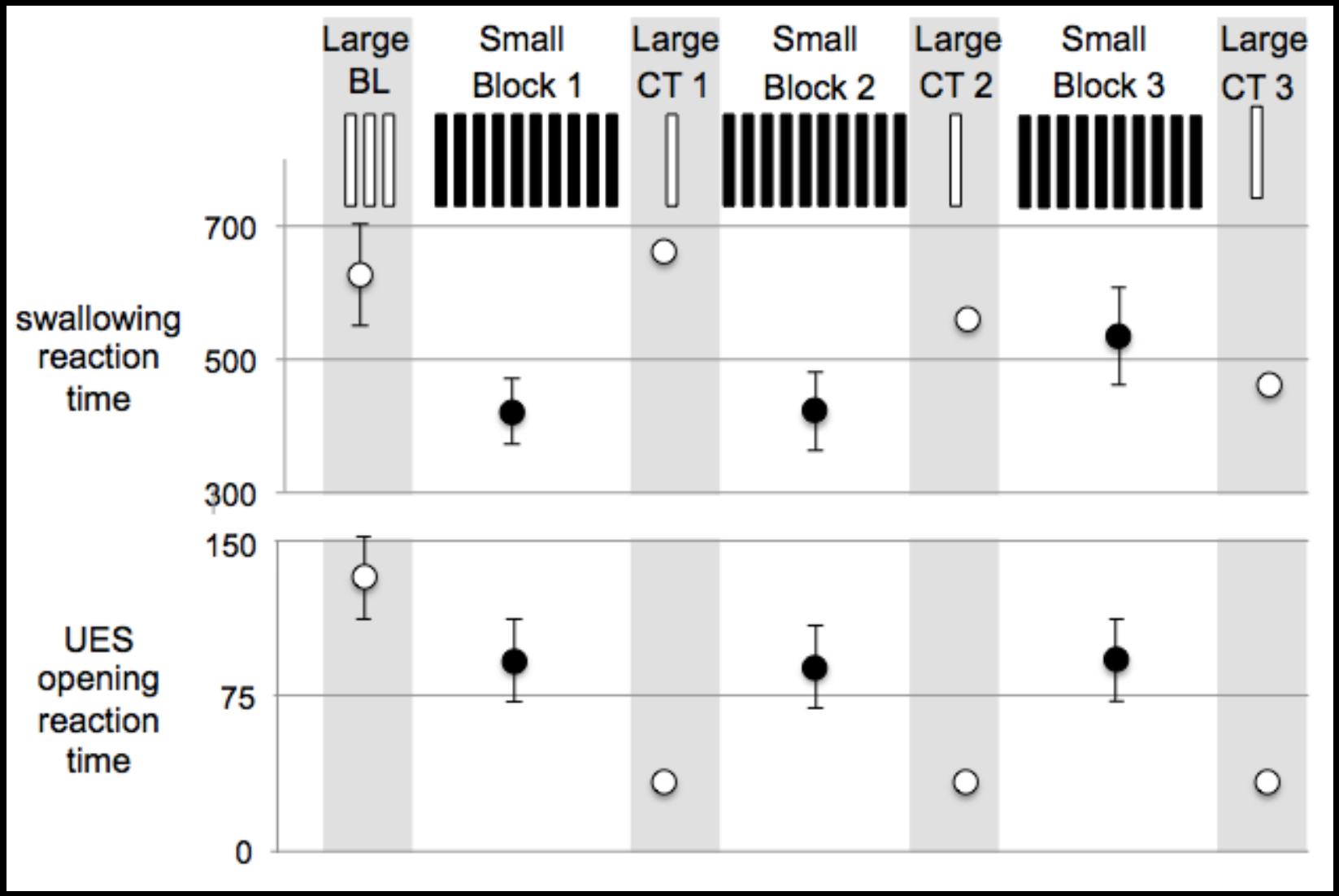
Sensitivity Shifting in one patient post-stroke

