



# SWALLOWING FUNCTION IN AGING: ENSURING EATING SAFETY & ENJOYMENT






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## Disclosures

- Salary
  - Purdue University
- Research support
- Donation to CEREBBRAL center











David C. Greulich & Deanna M. Greulich Research Fund

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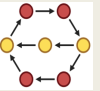
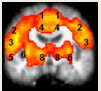



Control of swallowing in typical aging and in patients with neurological disorders

Swallowing treatment / treatment efficacy

Telehealth for swallowing disorders (dysphagia) management

[www.purdue.edu/i-eatlab](http://www.purdue.edu/i-eatlab)

Methods & Instrumentation



Behavior

Function

Muscle Level




Brain Level

AI-integration

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More than just meals...  
memories that nourish our bodies and souls

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Now, imagine...




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Swallowing disorders = Dysphagia



10 million adults & > half million children/year in US

Neurological & Structural Disorders


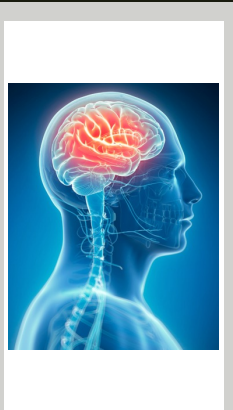
Inpatient costs increase by \$6,000/person

1.7 times more likely to die in hospital

~40% of people > 60 have dysphagia  
(Howden, 2004; Ney et al. 2009)

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WHY ARE SWALLOWING PROBLEMS SO PREVALENT IN OLDER AGE?

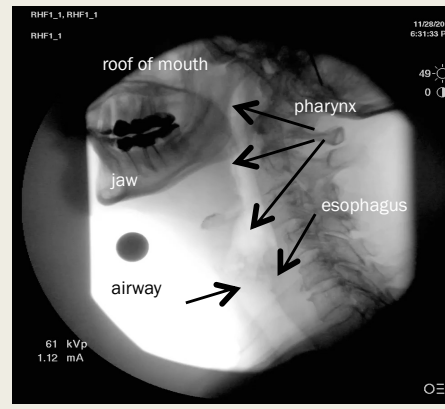
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Swallowing  
Seems very simple, BUT....!



roof of mouth

jaw

airway



pharynx

esophagus

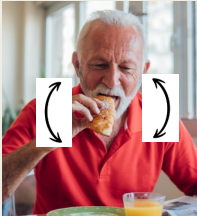
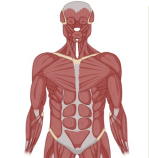
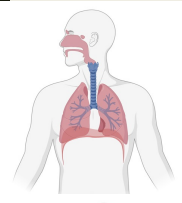
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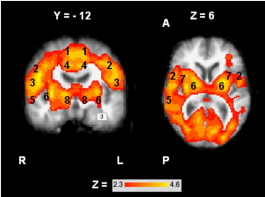


### Neural Control of Swallowing



To complete a single swallow



- >5 types of sensory receptors
- >40 pairs of muscles
- >6 cranial nerves and several spinal nerves



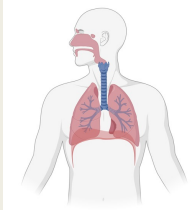
Malandraki et al., 2009; Human Brain Mapping

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### Multi-system Integration



Changes in involved body systems



Nutrition needs

Cognitive factors

Psychosocial factors

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### What happens to the involved body systems as we age?

Reduced sensory inputs (smell, taste, somatosensation)

Reductions and slowness in movements

- Sarcopenia and hardening of cartilages

Reduced saliva production



Neurophysiological changes

Other factors (meds, loss of teeth)

Reviews: Inamoto & Kaseoka, 2022; Cichero, 2018; Malandraki & Robbins, 2013

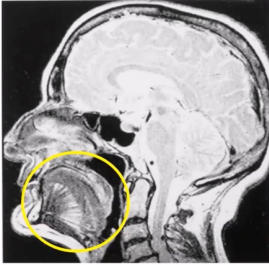

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### Sarcopenia

#### Changes in tongue muscle



Young adult


Older adult

Images courtesy of Dr. JoAnne Robbins

Nakayama et al., 1991

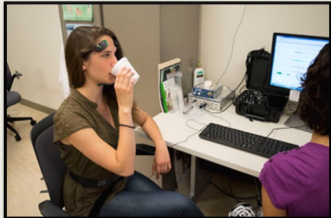
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**Peripheral (Muscle) Control**


Surface electromyography



Tasks

- Swallow liquids
- Swallow solids

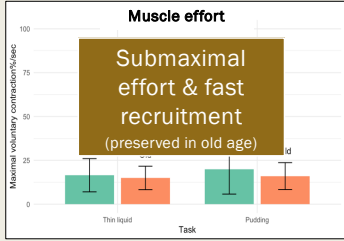
Submental muscle activity effort & timing



Ching Hsuan (Freddie) Peng

Muscle effort


Submaximal effort & fast recruitment (preserved in old age)