heap 1/2 heap 1/2 heap 1/2 heap



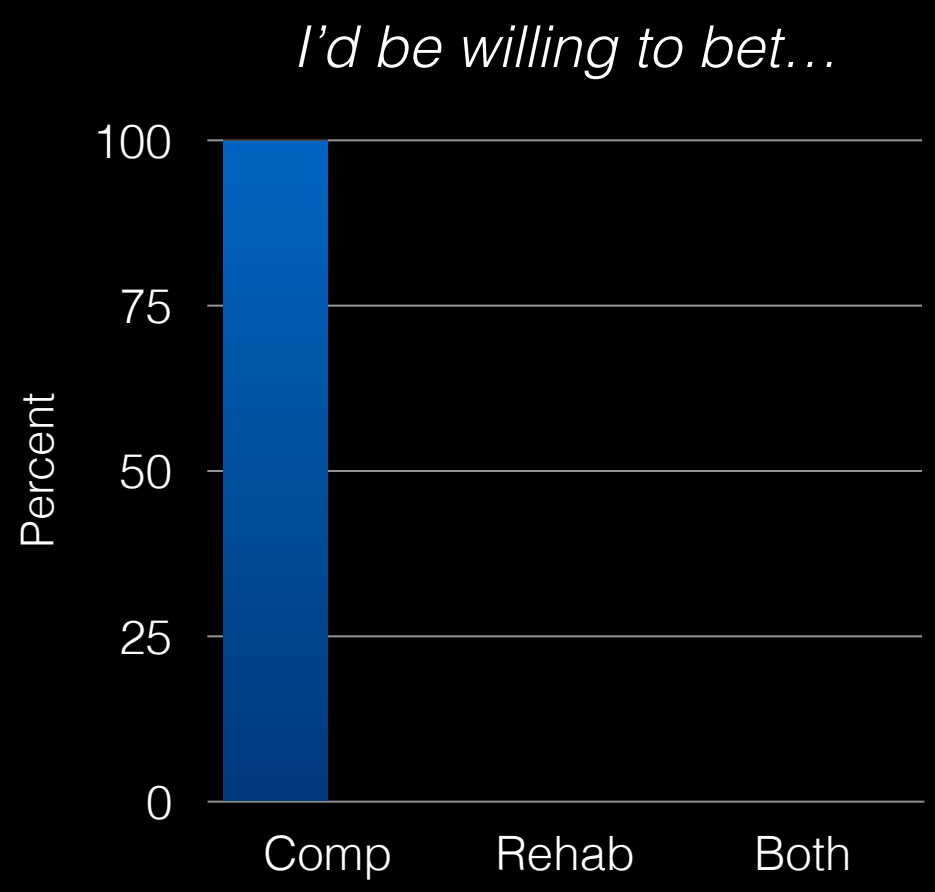
small - 1/2 tsp pudding; large heaping tsp pudding

Sensitivity Shifting in one patient post-stroke



small - 1/2 tsp pudding; large heaping tsp pudding

Bolus Modification

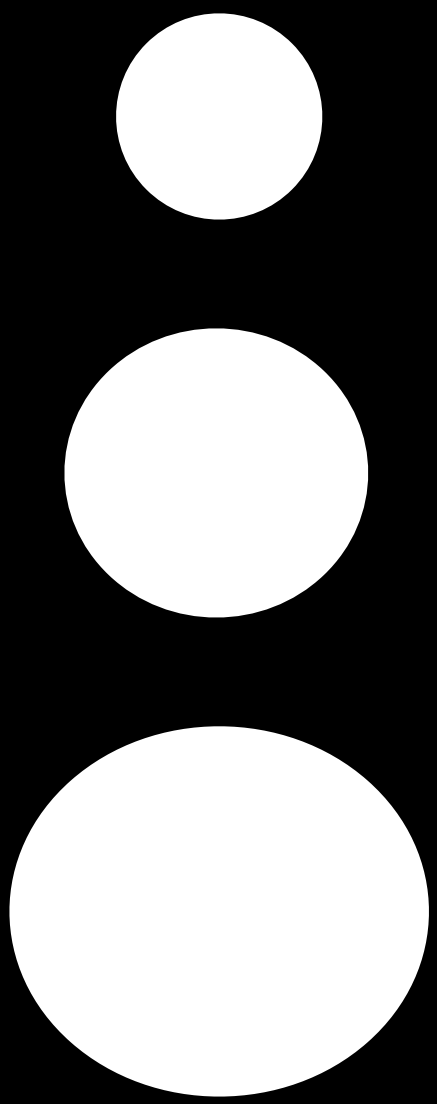


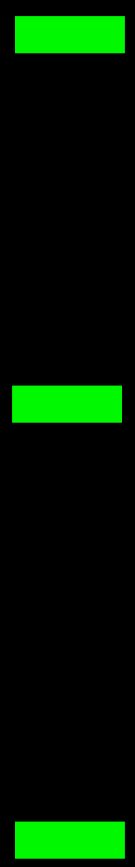
Now:
Think of it as a way to tease out the problem with the swallowing system