Peng et al., in prep

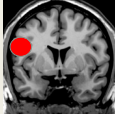
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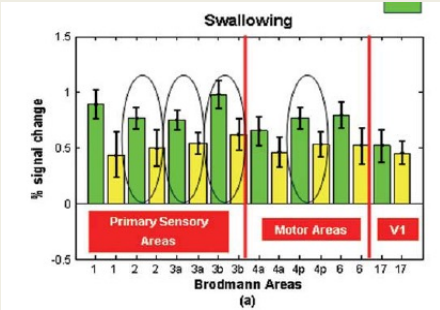
**Central Control Changes**

**YOUNG vs. OLD**



N=10 healthy young adults & 9 older adults


- Mostly reductions in sensory areas
- Motor areas function preserved



Malandraki et al., 2011 Human Brain Mapping

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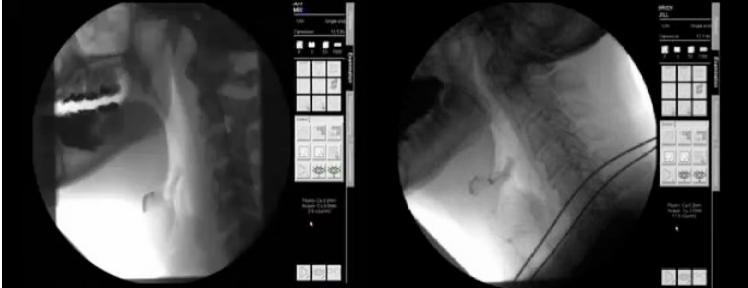
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**What do these changes look like?**


Young swallow

Presbyphagia



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**The good news!**


Most older adults adapt to these changes very well, without need for intervention.

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**Who cannot adapt as well?**

- **People with neurological conditions**
  - Examples: stroke, Parkinson's disease, dementia, ALS, multiple sclerosis, cerebral palsy, brain tumors, etc.
- **People with structural conditions**
  - Examples: head and neck cancer and its treatment, trauma, surgery/intubation, congenital anomalies, etc.
- **People with autoimmune conditions**
  - Examples: inflammatory myopathies (myositis), multiple sclerosis, thyroid disease, etc.
- **People with respiratory disorders**
  - Examples: COPD, lung cancer, cystic fibrosis, etc.
- **People with esophageal disorders**
  - Examples: Reflux, esophageal cancer, strictures (narrowing), diverticula (outpouchings)

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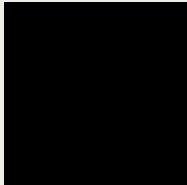
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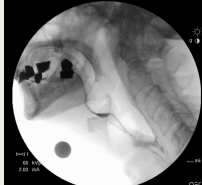


**Examples of dysphagia in older adults**


*Patient with brainstem stroke*




*Patient with PD*



*Patient with head and neck cancer*




*Patient with diverticulum*



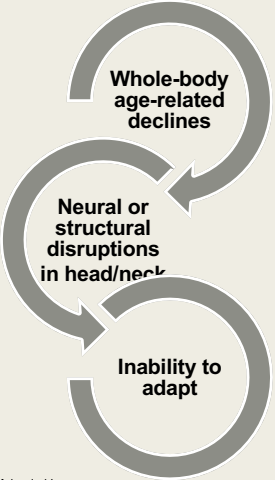
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**Why do these individuals develop dysphagia?**



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**Is it a problem?**

Malnutrition/Dehydration

Respiratory infections

Increased length of hospital stay

Increased health care cost

Death

Reduced quality of life


Social isolation

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## How can we prevent it in healthy aging?

### Emerging work in this area




#### Head and Neck

- Building functional reserve
  - Head/neck muscles
  - Respiratory muscles
- Maintaining excellent oral hygiene


#### Whole-body

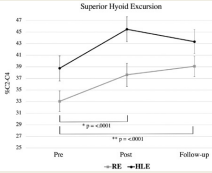
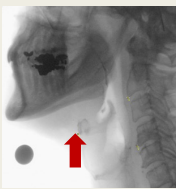
- Whole-body exercise
- Maintaining whole body health

#### Head lift exercise



#### Recline exercise



© Georgia A. Malandraki *Fujiki et al., 2019* 21

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## How can we prevent it in healthy aging?

### Emerging work in this area



#### Head and Neck

- Building functional reserve
  - Head/neck muscles
  - Respiratory muscles
- Maintaining excellent oral hygiene

#### Whole-body

- Whole-body exercise
- Maintaining whole body health

#### Expiratory Muscle Strengthening Exercise





- Improved maximum expiratory pressures
- Improved cough strength *Kim et al., 2009*

Poor oral hygiene: highest predictor of pneumonia in elderly patients


*Langmore et al. 1998 and 2002*

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## When to seek help?



- **IN THE ABSENCE OF AN UNDERLYING DISEASE**
  - If you notice any of these, talk to your primary care physician
    - Frequent coughing during or shortly after meals
    - Frequent choking episodes
    - Frequent feeling of food stuck in the throat
    - Frequent nighttime coughing (esophageal)
- **IF YOU HAVE ANY of the DISEASES DISCUSSED**
  - It may be good to be screened/evaluated even in the absence of overt symptoms
  - Especially if **a** though **d** are present
  - Frequent respiratory infections
  - Unintended weight loss
  - Sudden or gradual loss of appetite

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## How can we treat it?




- **Compensatory Strategies**
  - Postural changes
  - Dietary changes
  - Assistive devices
  - Changes in eating habits
- **Rehabilitative Treatment**
  - **Therapeutic exercise**
    - Strength training
    - Skill training
    - Mixed approaches





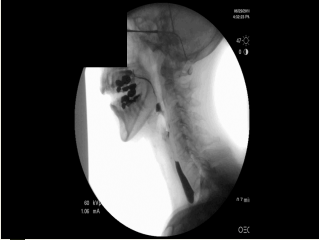

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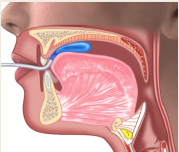



**First, we need to evaluate  
what is “driving” the symptoms**


Measure safety & efficiency  
& movement patterns




Measure pressures  
and muscle activity  
in head /neck

Measure pressures  
and muscle activity  
in respiratory  
system





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**Based on the evaluation results, we  
can then plan  
targeted **rehabilitative** treatment**

Strength & Skill Training

Specialized speech-language pathologists




But we urgently  
need more evidence  
in this area



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**Our missions/goals**

Better understanding  
all levels of  
swallowing control  
(brain and muscles)  
across lifespan and in  
neurologic patients



Identify physiology-  
based therapy  
targets



What new  
developments  
are needed?


Test treatment  
efficacy and  
disseminate



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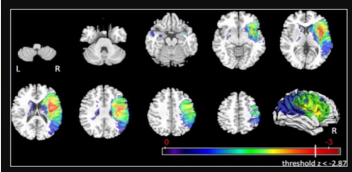


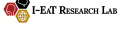
**Developing new diagnostic tools**

Looking deeper at what the brain & the  
muscles are doing at once!

Currently, 2 separate procedures










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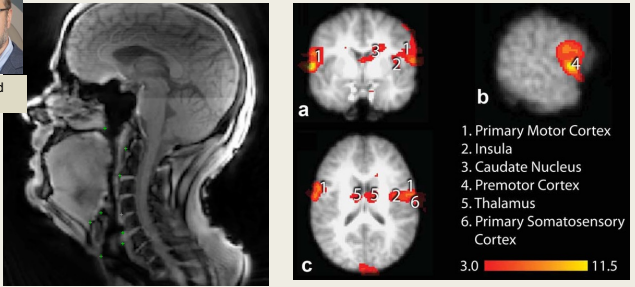
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Dr. Brad Sutton

### We developed: SimulScan



1. Primary Motor Cortex  
2. Insula  
3. Caudate Nucleus  
4. Premotor Cortex  
5. Thalamus  
6. Primary Somatosensory Cortex

3.0 11.5



We can now do both at the SAME time!

ONGOING study – HEALTHY YOUNG AND OLDER ADULTS ACTIVELY RECRUITING!

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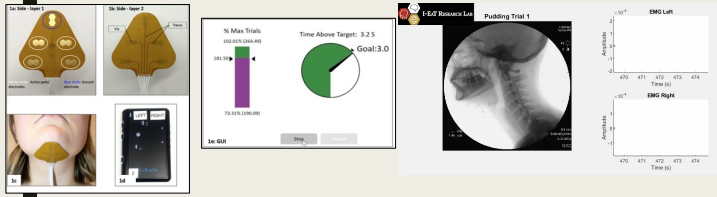
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### Developing new therapeutic tools

Reliable swallowing therapy from home & better diagnosis

### i-Phagia System





US Patent: 12,114,982; 1 more patent and copyright pending

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### NEW NIH-funded Biofeedback Clinical Trial with i-Phagia



- 12-week treatment protocol
- Indianapolis site as well
- Recruiting patients with PD or stroke



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### Summary points

- Healthy swallowing is essential for healthy aging and vice versa
- Swallowing difficulties prevalent in aging
- Proactive vs reactive approaches [emerging research]
- I-EaT lab at the forefront of this research

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**I-EaT Research Lab**



Lab website: [www.purdue.edu/i-eatlab](http://www.purdue.edu/i-eatlab)  
I-EaT Lab: [swallowinglab@purdue.edu](mailto:swallowinglab@purdue.edu)  
Georgia A. Malandraki: [malandraki@purdue.edu](mailto:malandraki@purdue.edu)




  
I-EaT Swallowing Laboratory

  
@ieat.lab


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**I-EaT Swallowing Clinic**



<https://www.purdue.edu/i-eatlab/i-eat-clinic/>


- Weekly / Fridays
- Serves adult and pediatric patients
- Director
  - Jaime Bauer Malandraki, MS-CCC-SLP, BCS-S




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**THANK YOU!**



Questions?

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