bolus volume

Brain ✓

UES opening duration ✗



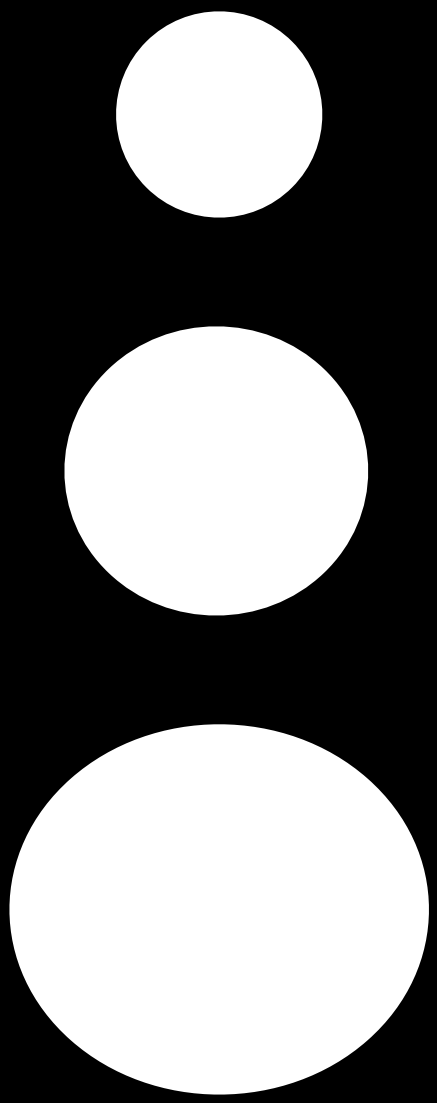


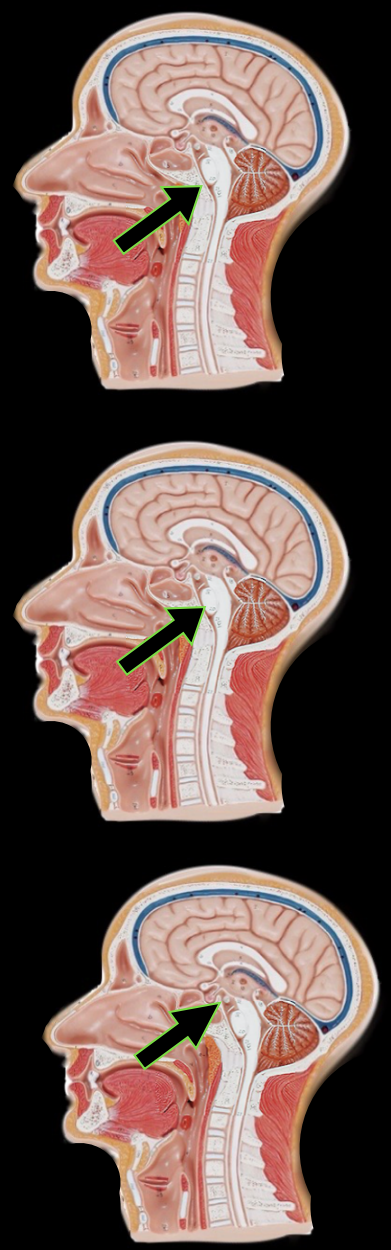
How can you probe the brain in this example?

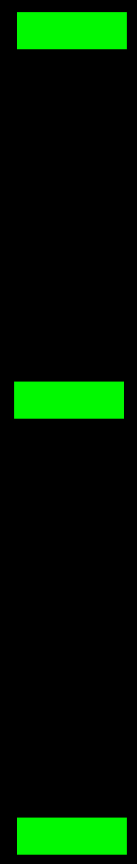
bolus volume

Brain ✗

UES opening duration ✗

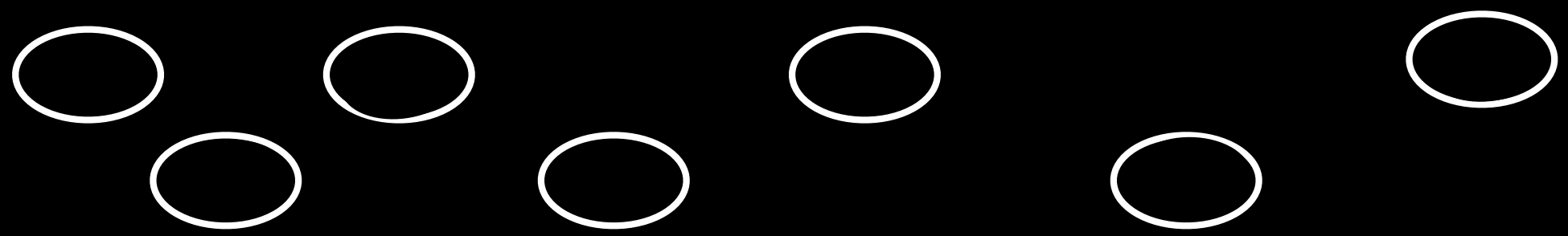






How can you target the brain in this example?

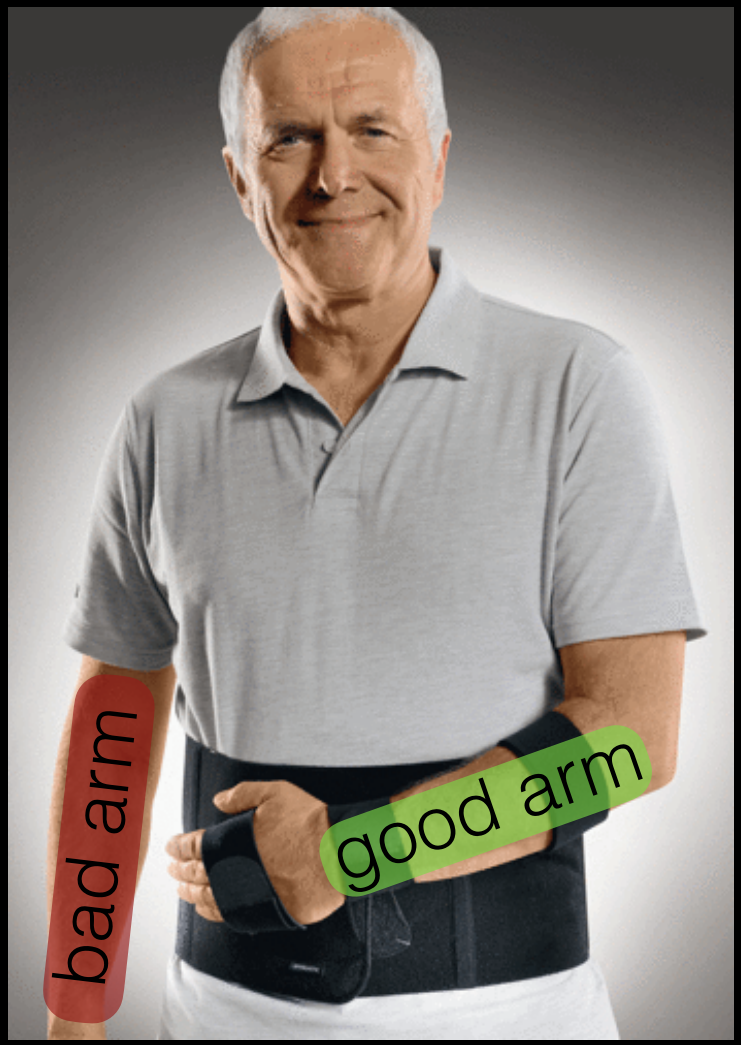
Would you have an advantage if I told you that the step circles are farther from one another with each step?



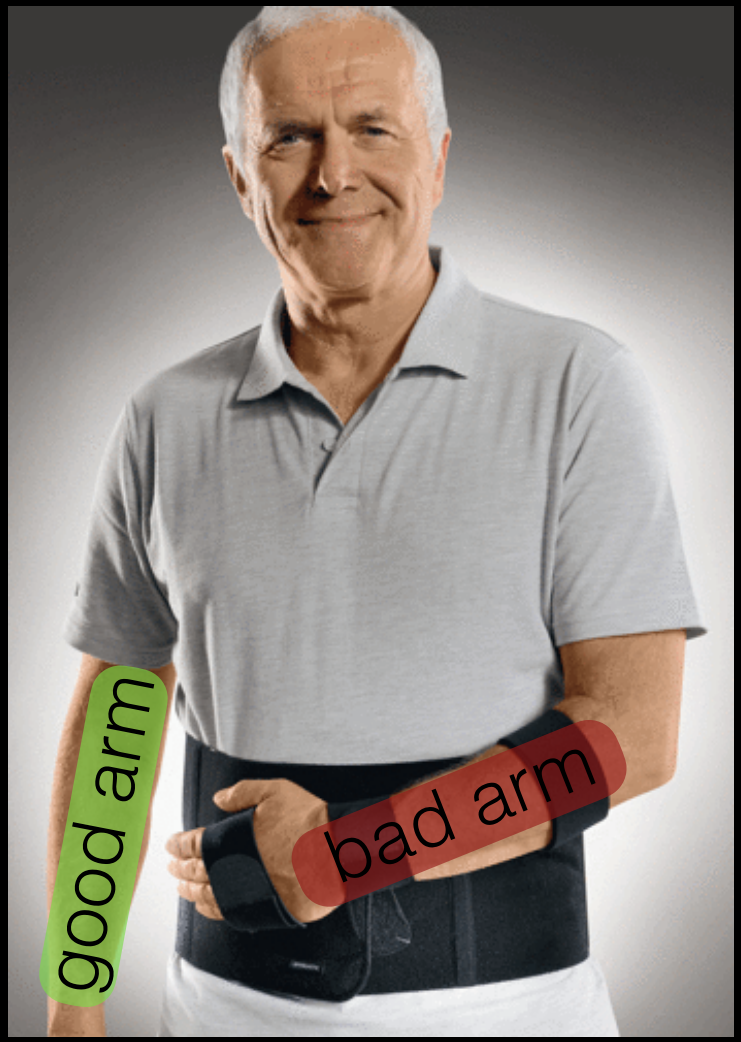
Hallmark of dysphagia: Inability to manage a wide range of boluses

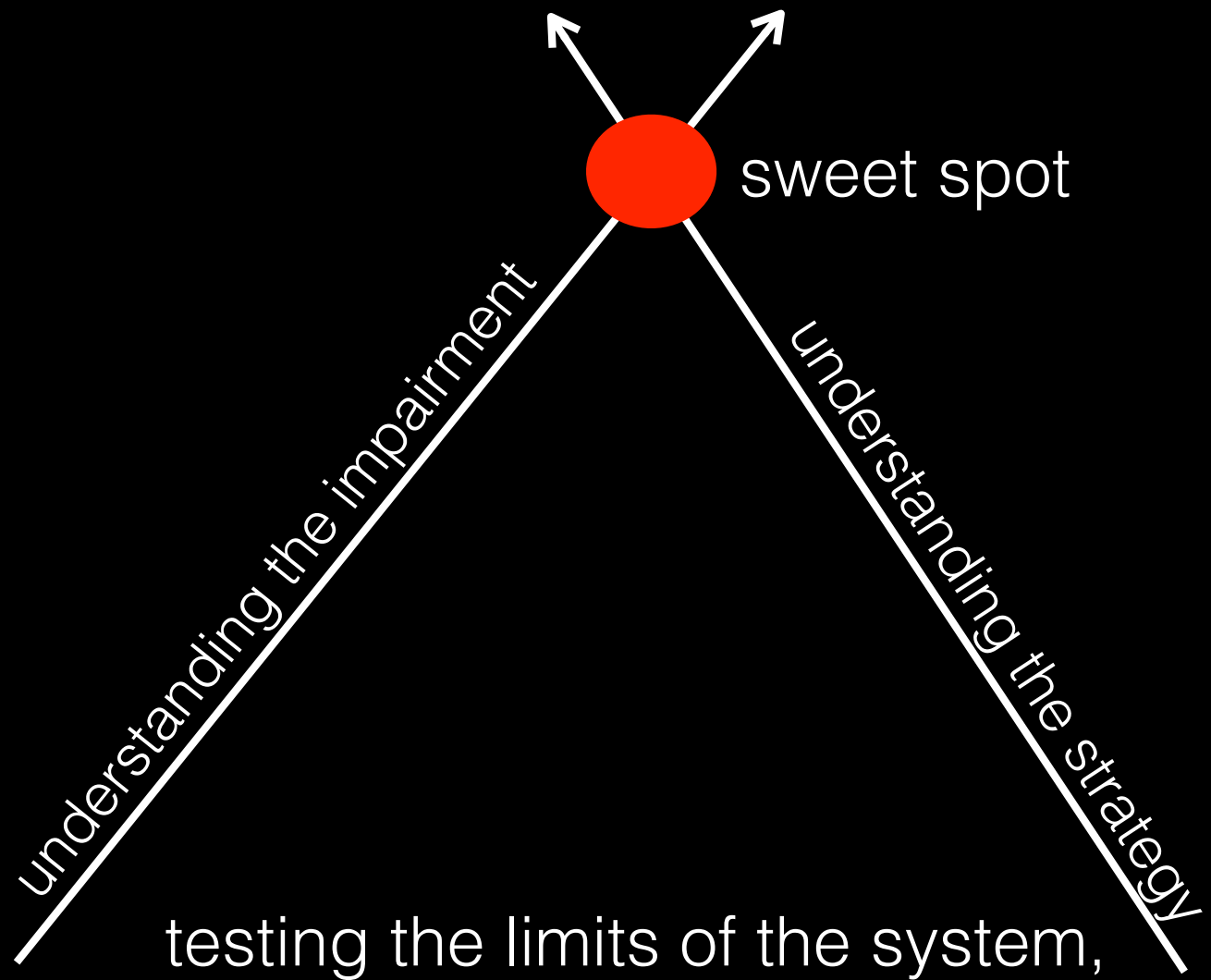
- belief: sensorimotor response fixed
- boluses tested small to large
- restrict bolus volumes and consistencies
  - deprived of practice?

Physical Therapy
Occupational Therapy



Swallowing Therapy





testing the limits of the system,
not limiting the system

Neuroplasticity

The brain's ability to reorganize itself by forming new neural connections:

normal development

after injury

in response to new situations / changes in environment.

Principles of Neuroplasticity

Use

Repetition

Intensity

Specificity

Salience

Difficulty

Transference

Use it or lose it!

If certain brain areas are not biologically active, they may begin to degrade

Principles of Neuroplasticity

Use

Repetition

Intensity

Specificity

Salience

Difficulty

Transference

Use it repeatedly!

If certain brain areas are not biologically active <u>frequently</u>, they may begin to degrade

Principles of Neuroplasticity

Use

Repetition

Intensity

Specificity

Salience

Difficulty

Transference

Use it intensely!

If certain brain areas are not used <u>beyond typical activity</u>, they may remain stagnant.

Principles of Neuroplasticity

Use

Repetition

Intensity

Specificity

Salience

Difficulty

Transference

Use it with specificity!

If certain brain areas are not used <u>for a specific task</u>, performance of that specific task might not improve

Principles of Neuroplasticity

Use

Repetition

Intensity

Specificity

Salience

Difficulty

Transference

Use it with attention!

If certain brain areas are <u>motivated or heightened</u> during a specific task, performance of that specific task might not improve

Principles of Neuroplasticity

Use

Repetition

Intensity

Specificity

Salience

Difficulty

Transference

Use it and challenge it!

If certain brain areas are not <u>challenged</u> during a specific task, performance of that specific task might not improve

Principles of Neuroplasticity

Use

Repetition

Intensity

Specificity

Salience

Difficulty

Transference

Use it in different ways!

If certain brain areas become plastic, they may <u>transfer or generalize</u> to other behaviors, tasks, or domains

Principles of Neuroplasticity

Use

Repetition

Intensity

Specificity

Salience

Difficulty

Transference

Can we use "compensatory strategies" to **challenge** swallowing?

Thanks

SWALLOWING
SYSTEMS
CORE

Neuromotor Speech & Swallowing Restoration Laboratory
Swallowing Neurophysiology Laboratory

Swallowing
Neurophysiology
Laboratory

Principal Investigator:
Ianessa A. Humbert, Ph.D., CCC-SLP
humbertlab.com

Funding Acknowledgments

National Institutes of Health
5K23DC010776-05
1R01DC01428501A1

American Heart Association
14BGIA20380348

Dr. Emily Plowman for sharing some of her slides with me